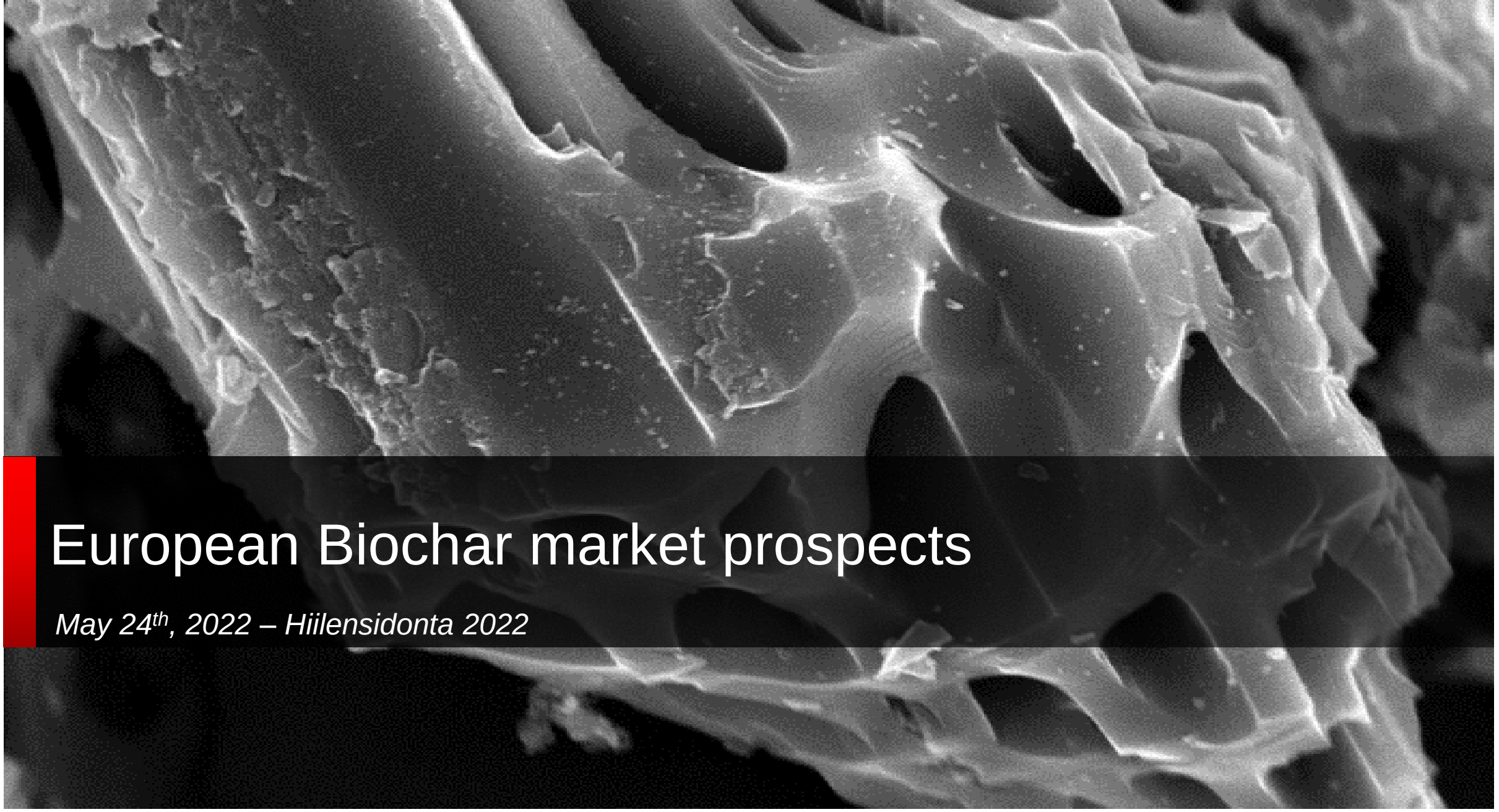
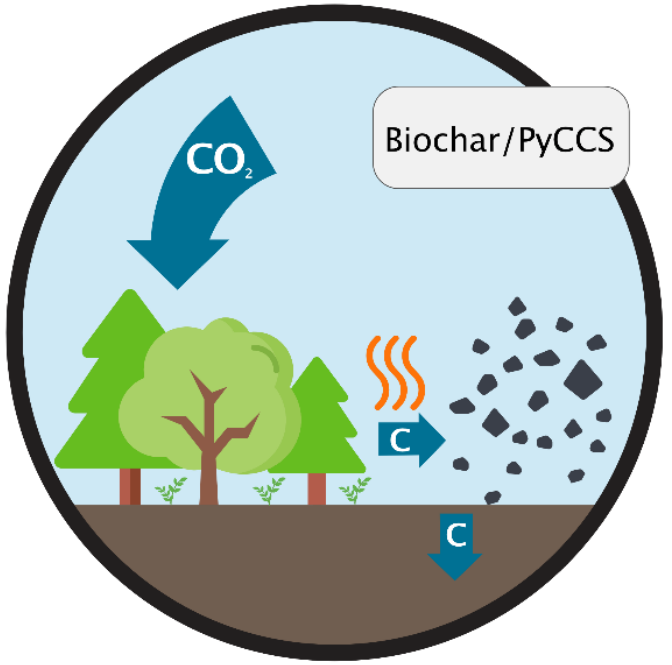


European Biochar market prospects

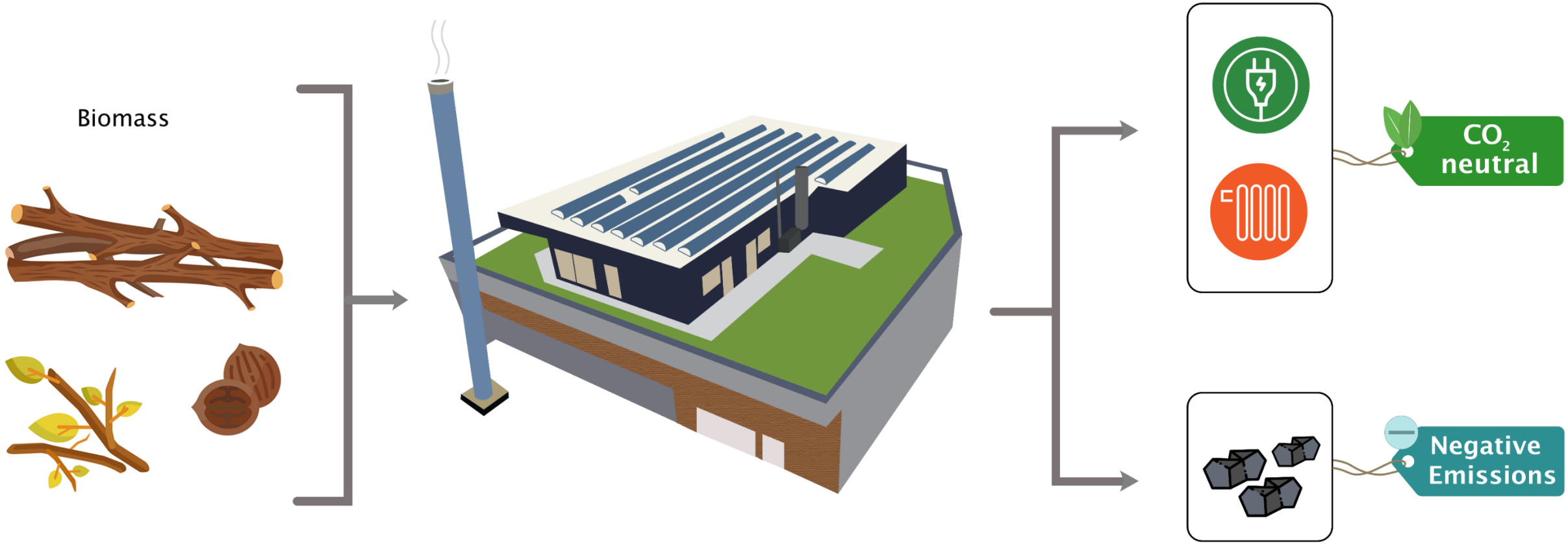
May 24th, 2022 – Hiilensidonta 2022

Biochar & Pyrogenic Carbon Capture and Storage (PyCCS)



