



EBI

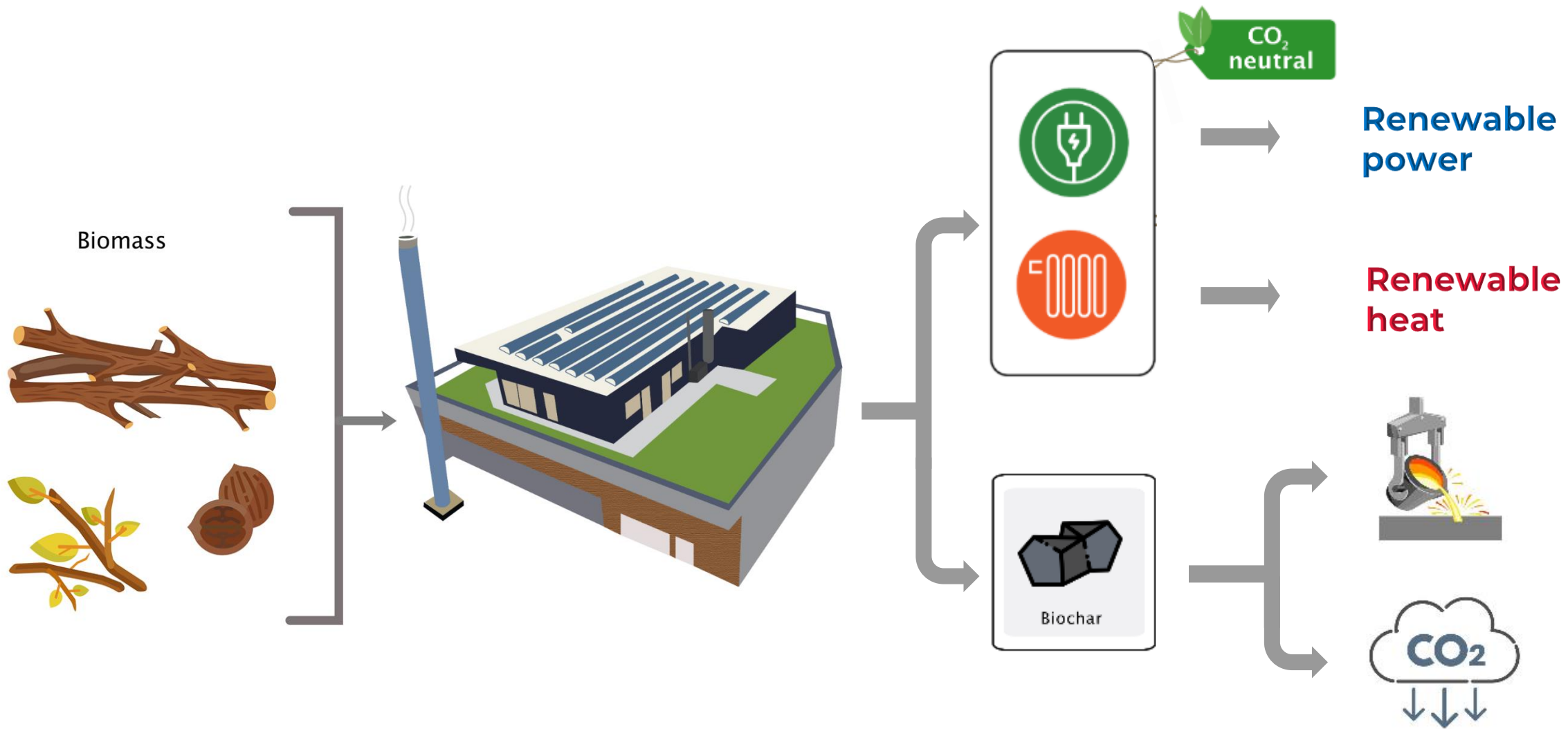
European
Biochar
Industry

Recent developments in the biochar market

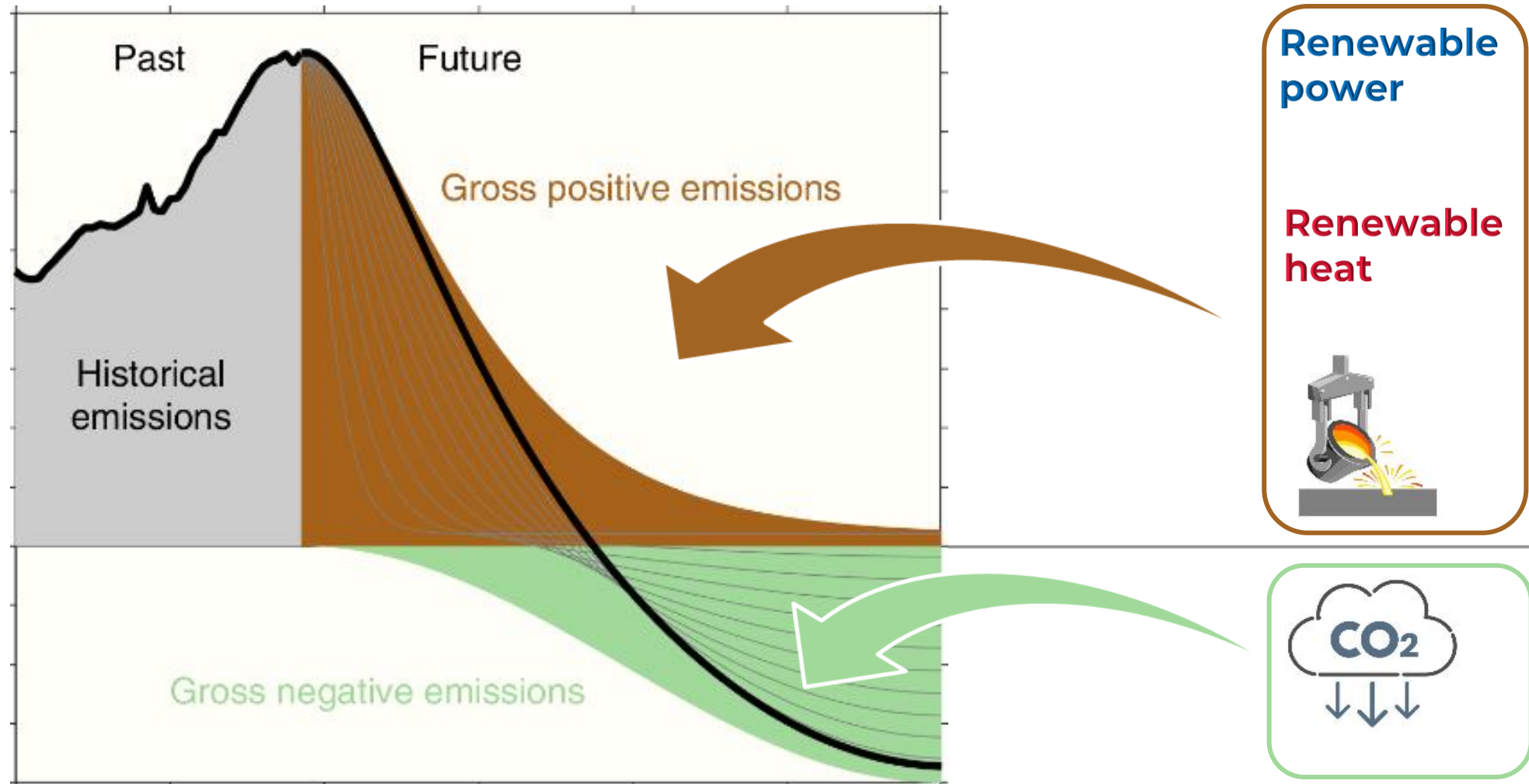
*April 2024
Hansjörg Lerchenmüller*



Use of biomass for **emission reduction** and **carbon removal**



Use of biomass for **emission reduction** and **carbon removal**

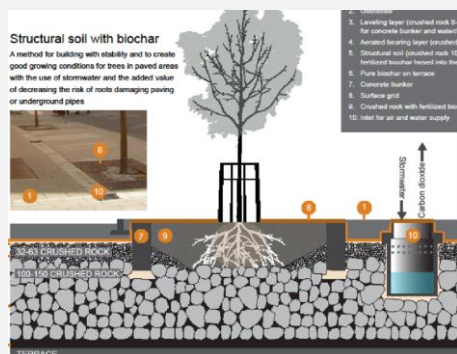


Broad range of biomass suitable for carbonization

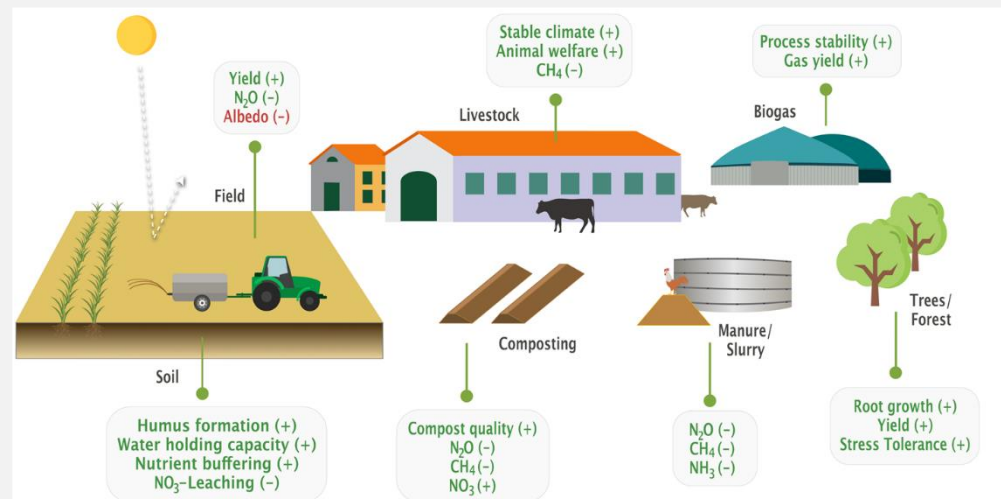


Broad range of applications of Biochar

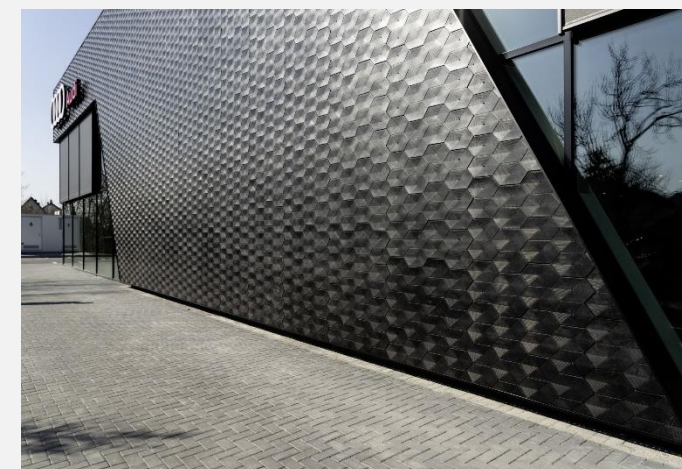
Urban Applications



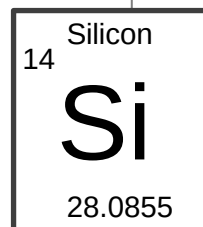
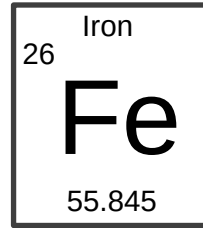
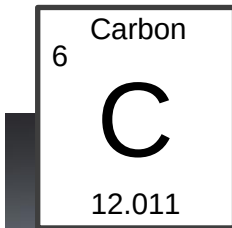
Agriculture



Construction materials



Biochar replacing fossil carbon in the metallurgic industry starts to become important for several biochar producers



CDR credits: Key driver for further market growth

Digital Monitoring Reporting and Verification



Producer



