SCCS
Annual Conference 2023

The Carbon Landscape:
Methods & Metrics of CO_2 Storage

Biochar and its applications

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UK Biochar Research Centre

University of Edinburgh

- **Established in 2009** to complement research on CO_2 capture and sequestration
- Focussed on integration of biochar in **bio-economy systems**
- Multi-disciplinary centre in collaboration of Schools of ***GeoSciences***, Biology, Chemistry, and Engineering
- Member of the **European Biochar Industry Consortium** (EBI)

- Pyrolysis technology - Material engineering - Soil science – Bioenergy & biorefinery concepts - Environmental and sustainability assessments -

Unique ability to offer multiscale production facilities for biochar

What is biochar?

Biochar is the solid, carbon rich residue of biomass pyrolysis – think of charcoal

Miscanthus pellet biochar
[700°C]

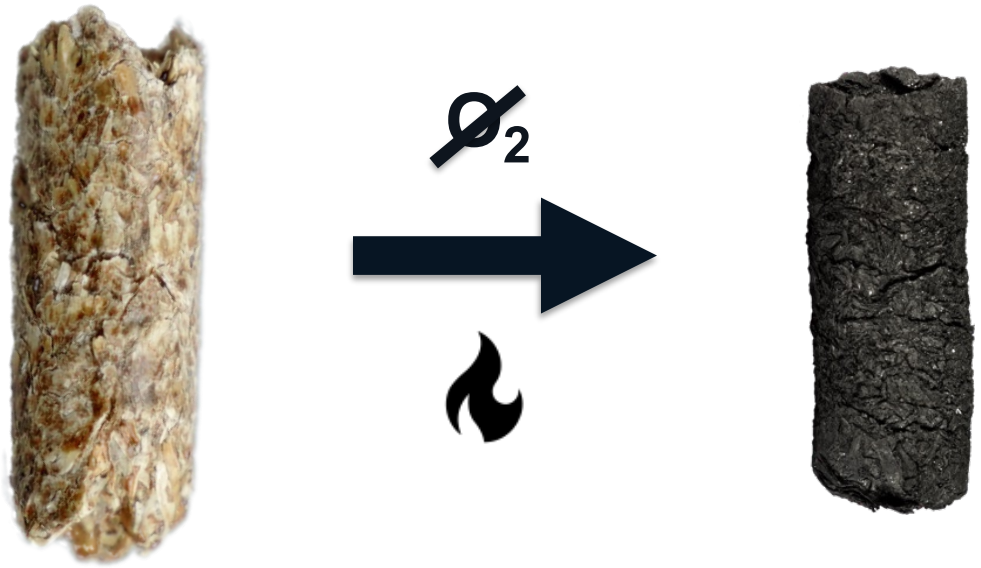
Oak chip biochar
[550°C]

Sewage sludge biochar
[550°C]

Biochar carbon removal

Pyrogenic Carbon Capture and Storage [PyCCS]

- CO_2 is first captured by plants
- The biomass is heated under oxygen-limited conditions to produce biochar
- Biochar sequesters the carbon in a solid form for centuries