PyCCS/Biochar goes hand-in-hand with bioenergy

Up to fourfold value creation: electricity, heat, biochar and negative emissions

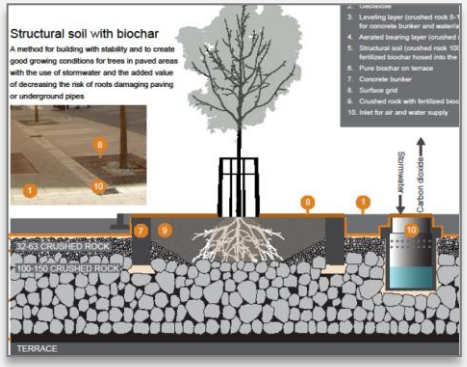


Agenda

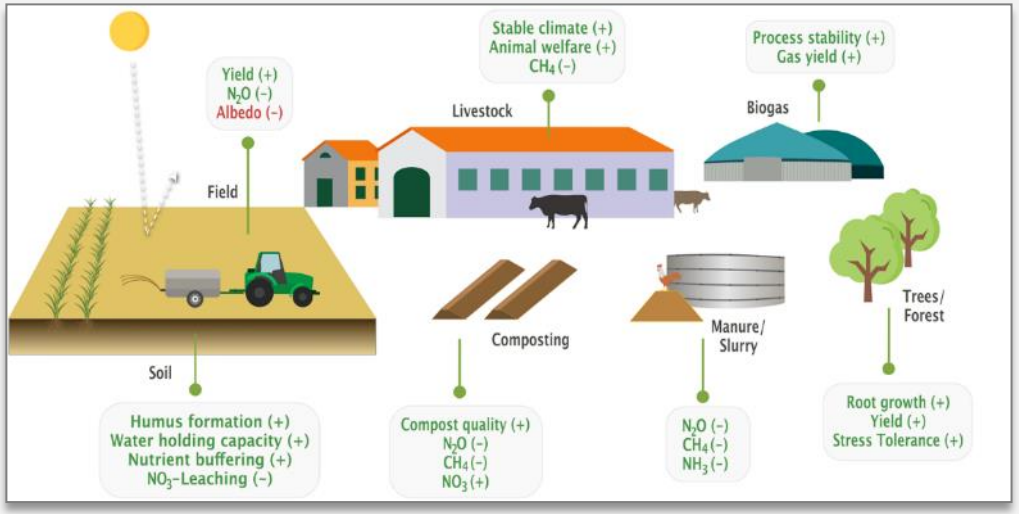
1. Broad range of applications of Biochar
2. Biochar manufacturing equipment & project examples
3. European Biochar Market 2021/2022
4. Biochar/PyCCS – Scaling to climate relevance

Broad range of applications of Biochar

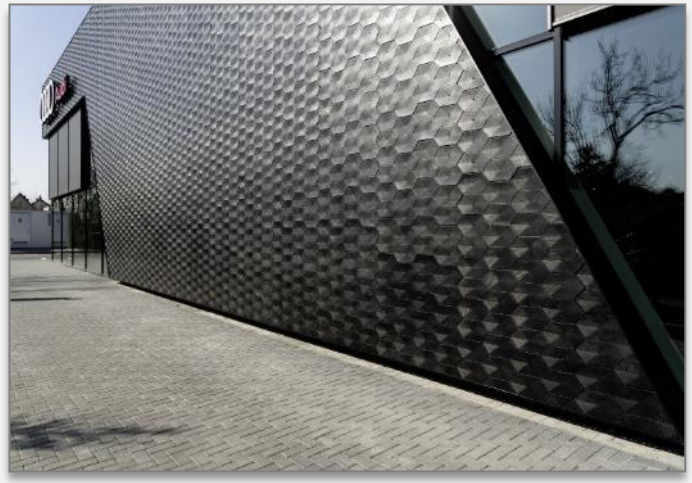
Urban Applications



Agriculture



Construction materials



Results of 26 Biochar meta-analyses (link)

Compelling scientific evidence of benefits from biochar application on agronomic parameters

Received: 22 May 2021 | Revised: 11 August 2021 | Accepte

DOI: 10.1111/gcbb.12889

RESEARCH REVIEW

Biochar in agriculture meta-analyses

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Abstra

Biochar

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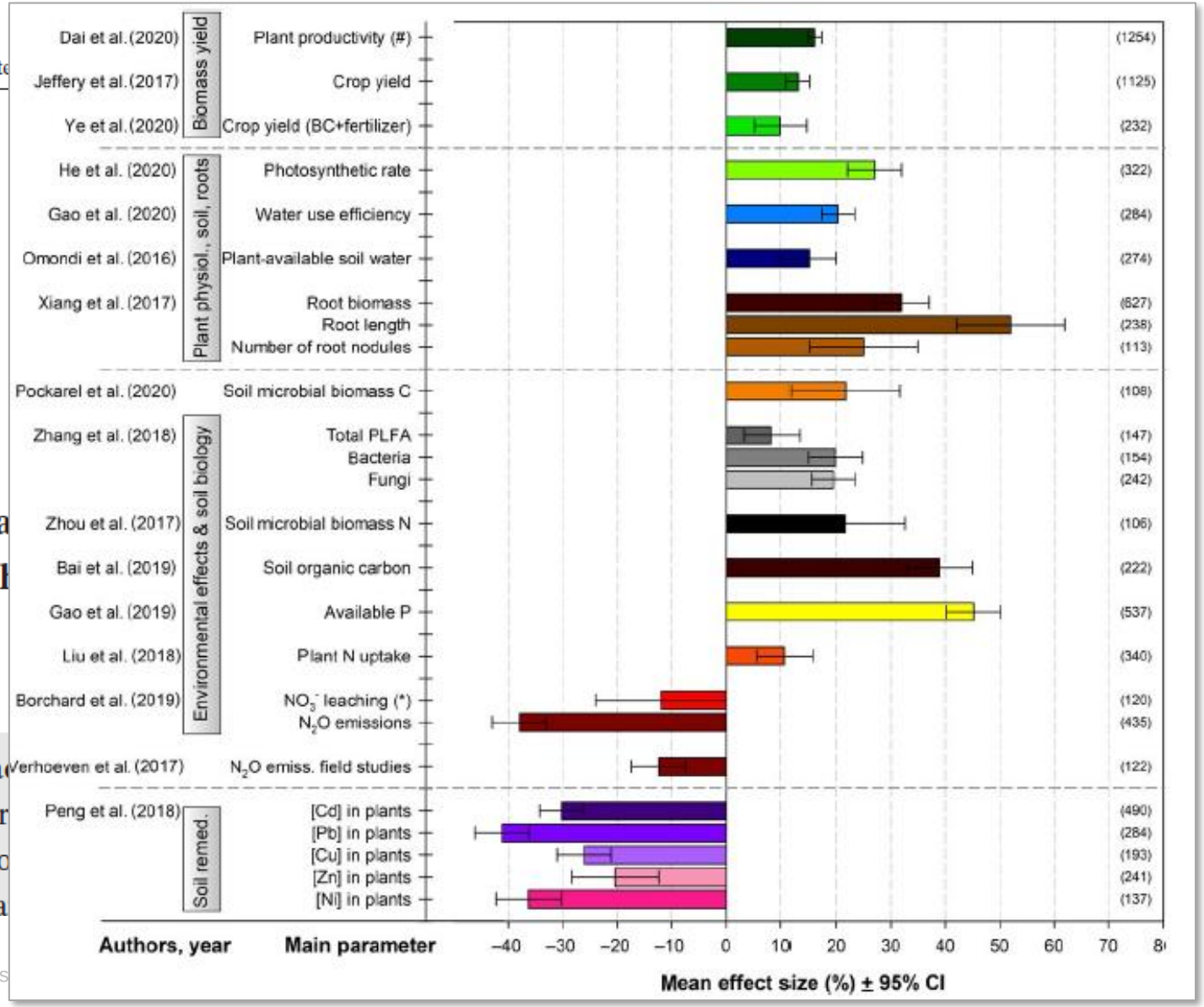
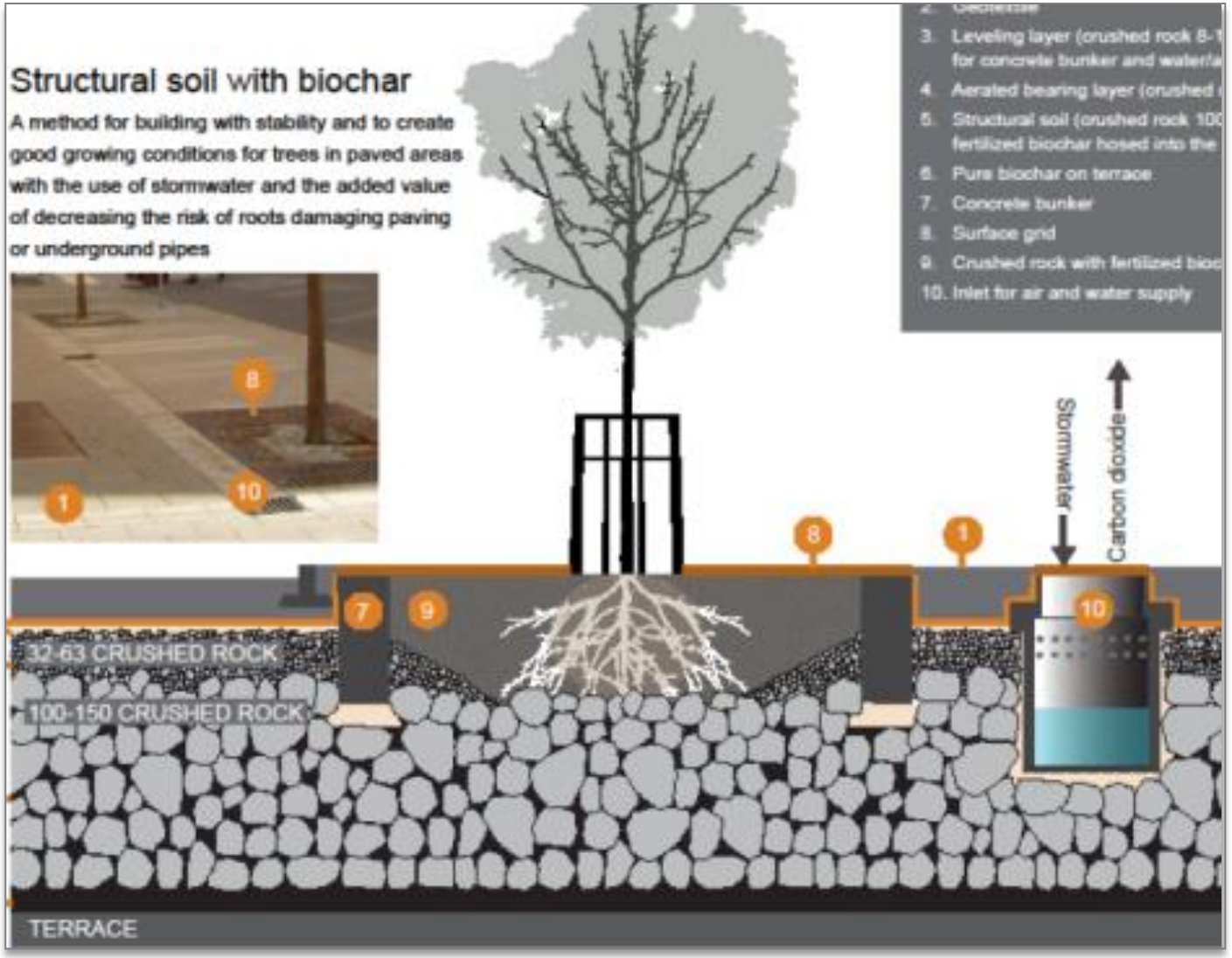