Sink Creator



Certifier



Broker



Balancer

TRACKING



Carbonfuture

Carbonfuture Platform

SINK MODELING

CREDIT ISSUING

REGISTRY

CREDIT MANAGEMENT



**puro
earth**



EU Trilogue on CRCF ended successfully in Feb 2024 – BCR included in industrial permanent carbon removal



- **Carbon Removal Certification Framework (CRCF)** will rule all CDR activities in Europe
- **Biochar** is included in all three removal categories, with the **focus** on **permanent industrial removal**



Report on Permanence of Biochar

Perspectives from two recent publications
and EBI conclusions

Bier, H. & Lerchenmüller, H. (2024)

14. March 2024



Authors of this Report (EBI)

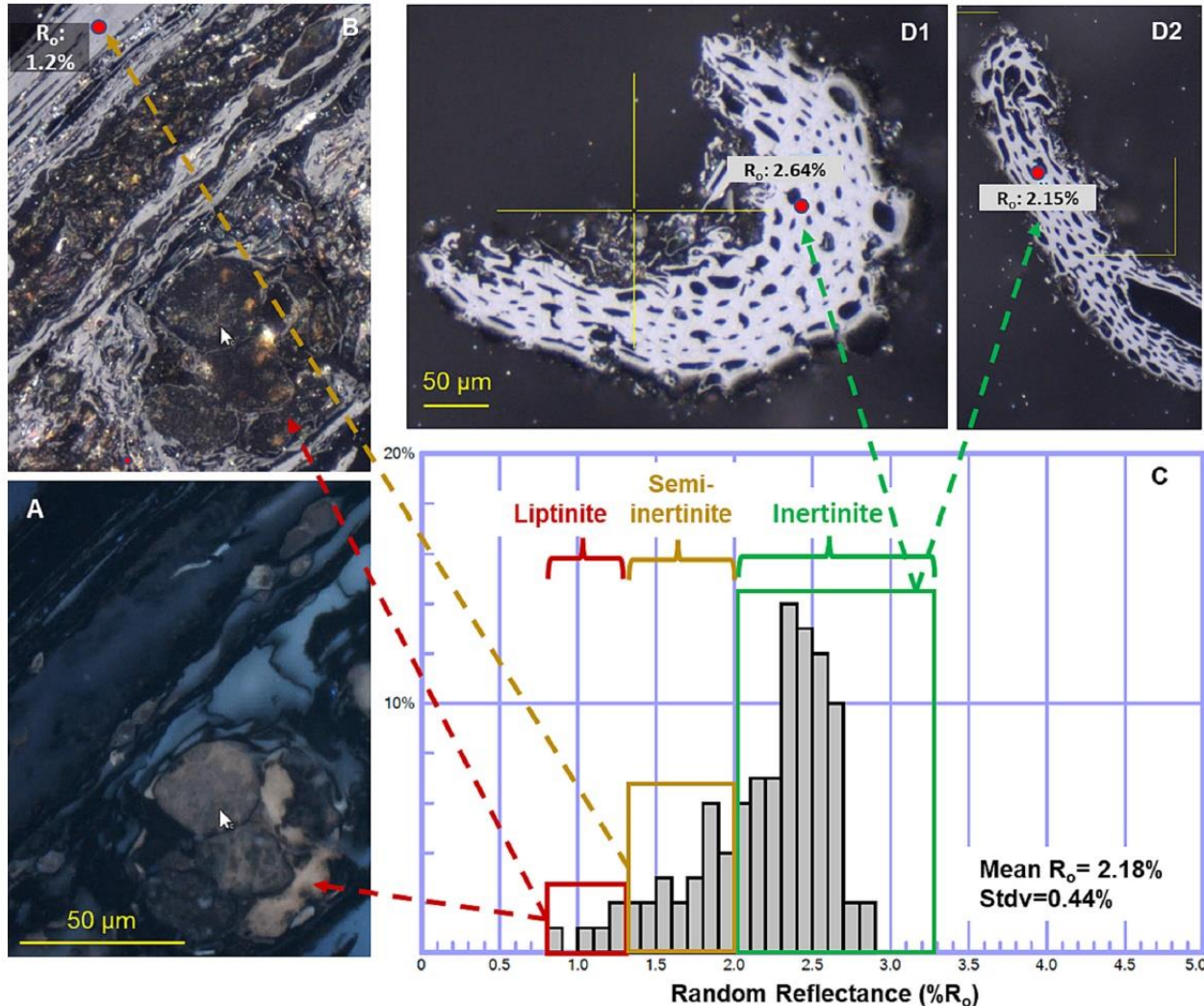
- Harald Bier
- Hansjörg Lerchenmüller

Published: March 2024

Review Board

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Biochar consists of different fractions with fundamentally different chemical properties that can be quantified