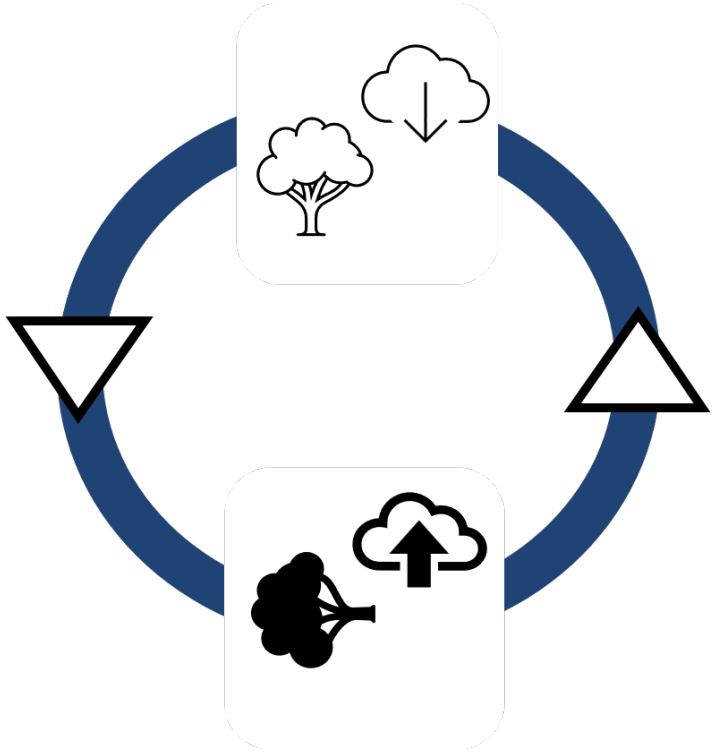
Wood pellet

Wood biochar pellet

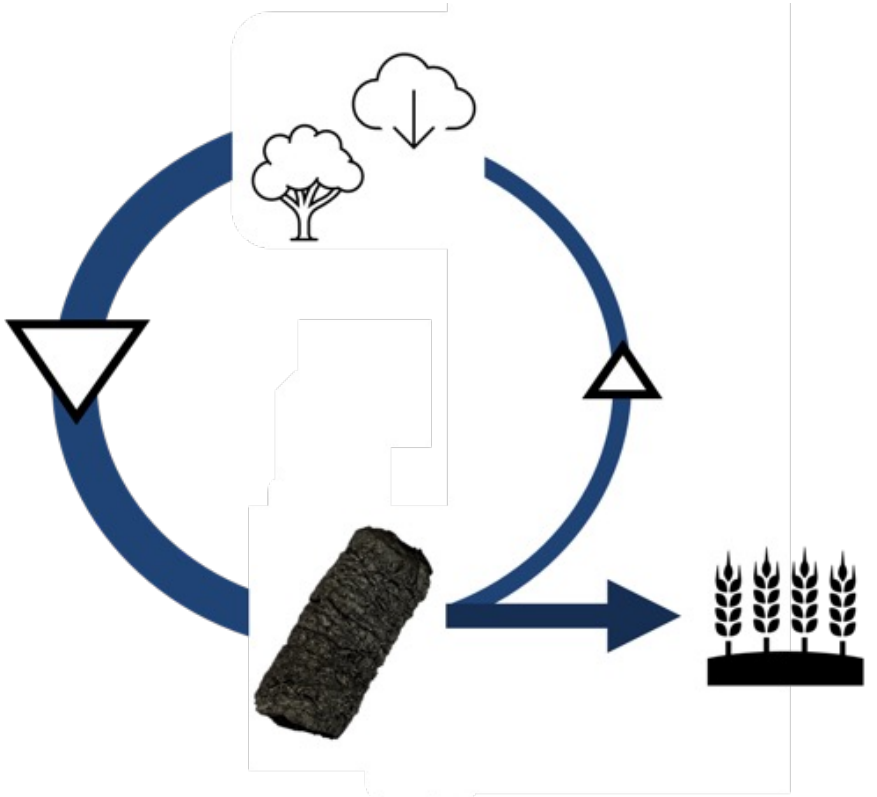
Biochar carbon removal

Pyrogenic Carbon Capture and Storage [PyCCS]

Biochar hacks the natural carbon cycle



Natural biomass decay – CO_2 re-released



Biochar carbon removal from the natural cycle

Biochar production

Sludge, manure, straw, trimmings, algae, RDF, MSW…

Pyrolysis
500-700°C

No oxygen
No combustion

50-70 %

Biomass pyrolysis produces excess heat and/or electricity

Carbon neutral

30-50 %

Carbon negative

~2.5 tons of CO_2e per ton of biochar

- Industrial production is energy-positive
- Pyrolysis reactors can be up or downscaled [500 - 50,000 t yr^{-1}]
- Decentralised deployment possible