EBI European Biochar Industry

Application of Biochar in urban environments

City trees grow excellent in structural soils with Biochar



Pilot applications of Biochar in construction and materials

Biochar in façade elements acting as engineered carbon sink

made of air

*500 m² of **made of air** Biochar composite facade, >85% atmospheric carbon content*

EBI European Biochar Industry

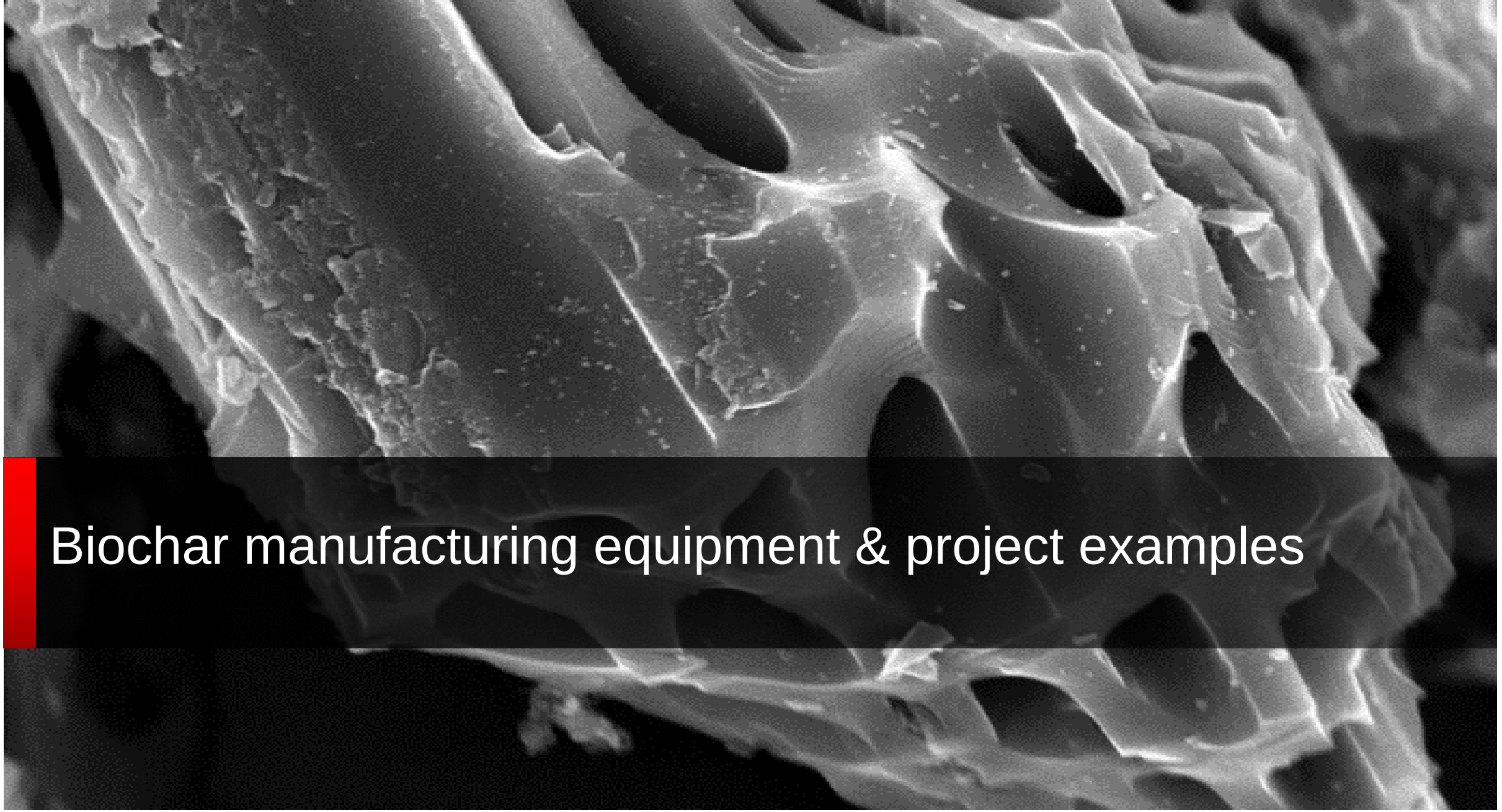
Pilot applications of Biochar in construction and materials

Biochar for production of CO_2-negative concrete construction elements

Members of the Industry Consortium

The EBI membership base is growing constantly

EBI European Biochar Industry

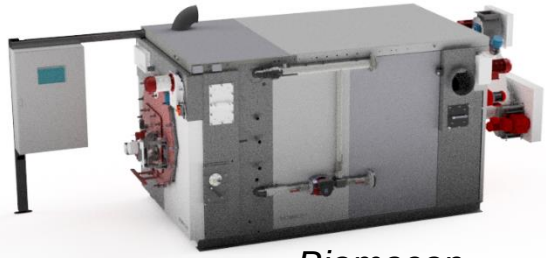


Biochar manufacturing equipment & project examples

Biochar manufacturing equipment

Examples for industrial equipment producing Biochar in EBC quality

SYNCRAFT®
Climate Positive Solutions.