- Biochars consist of different material fractions
- Biochar fractions that have been exposed to **high temperatures** are chemically/structurally **equivalent to inertinite**
- **Inertinite** is the **most stable form of organic carbon** and has long been accepted as a **benchmark for permanence** in earth science
- Today's industrial & commercial biochars consist in large parts of **inertinite** (typically >95%)

Inertinite Biochar fractions
will **not relevantly degrade**
in soils within
climate-relevant periods

(in any case beyond 1,000 years,
realistically well beyond 10,000 years)

Outline

1

BCR's role in
Net Zero
pathways

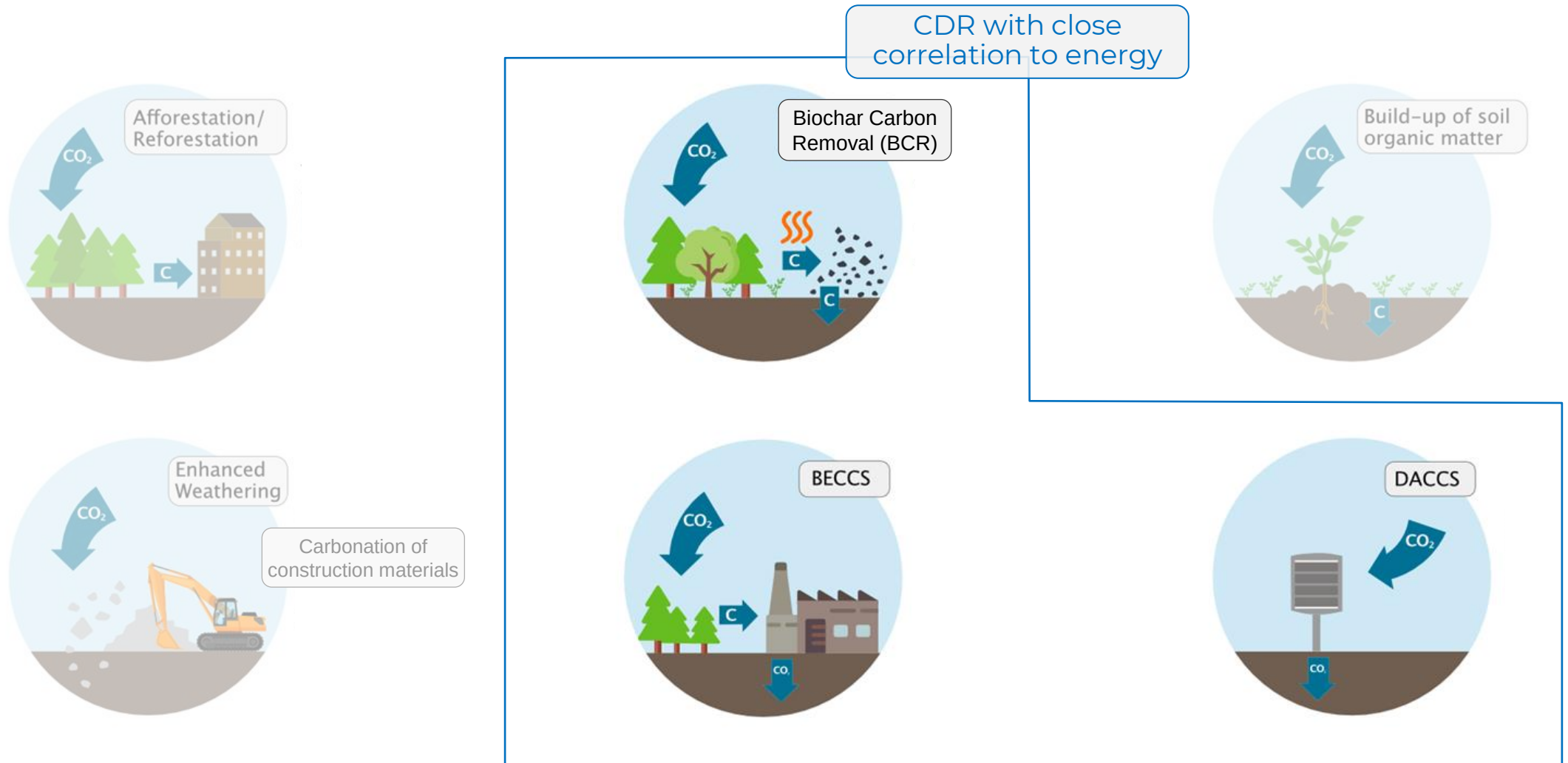
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European
Biochar Market
2023/2024

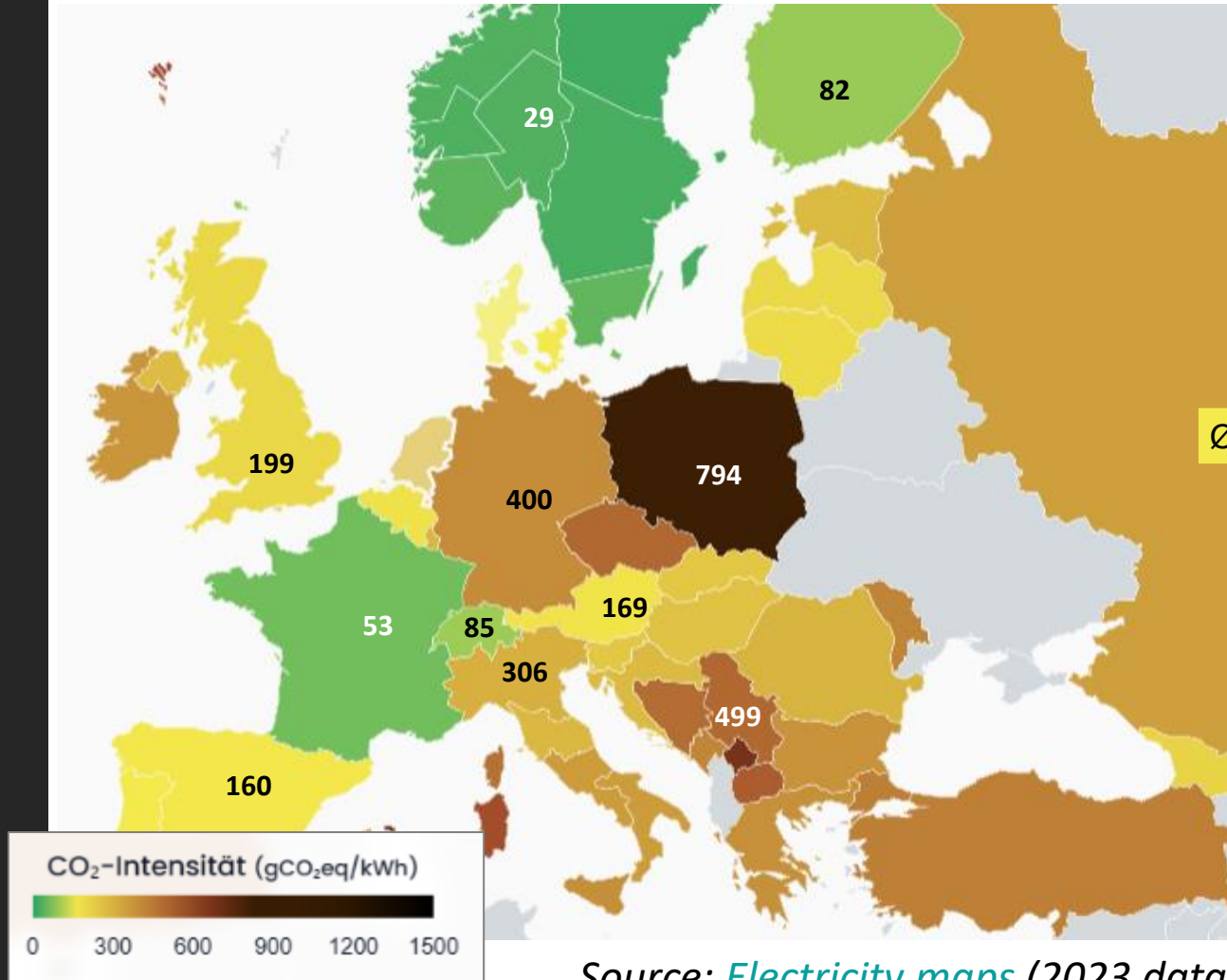
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Scaling BCR
to climate
relevance