Biochar application

- It can be used without diminishing its carbon sequestration value
- **It has value as a material beyond carbon removal**
- Production can be adjusted to produce different products

Main application areas

Soil amendment

Plastic additives

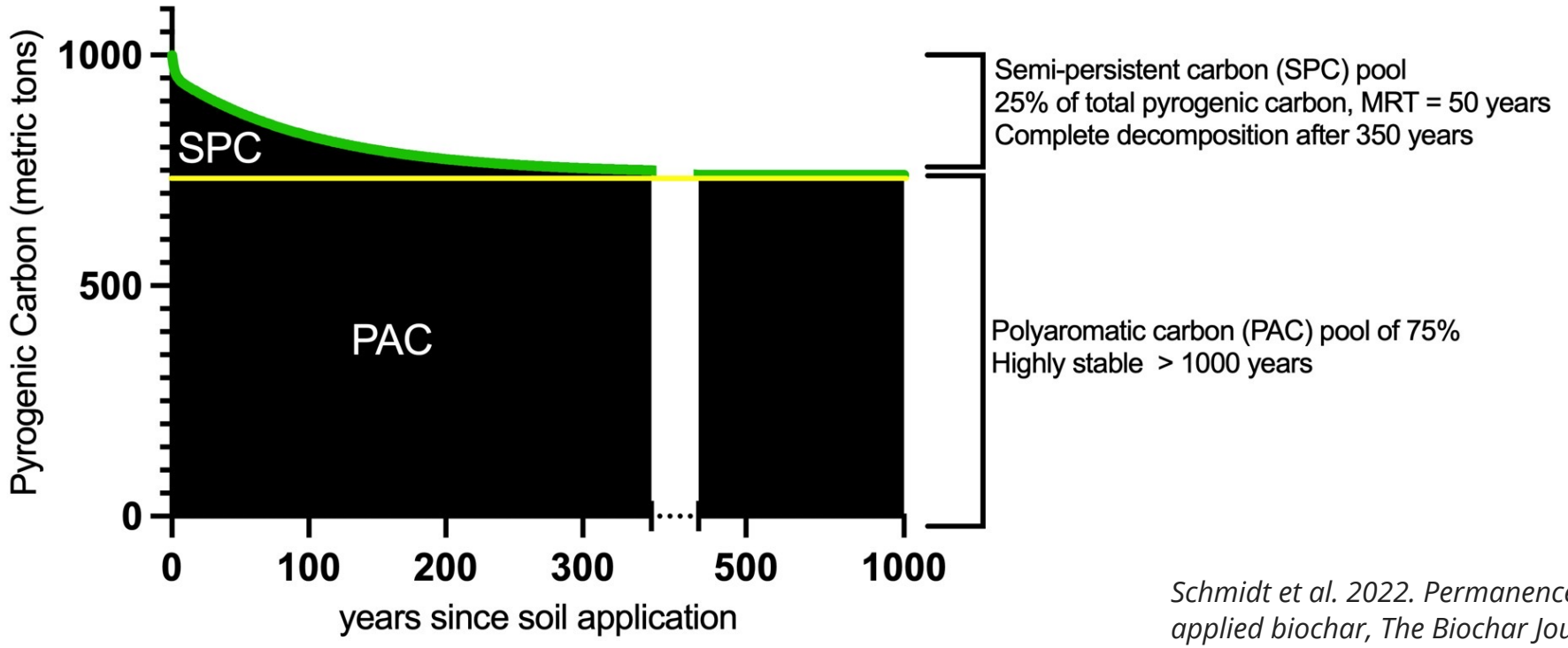
Construction materials

Research applications: Water filters, batteries, sensors, forestry,…