Biomacon

PYREG
NET ZERO TECHNOLOGY

cts | CARBON TECHNIK SCHUSTER

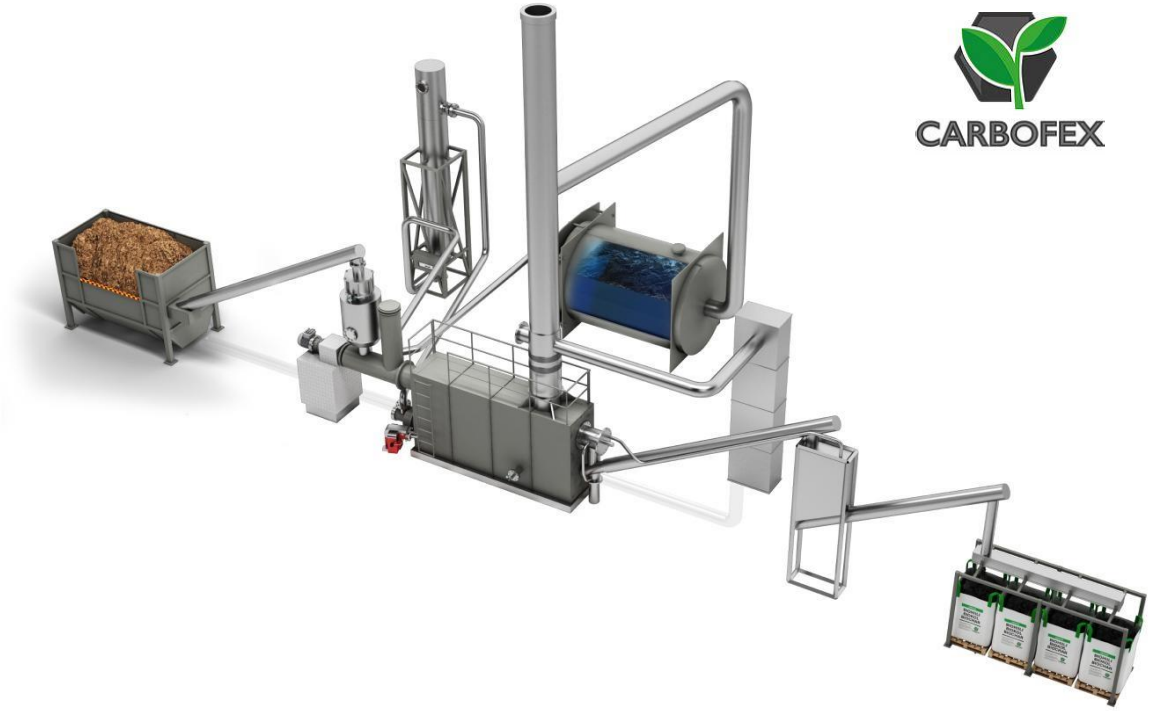
ETIA
ECOTECHNOLOGIES

EBI European Biochar Industry

Biochar manufacturing equipment

Further examples for industrial equipment producing Biochar in EBC quality

CARBONEX



CARBOFEX

EBI European Biochar Industry

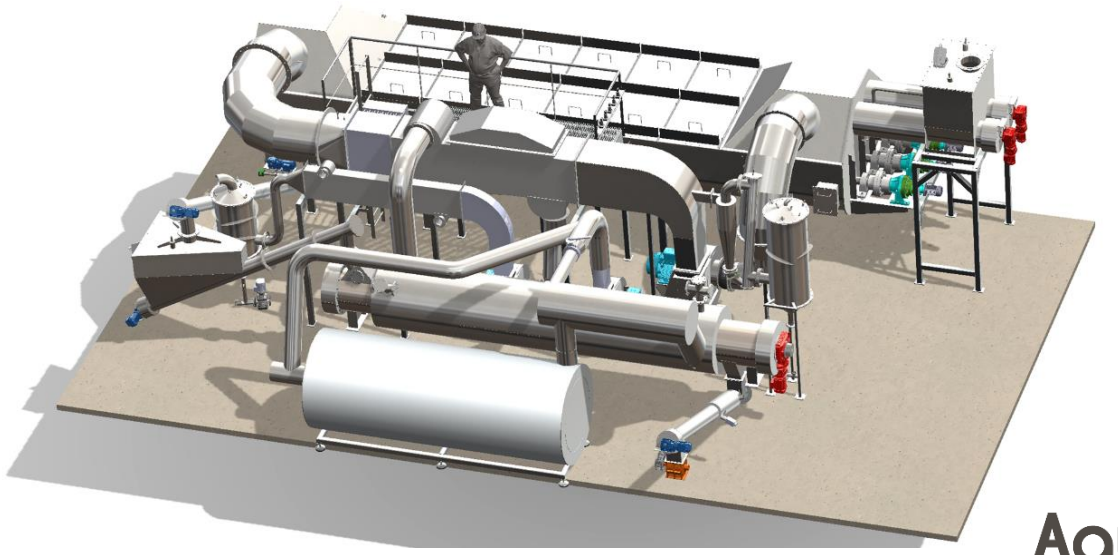
Biochar manufacturing equipment

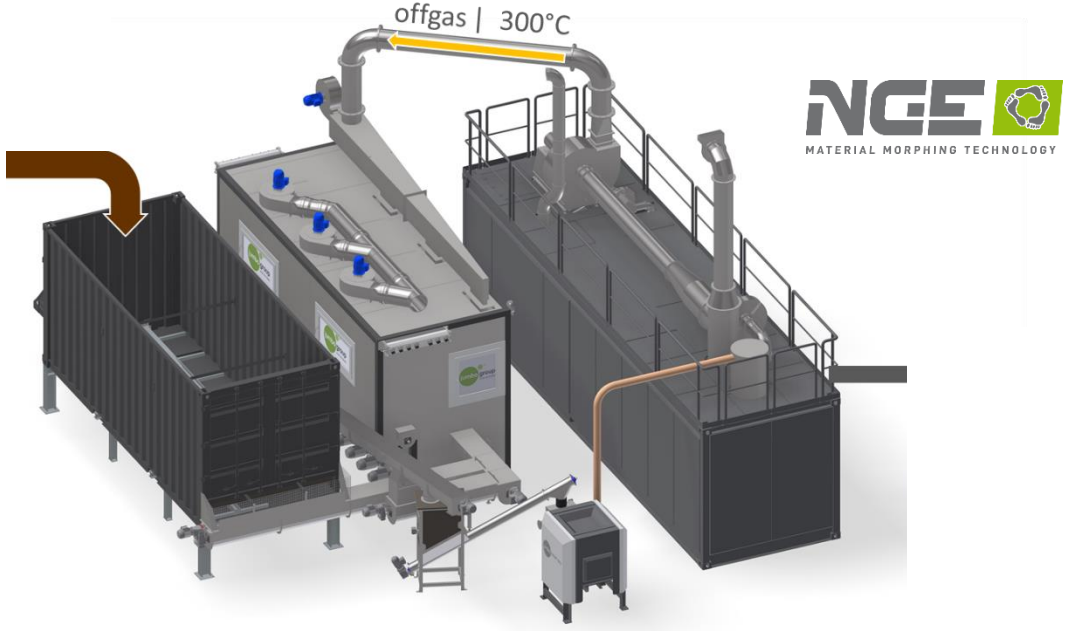
Further examples for industrial equipment