Three of the options have an inherent correlation with energy



CO₂ footprints of energy generation are important to find sensible net-zero pathways



Ø EU*

Electricity

Heating

225 g/kWh_{el}

200 g/kWh_{th}

EU 2023

110 g/kWh_{el}

150 g/kWh_{th}

EU 2030

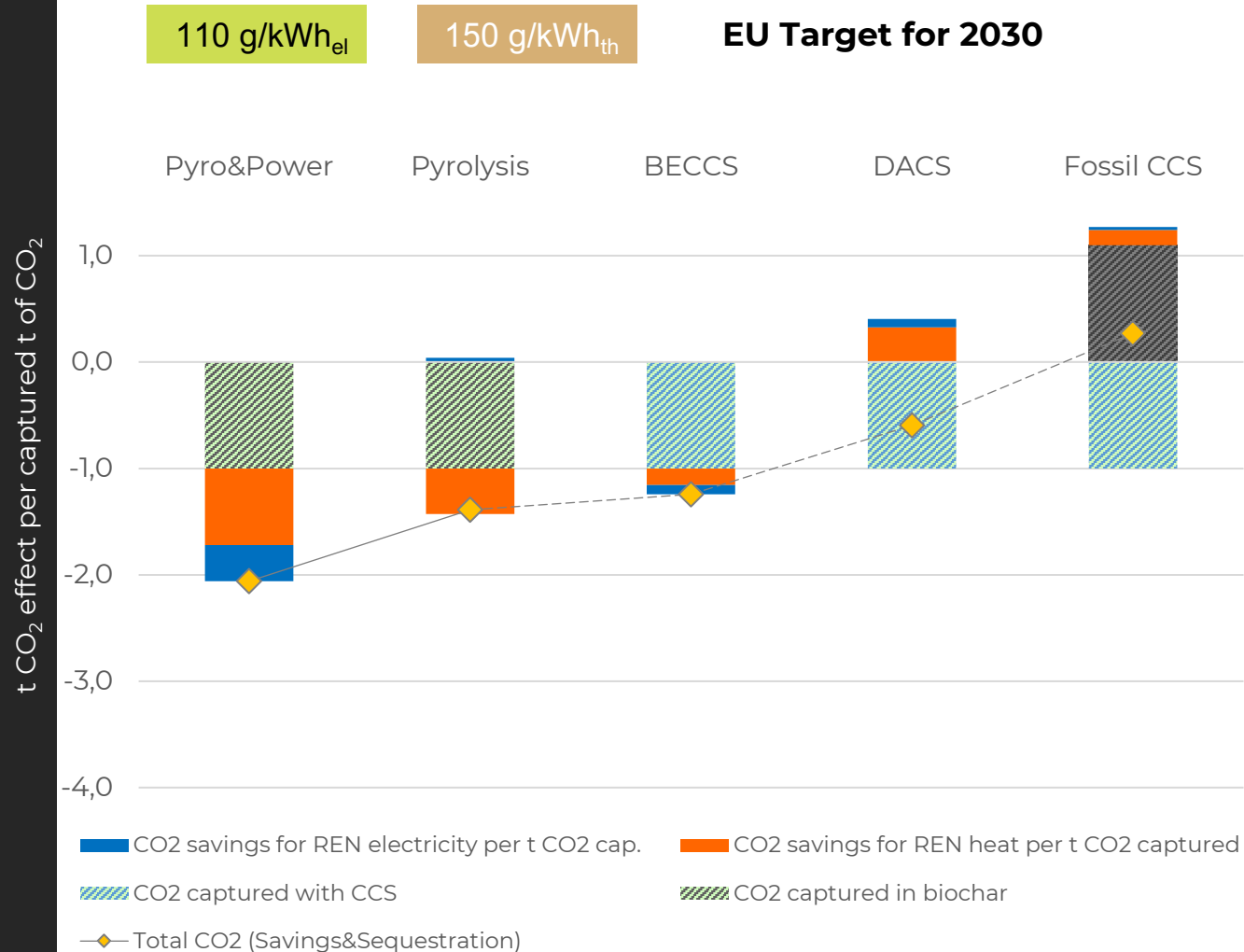
50 g/kWh_{el}

75 g/kWh_{th}

EU 2035/40

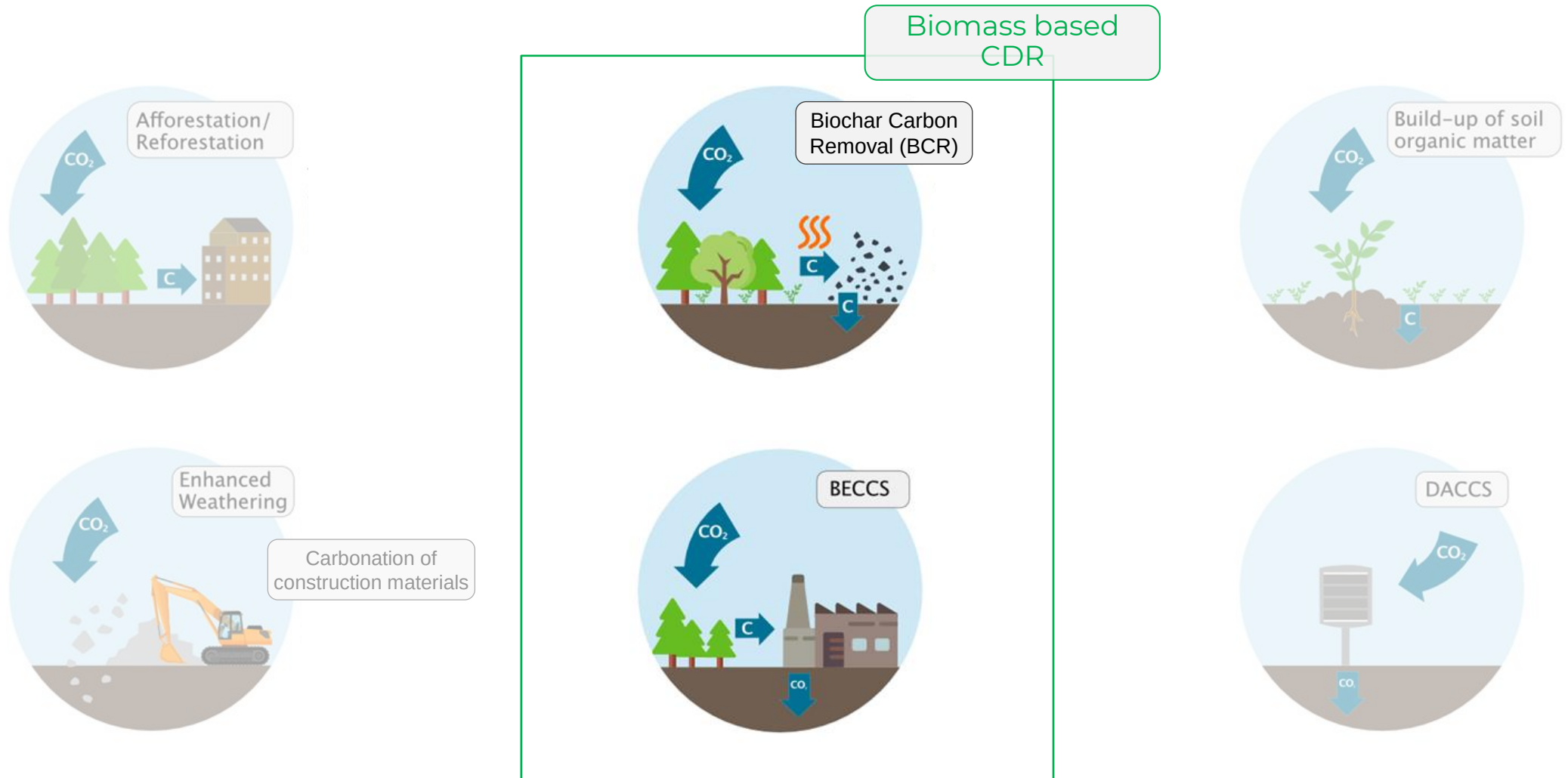
Evolution over time

The net CO₂ effect per captured tonne of CO₂ – a key metric for effective climate impact – is highest for BCR