Biochar stability

Permanence

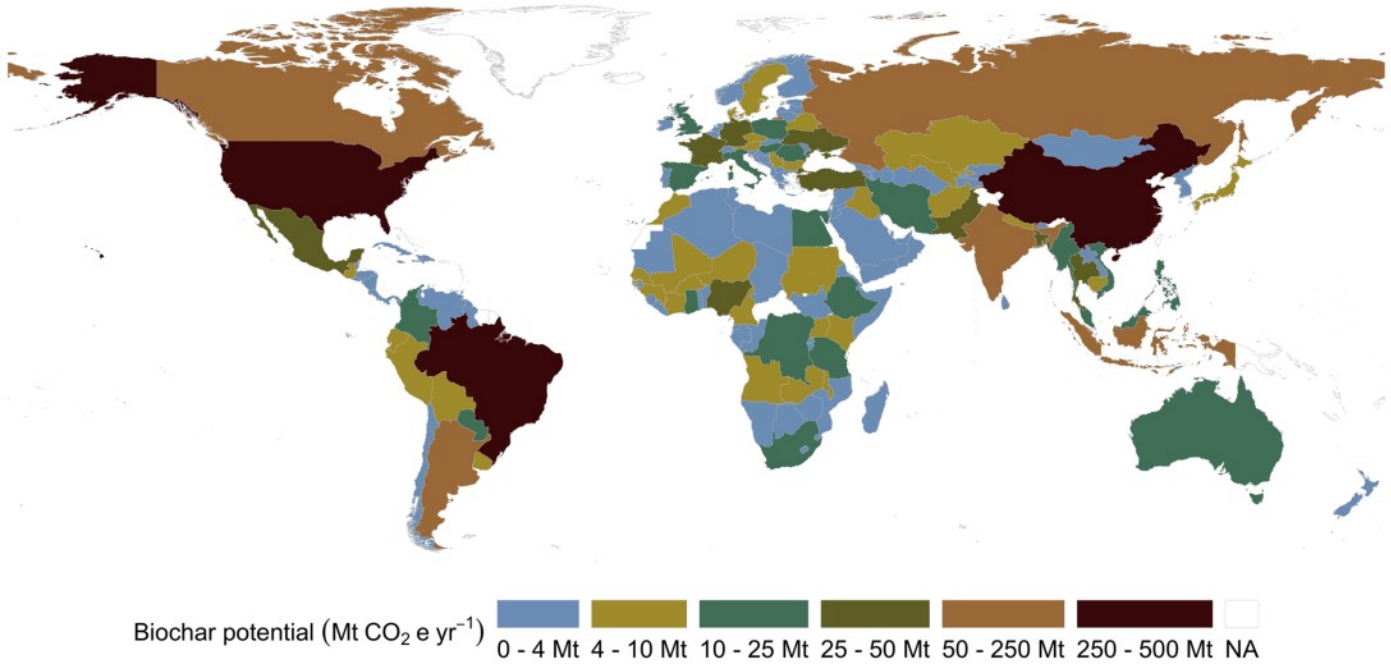
- Biochars generally consists of two carbon pools – semi-persistent and persistent
- The higher the production temperature – the more persistent the carbon
- Polyaromatic carbon will be stable on geological timescales



Schmidt et al. 2022. Permanence of soil applied biochar, The Biochar Journal.