EBI European Biochar Industry

Biochar manufacturing equipment

Examples for industrial equipment with a focus on sewage sludge





AquaGreen

EBI European Biochar Industry

Broad range of biomass suitable for carbonization






IWB Basel

Reference Project (“Large”)

- Customer: **IWB Basel (Switzerland)**
- Equipment: **PYREG PX1500**
- Commissioning: **early 2021**
- Feedstock: **Municipal green waste**
- Energy utilization: **Feeding** up to **750 kW_{th}** into the local **district heating network**
- Biochar production: **700 t/a of Biochar** corresponding to **1.500 t CO_2**

EAD Darmstadt

Reference Project (“Large”)

- Customer: **EAD Darmstadt (Germany)**
- Equipment: **CTS 20,** two carbonization units
- Commissioning: **in process**
- Feedstock: **Municipal green waste**
- Energy utilization: **Feeding** up to **400.000 kWh_{el}** into the electrical grid
- Biochar production: up to **800 t/a**

Circular Carbon

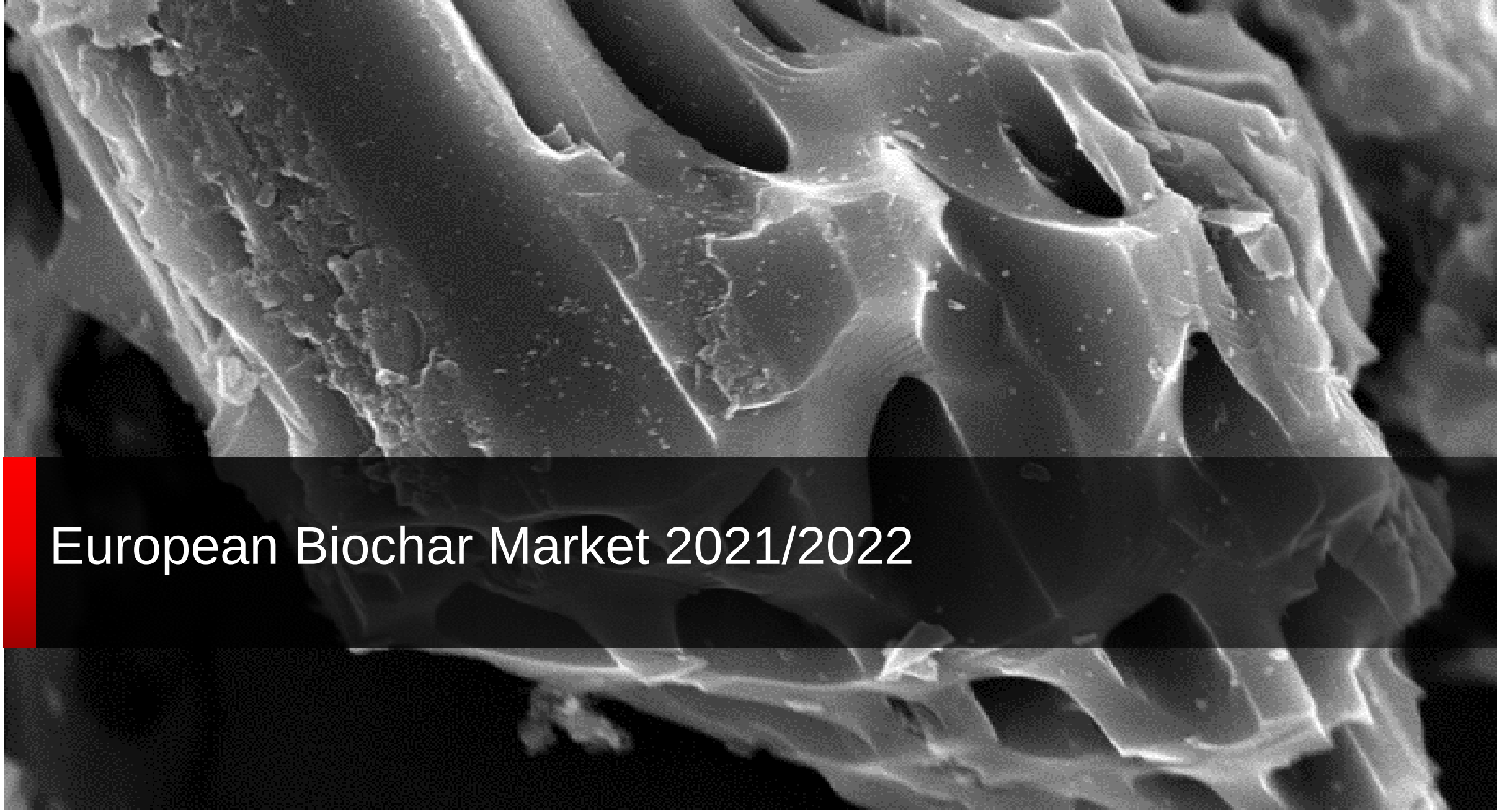
Reference Project (“Very large”)

- Customer: **Circular Carbon GmbH** (GER) (general contractor)
- Equipment: **ETIA/VOW** (carbonisation unit)
- Commissioning: end **2021**
- Feedstock: **Cocoa shells**
- Energy utilization: up to **2.500 kW_{th}** steam for an industrial company
- Biochar production: up to **3.000 t/a**

Bioenergie Frauenfeld

Reference Project (“Very large”)

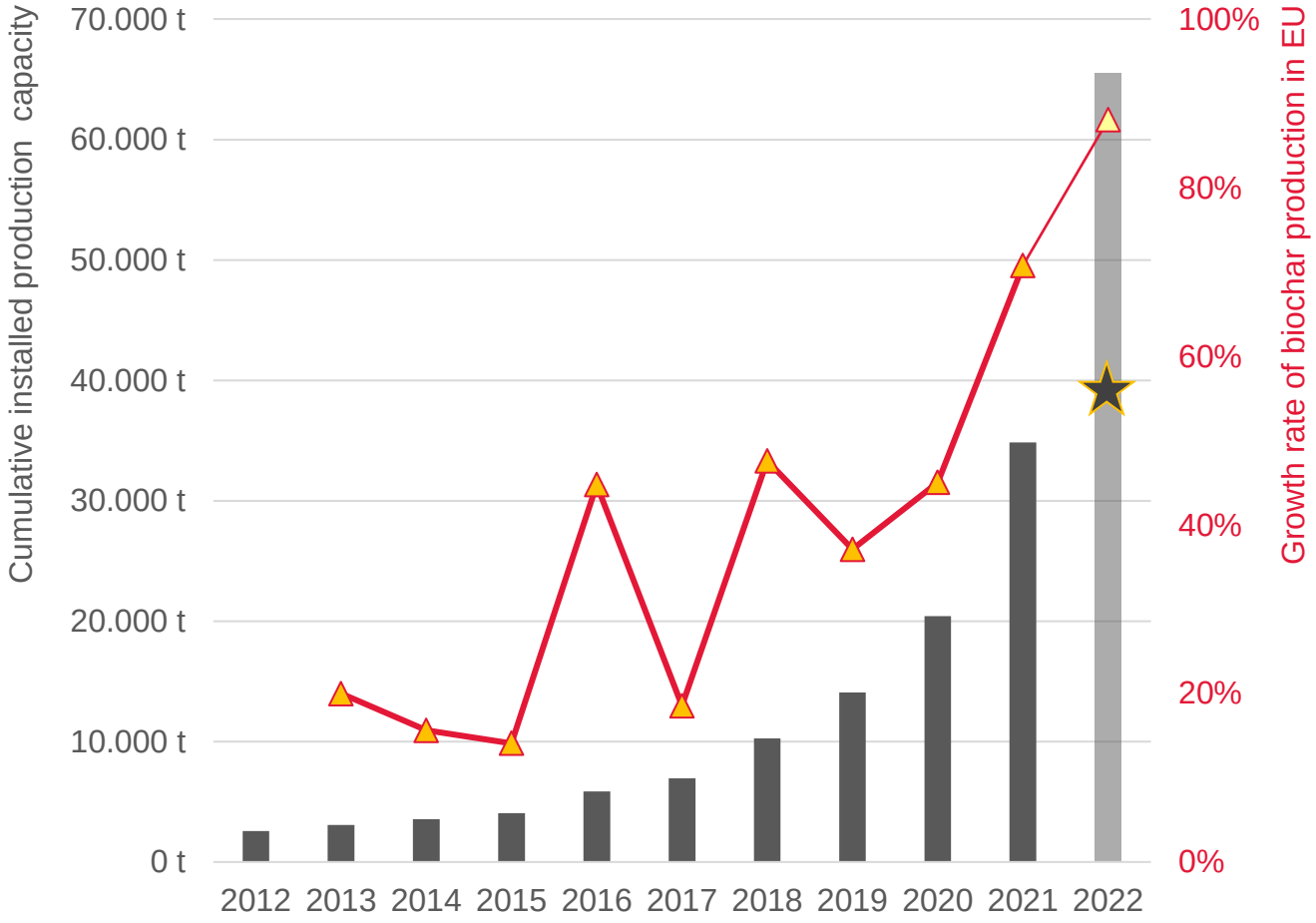
- Customer: **Bioenergie Frauenfeld (CH)**
- Equipment: **4 x SynCraft CW1800x2-1000**
- Commissioning: **in process**
- Feedstock: **Forest residues, wood chips**
- Energy utilization:
  - up to **45 GWh/a renewable heat** for the **local district heating network** and a **sugar factory**
  - **30 GWh/a electricity** (8.000 households)
- Biochar production: **4.000 t/a Biochar**
  up to **12.000 t CO_{2e}**