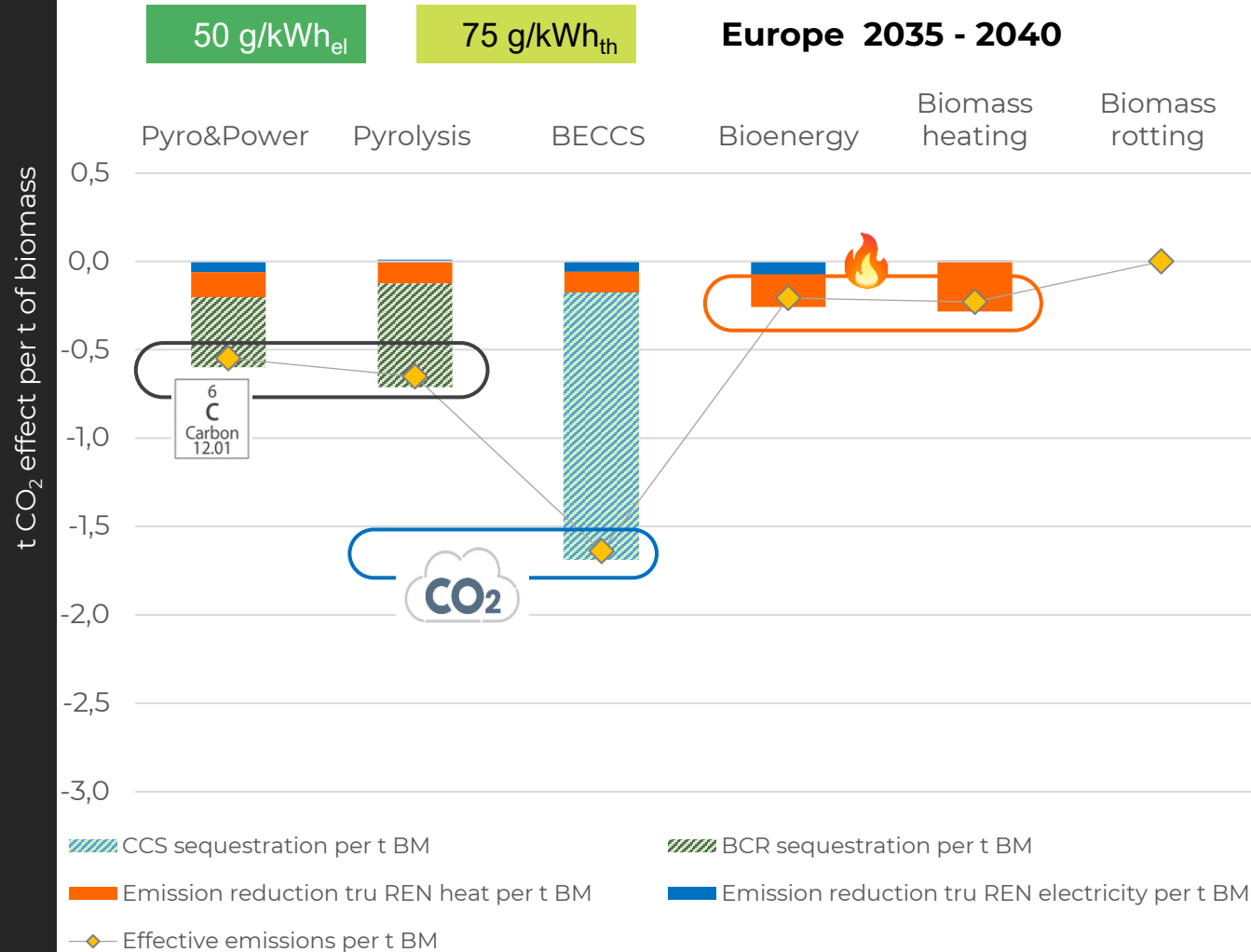


- Further **adding the perspective** of **power provision** or **consumption** with 110 g/kWh_{el} (EU Target for 2030)
- **Regardless** of the progress on **de-fossilization**, **BCR** always has the **highest net CO₂ effect** per **tonne of CO₂ removed**

Two of the permanent options are biomass-based



Another key metric is the net CO₂ effect per tonne of biomass which awards BCR the silver medal, gold medal goes to BECCS



- **BECCS** offers **highest biomass efficiency**, but comes with significant infrastructure challenges, including CO₂ logistics and heat utilization for large installations
- **BCR** shows higher net CO₂ effects than bioenergy solutions and is a good option when **infrastructure requirement** and/or **economics** are difficult/prohibitive for BECCS
- **Combination of BCR & CCS** is comparable to BECCS (first projects will start construction in 2024)



BCR is a **no-regret solution** on the
net-zero pathway,
it contributes both to **carbon**
removal and to **emission reduction**





European Biochar

Market Report 2023 | 2024

March 2024



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Carbonfuture

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Published: March 2024

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- Equipment Manufactures & Plant Operators
- EBI Policy Working Group

Broad variety of technology providers

30 technology providers, many of them at TRL8 or even TRL9



Exemplary pyrolysis equipment providers

There are over 30 technology providers on the market in Europe, with some having installed dozens of systems

For further info see the European Biochar Market Report 2023/2024



Equipment manufacturers

Examples for industrial equipment in Finland



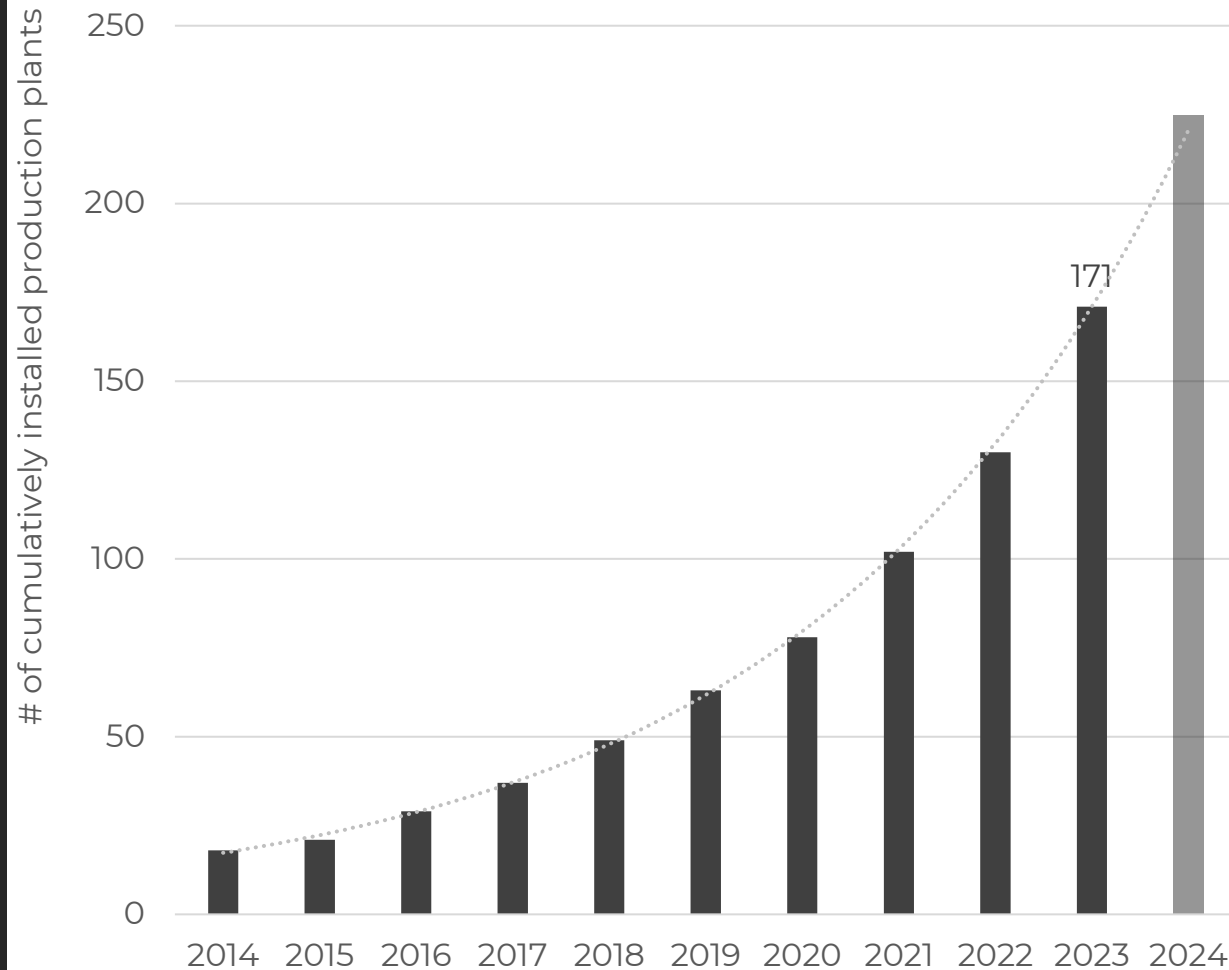
Beyond plants that are operated by equipment manufacturers themselves there are several other biochar production plants in Finland

EBI has three further members in Finland



Biochar market growth

Cumulative number of Biochar production plants in Europe

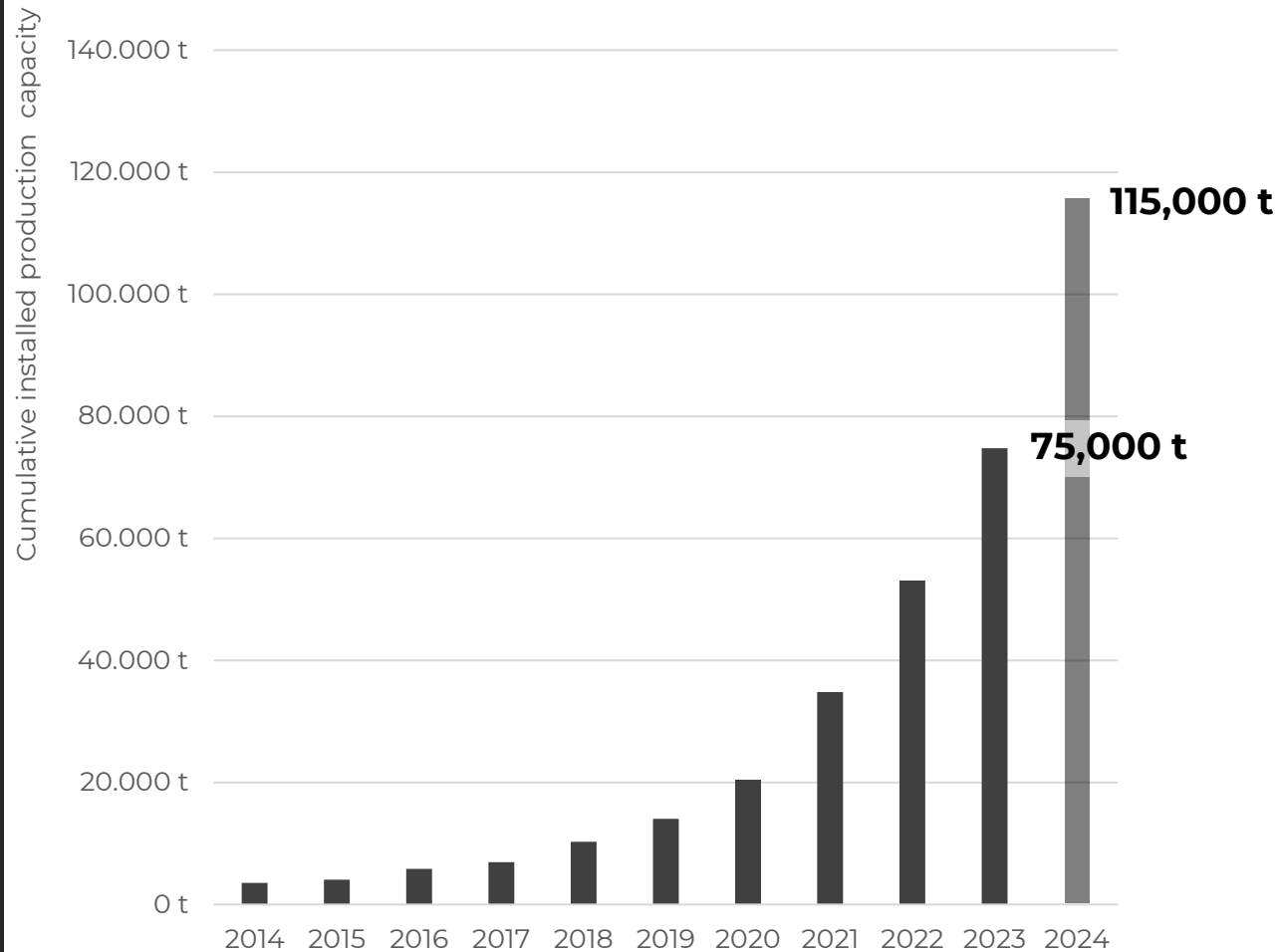


www.biochar-industry.com/market-overview/ © EBI 2024

- By end of **2023**, the **cumulative number** of operational production plants in Europe has **grown to 171 installations**
- Until the end of **2024**, the **cumulative number** of production plants in Europe is **expected to grow to over 220 installations**
- Many **further projects** are in **advanced planning and/or** in the **permitting process** for commissioning in **2025** *(almost 40 projects with >35,000 t production capacity)*

Biochar market growth and growth rates

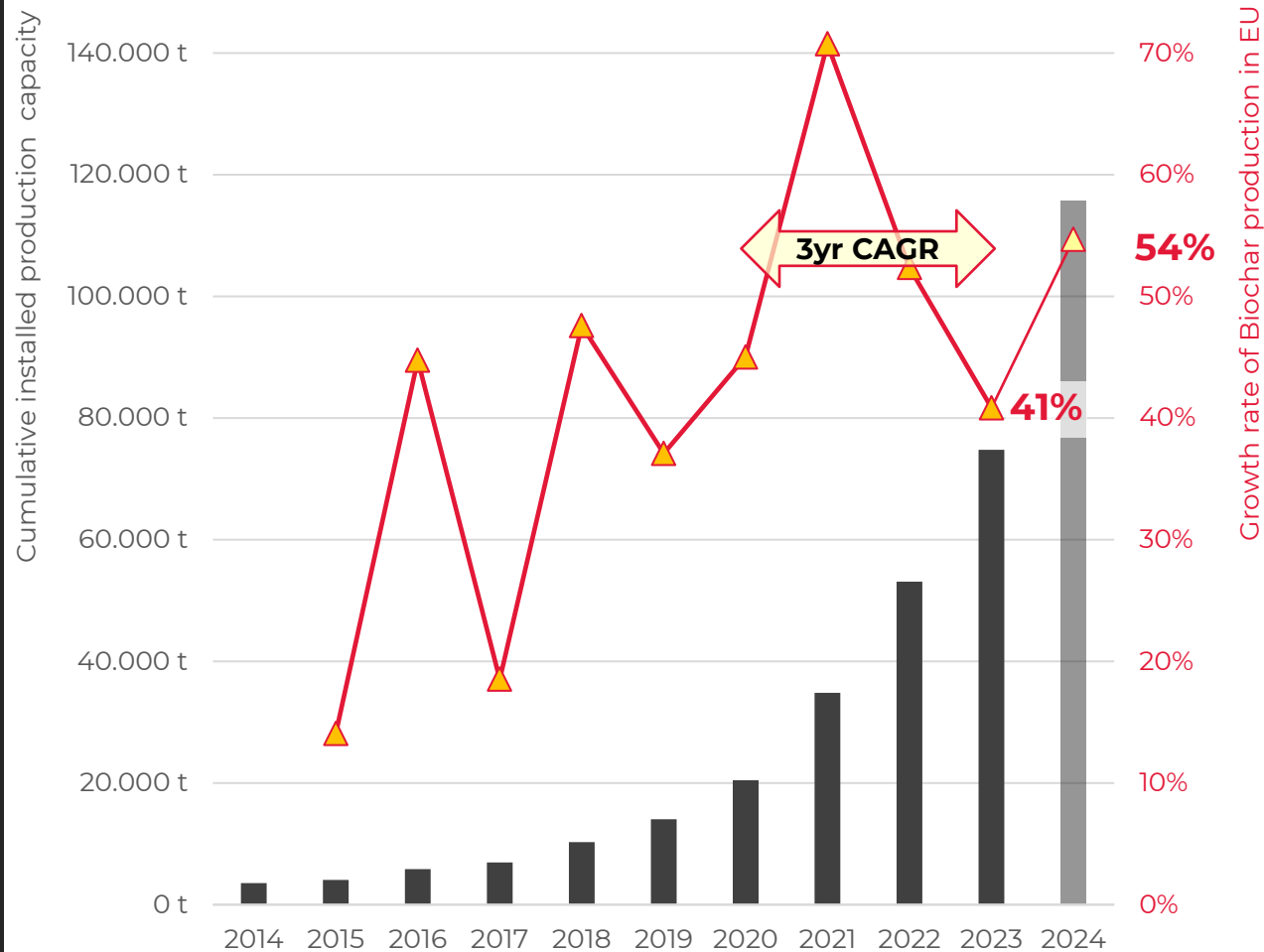
Cumulative Biochar production capacity in Europe