European Biochar Market 2021/2022

Biochar market growth and growth rates

Cumulative Biochar production capacity and actual Biochar production in Europe



- By the **end of 2021**, the **production capacity** for Biochar was **35,000 t**
- The market is **growing rapidly**
  - **Production capacity** doubled every 1-2 years, by the **end of 2022** production capacity will be around **65,000 t**
  - **Production** of Biochar in 2022 will be **40,000 t**, which corresponds to about **100,000 t CO2e**
  - Thus, Biochar/PyCCS is by far the most important industrial NET today

www.biochar-industry.com/market-overview/ © EBI 2022

The European Biochar Certificate (EBC)

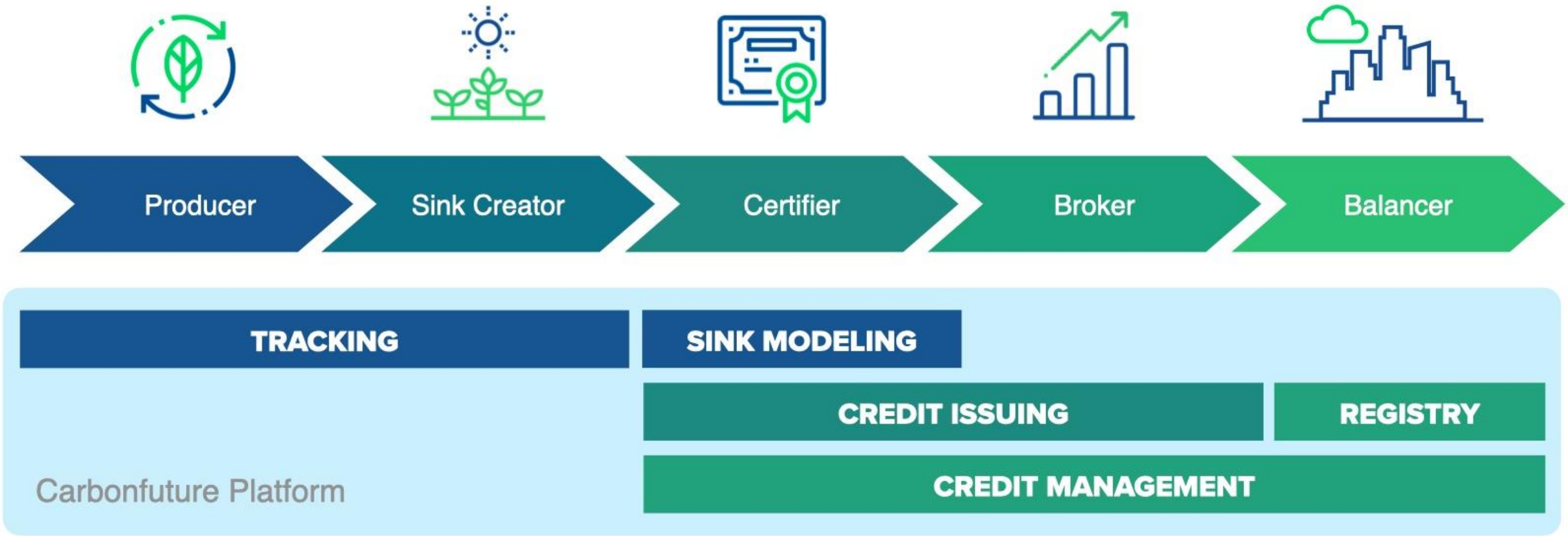
Standards and regulations are key for large-scale roll-out

https://www.european-biochar.org

- EBC Classes
  - EBC-Agro, EBC-AgroOrganic
  - EBC-Feed
  - EBC-ConsumerMaterials, EBC-BasicMaterials
  - EBC-Urban
  - **EBC-Sink (since 2020)**
- Production
  - Permitted feedstock
  - Energy efficient production
  - Calculation of carbon sink potential
- Characteristics
  - C-content
  - H/C, O/C
  - pH
  - heavy metals
  - PAH