- Biochar production capacity continues to show **strong growth**. In 2023 it **grew to 75,000 t** Biochar
- For 2024 we expect **the production capacity** to **grow to 115,000 t**

Biochar market growth and growth rates

Cumulative Biochar production capacity in Europe



- From **2022 to 2023** the **production capacity** grew by **41%**
- **3y CAGR** was **54%** (2020 - 2023)
- Based on **project pipeline for 2024** **growth rate** is expected to be at **55%**

For further info see the European Biochar Market Report 2023/2024



www.biochar-industry.com/market-overview/ © EBI 2024

“
**BCR is today's
most relevant industrial
CDR technology
for permanent carbon removal**”

NSR Helsingborg

Reference Project ("Large")



Sweden

VOW



- Customer: **Nordvästra Skånes Renhållnings AB (NSR)**
- Equipment: **Vow ASA BGR750**
- Commissioning: **2023**
- Feedstock: **Municipal green waste**
- Surplus energy use: **feeding** up to **1,500 kW_{th}** into for the local **district heating network**
- Biochar production: **1,200 t/yr of Biochar** corresponding to **3,300 t CO_{2e}**



Follum Industrial Pilot

Reference Project ("Large")



- Customer: **Vow Green Metals**
- Equipment: **Vow ASA BGR750**
- Commissioning: **2023**
- Feedstock: **Demolition wood**
- Surplus energy use: **feeding** up to **2,000 kW_{th}** into for the local **district heating network**
- Biochar production: **1,500 t/yr of Biochar** mostly supplied to replace fossil coal in the metallurgic industry

Stiesdal SkyClean Vrå

Reference Project ("Industrial")



- Customer: **Agri Energy Vrå**
- Equipment: **Stiesdal SkyClean**
- Commissioning: **in commissioning (03/2024)**
- Feedstock: **biogas digestate**
- Surplus energy use: **7.5 MW_{th} high temperature process heat for biogas upgrade**
- Biochar production: **15,000 t/yr of Biochar** corresponding to **31,000 t CO₂**

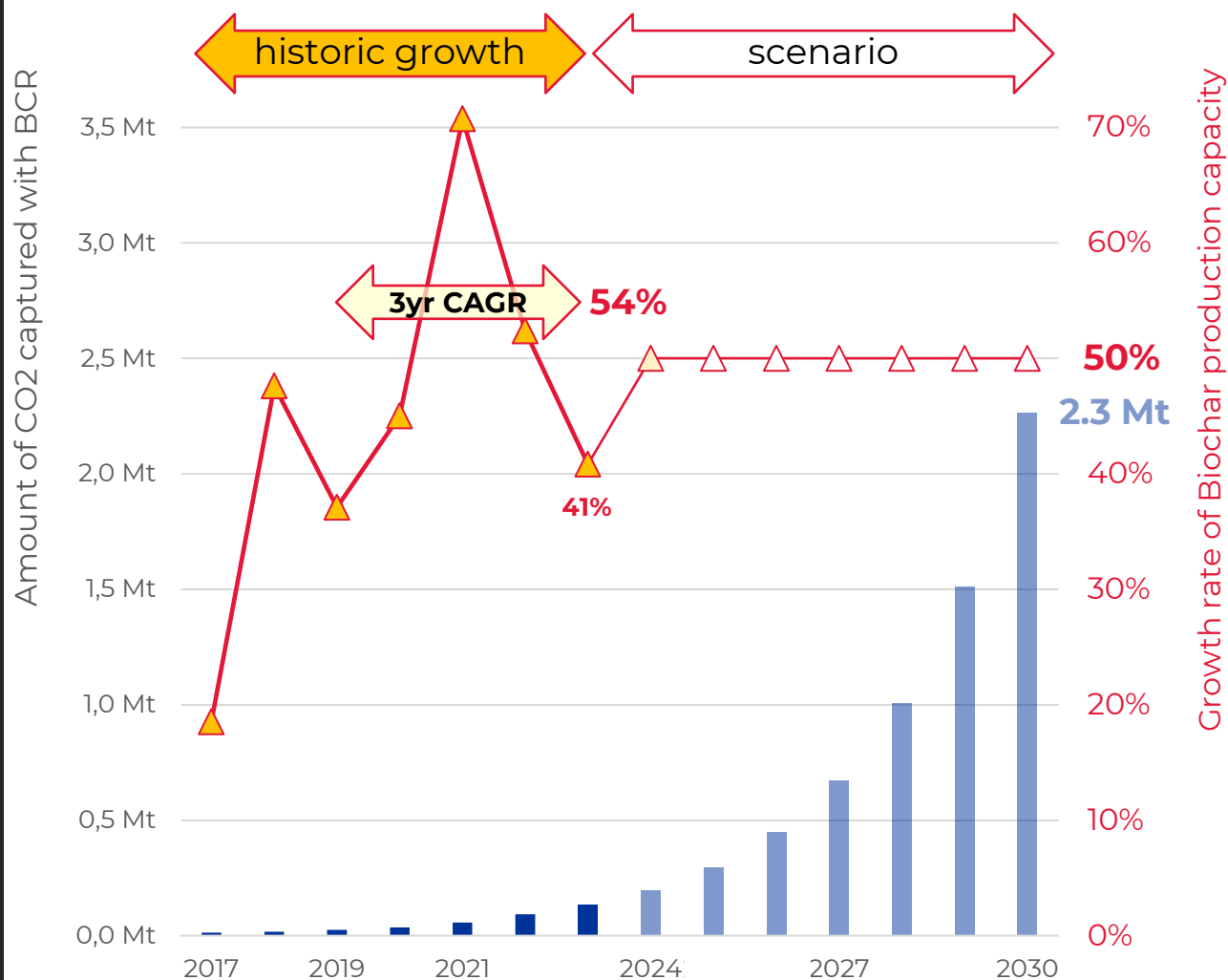
For further Reference Projects see
the European Biochar Market Report 2023/2024



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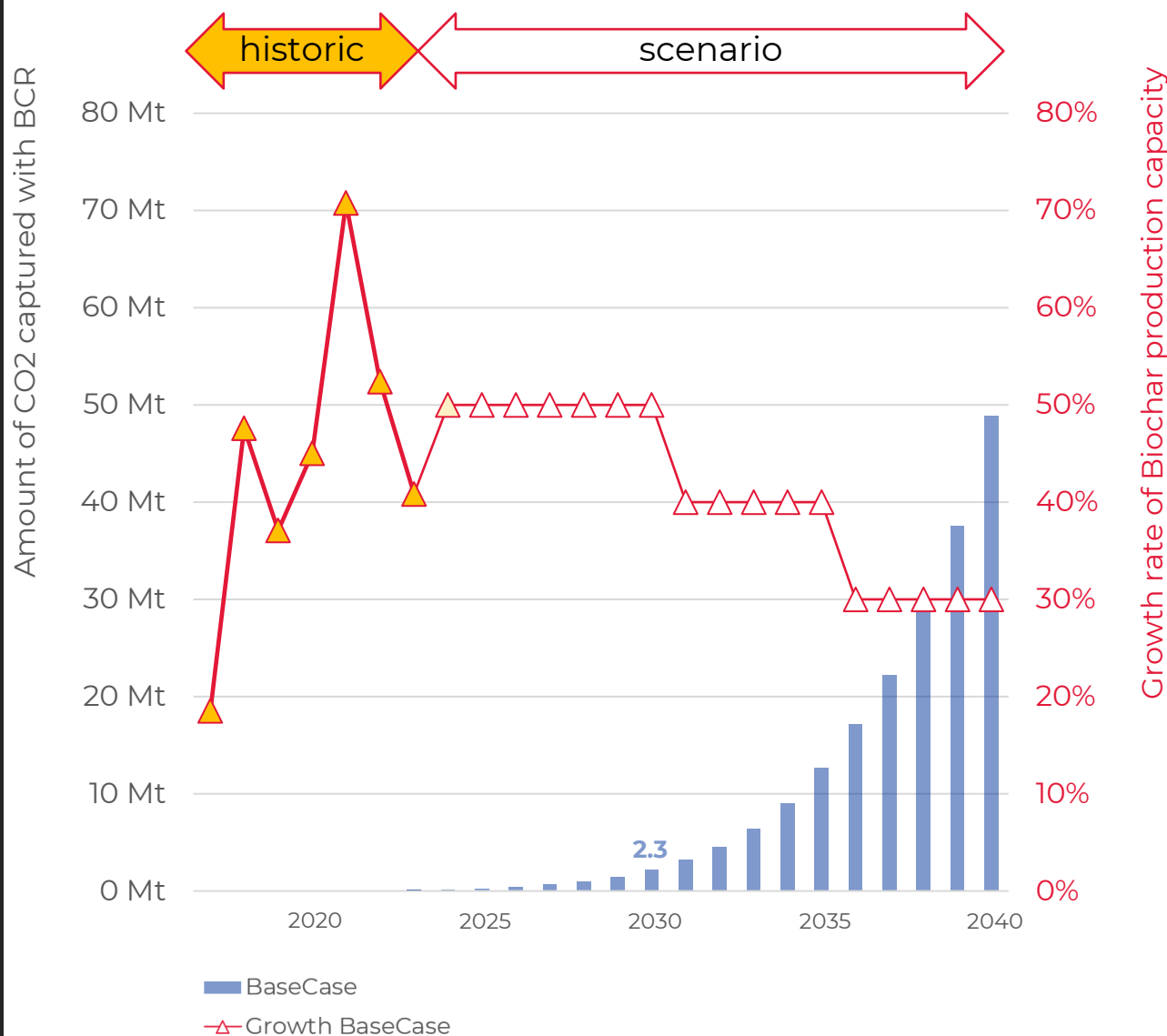
Scaling BCR to climate relevance

Extrapolating a growth rate of 50% will bring BCR to 2.3 megatons by 2030



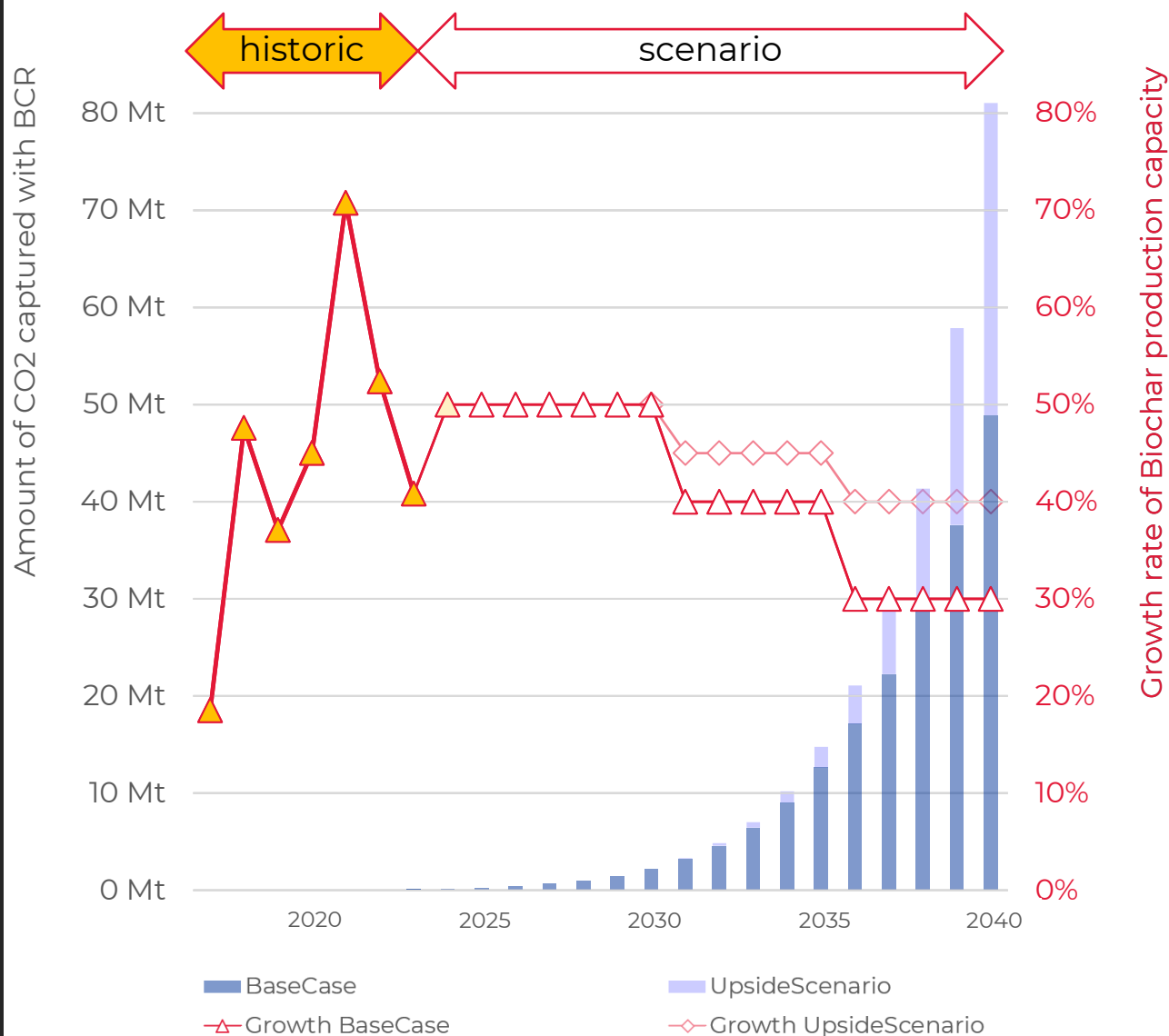
- Starting point is the **historic production of biochar until 2023**
- To **convert** the amount of **biochar** produced **into CO₂**, a conversion rate of 2.8 tons of CO₂ per t of biochar was used
- This growth path would bring **BCR** to **2.3 Mt by 2030**, which is **equivalent to just under 50%** of the **ambition of the EU Commission** for permanent **technical carbon removal**

Extrapolation growth rates beyond 2030 to 2040 guides the path to climate relevance



- To model beyond 2030, **declining growth rates** were used as a BaseCase:
 - 40%** until 2035
 - 30%** until 2040, which would bring BCR to **50 Mt** by **2040**

Extrapolation growth rates beyond 2030 to 2040 guides the path to climate relevance



- An UpsideScenario with
 - **45%** until 2035
 - **40%** until 2040, which would bring BCR to **80 Mt** by **2040**
- The numbers compare to a **2040 target** of the EU Commission of **75 Mt** for **permanent technical CDR** (including BCR) and an **overall target of 400 Mt** for all CDR solutions – and to a target to cut emissions by 90% to 490 Mt

Potential bottlenecks for the above basis growth scenario

- Could the equipment manufacturers **produce pyrolysis** equipment at this growth rate?
- Could **project development, permitting** and **project financing** facilitate such growth?
- Is there **sufficient biomass** to support such growth rates?
- Can **biochar application markets** grow fast enough to ensure **offtake** of the **produced biochar**?
- A growth rate of 33% in number of installations **appears** to be **perfectly achievable**
- We certainly need more professional project developers, but in principle it **does not seem to limit the growth**
- Allocating biomass accordingly makes sense
 - **BCR** shows **higher net CO₂ effects** than combustion
 - **75 Mt of CO₂** would require **15%** of the **biomass**
- This is probably the **biggest challenge** to **maintain high growth rates**



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