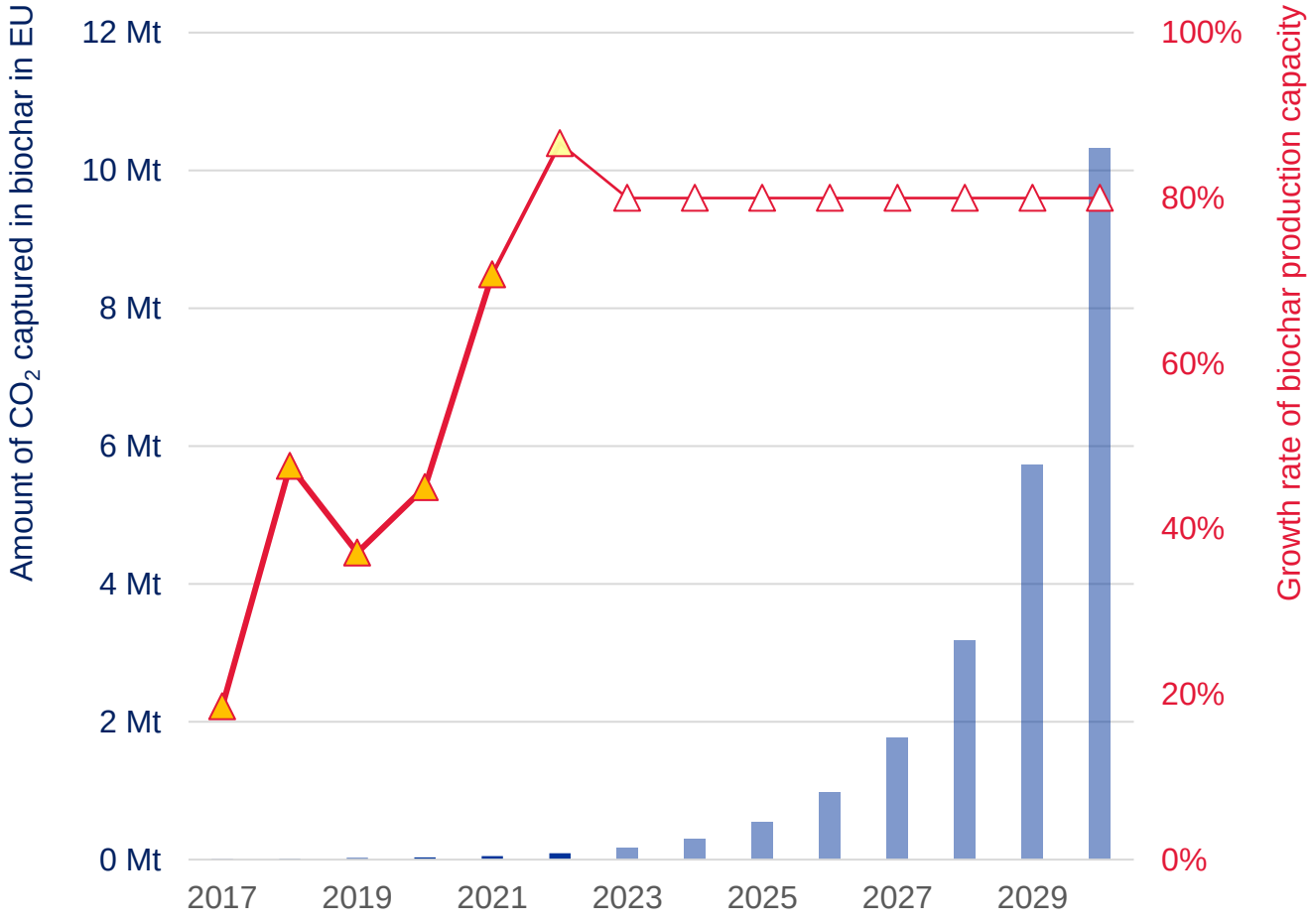
Carbon removal Value Chain

Carbon credits for C-Sinks: Key driver for further market growth



10 megaton of carbon removal by 2030

Extrapolation of the current growth rates



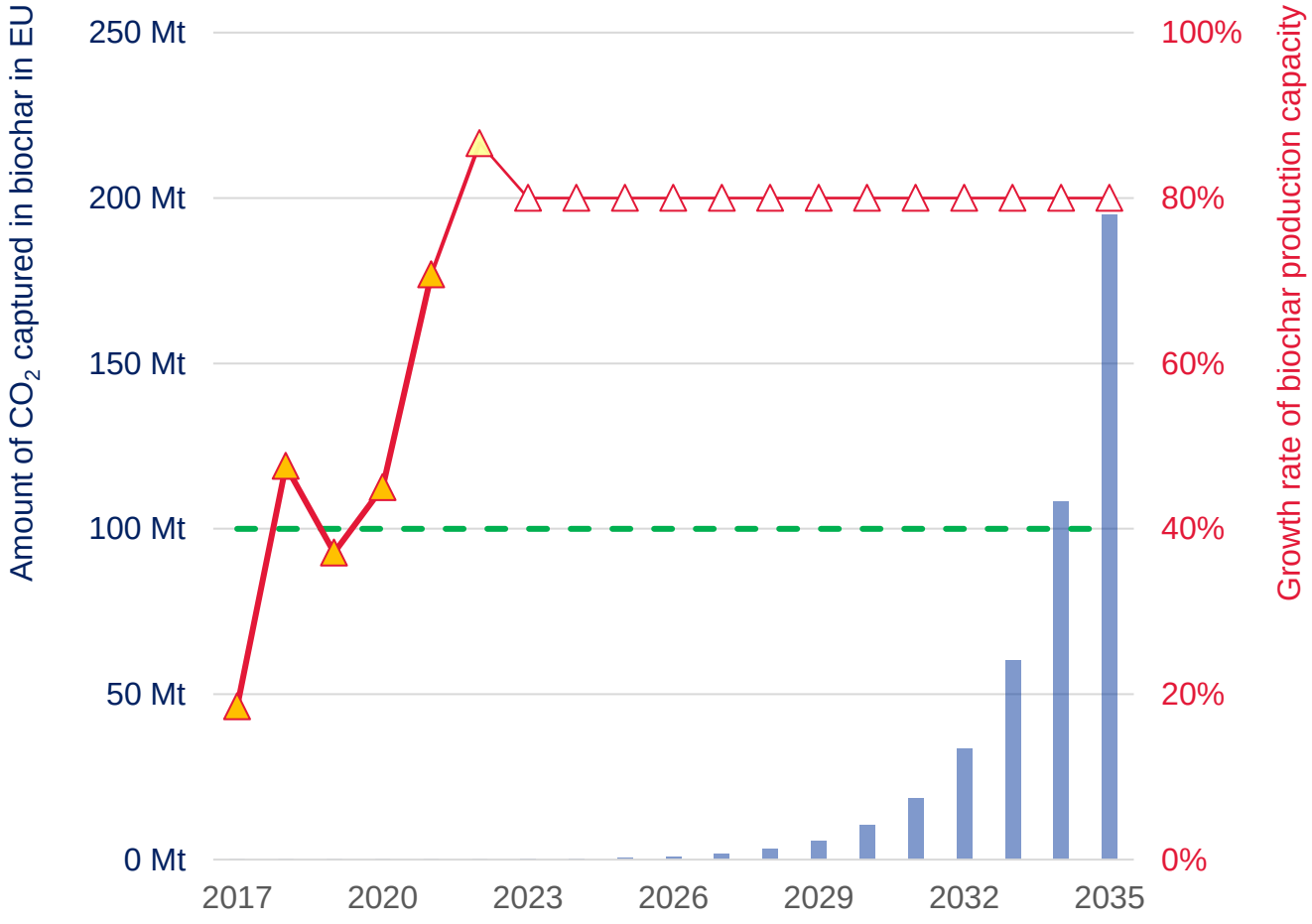
- There is **no reasons why growth** rates of **80% could not be maintained** until 2030
- With that, PyCCS will sequester just over **10 megatons by 2030** in Europe (*2x of the Commission's current target for all industrial sinks*)

www.biochar-industry.com/market-overview/ © EBI 2022

EBI European Biochar Industry

100 megaton of carbon removal by 2034

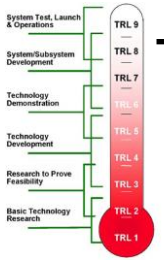
Extrapolation of the current growth rates



- … and there is even **no reasons why growth** rates of **80% could not be maintained even beyond 2030**
- With that PyCCS will sequester just over **100 megatons by 2034** in Europe
- Under this growth scenario, we will exceed the **EBI target of 255 Mt** in **2036**; from then on, growth will have to slow down, as the limited availability of biomass will not allow for further exponential growth

www.biochar-industry.com/market-overview/ © EBI 2022

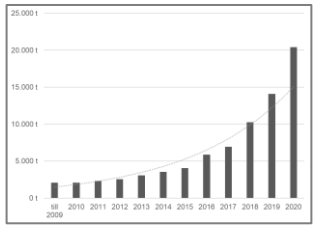
Summary



TRL8

- Biochar production **technology is mature** with at least ten serious EU technology providers, from which at least five are at **TRL8+** levels

- With EBC there is an established certification system for Biochar in place and **EBC-Sink** is a mature and trusted methodology for **CO_2 accounting and certification**



- The **market is growing fast** and **production** in **2022** will be almost **40.000 t** (equivalent to **100.000 t CO_2**)

- Among the industrial **NET** solutions, **Biochar/PyCCS** is easiest to **scale** to significant volumes in the **near term**

Biochar/PyCCS
will likely
continue to dominate NETs
in terms of volume
for at least a decade

Hansjörg Lerchenmüller
in a discussion with DG-CLIMA, February 2022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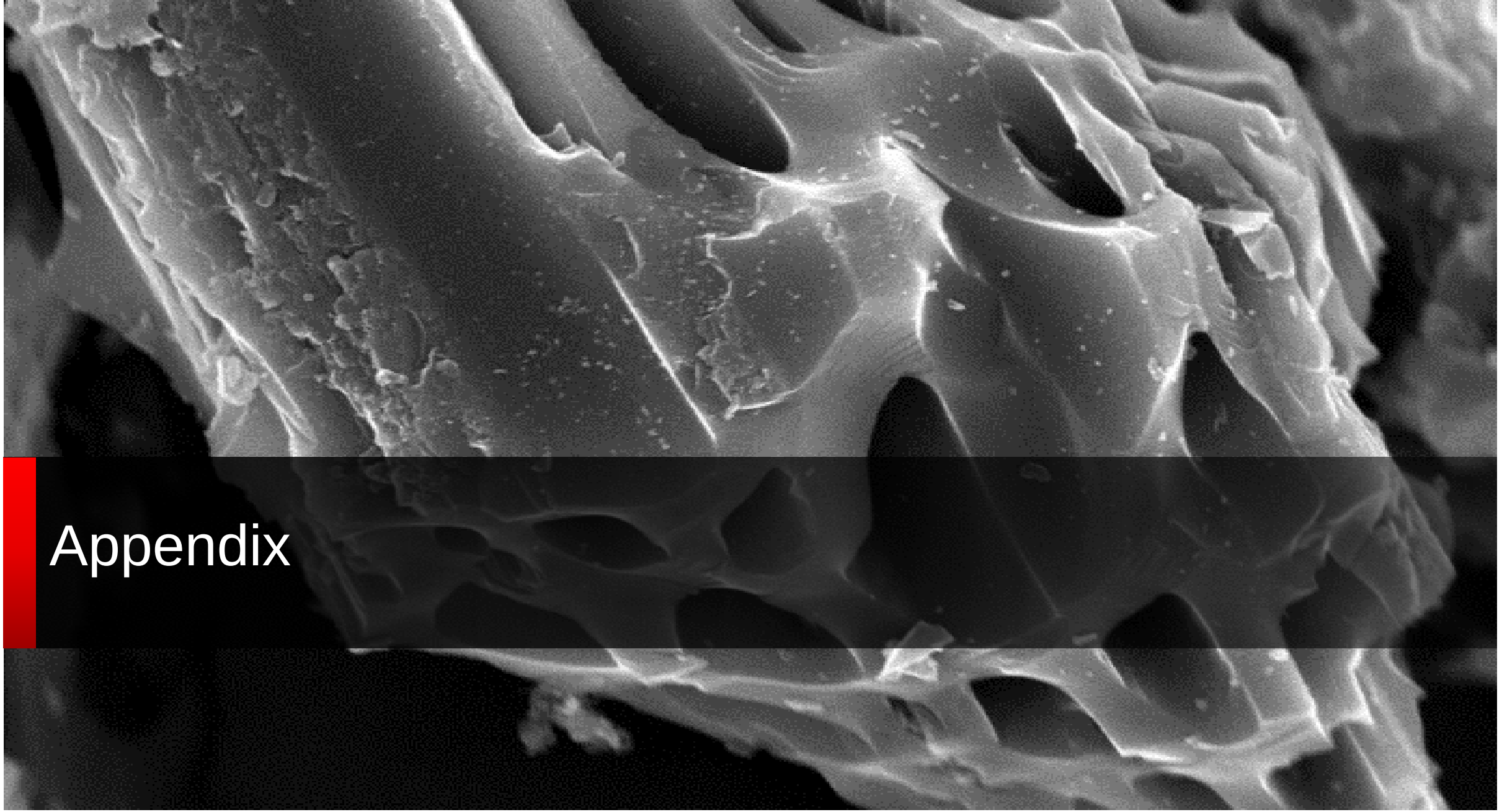
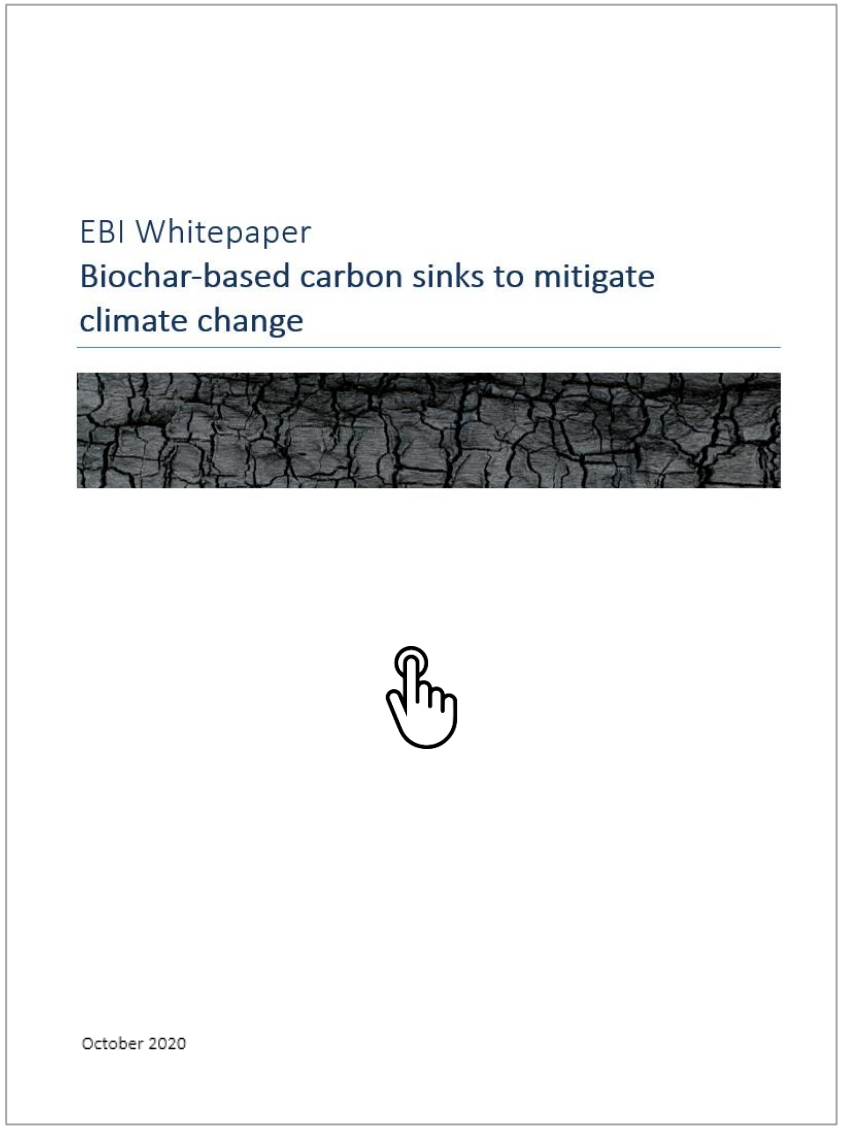
Biochar
Industry



Appendix

White Paper on Biochar



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Hansjörg Lerchenmüller
Business Angel & Advisor

- Environmental entrepreneur
- Multiple Entrepreneur
- founder/CEO of a high-tech company (solar energy)
- 25 years of experience in the commercialisation of new technologies

- Hansjörg Lerchenmüller is Chairman of the European Biochar Industry Consortium e.V.
- Investor and supervisory board at Carbuna AG, a leading producer of biochar-based products for agriculture
- Co-Founder and investor in carbonfuture GmbH, operator of a transaction platform for carbon sinks

Twelve good reasons for using biochar

The arguments can be scientifically well substantiated by current literature

#	Twelve good reasons for using biochar	Sources/Documents
1	Biomass pyrolysis is a key technology for saving the climate	(Werner et al, 2018; Woolf et al, 2010; Woolf et al, 2016)
2	The use of certified biochar has been proven to meet the highest environmental standards and, when used properly, is safe for soils, ecosystems and users	(EBC, 2020; Lehmann & Joseph, 2015)
3	Pyrolysis can be used to close organic material cycles. This is a prerequisite for the principle of recycling in the bio-economy.	(Woolf et al, 2016)
4	Biochar improves the water retention capacity of soils and, in combination with fertilizers, leads to yield increase and stabilization	(Ye et al, 2020; Razzaghi et al, 2020)
5	Biochar helps to build up humus	(Blanco-Canqui et al, 2020; Weng et al. 2018)
6	Biochar reduces GHG emissions from agriculture	(Borchard et al, 2019; He et al, 2017; Liu et al, 2018)

Twelve good reasons for using biochar

The arguments can be scientifically well substantiated by current literature

#	Twelve good reasons for using biochar	Sources/Documents
7	Biochar reduces nitrate pollution of ground and surface water	(Borchard et al, 2019)
8	Biochar shows multiple benefits in animal husbandry and improves animal health	(Schmidt et al, 2019)
9	Biochar promotes tree growth and increases the stress resistance of urban trees	(Embrén et al, 2016; FLL, 2017)
10	Biochar can be used as an additive in composting to improve compost quality and reduce nitrogen losses	(Godlewska et al, 2017; Zhao et al, 2020)
11	Biochar can improve the properties of concrete and asphalt	(Gupta & Kua, 2017)
12	Biochar enables the rehabilitation of contaminated soils	(BMLFUW, 2017)