Biochar carbon removal potential

Biochar produced from agricultural residues, manure, and sludge



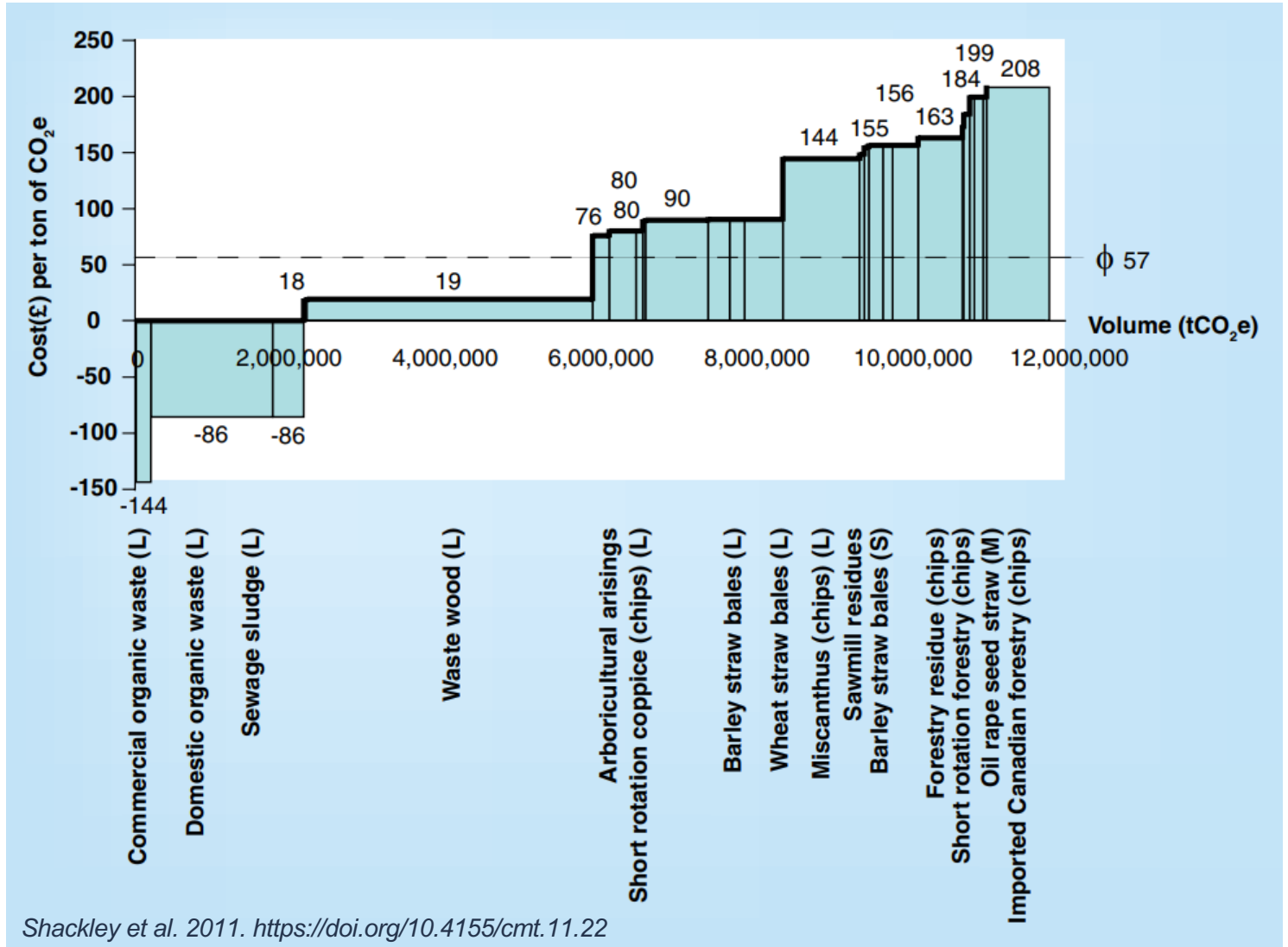
	Available biomass [Mio t yr-1]	Biochar potential [Mio t yr-1]	CO_2 potential [Mio t yr-1]
EU + Ukraine	556	148	243
UK	**32.5**	**9.6**	**14.5**

Lefebvre et al. 2023. https://doi.org/10.1007/s42773-023-00258-2

What does it cost?

- CO_2 abatement costs are dependent on feedstock price
- Regulatory framework for biochar application must be in place
- EU fertiliser regulation enables wide application in agriculture since 2022 [UK equivalent missing]

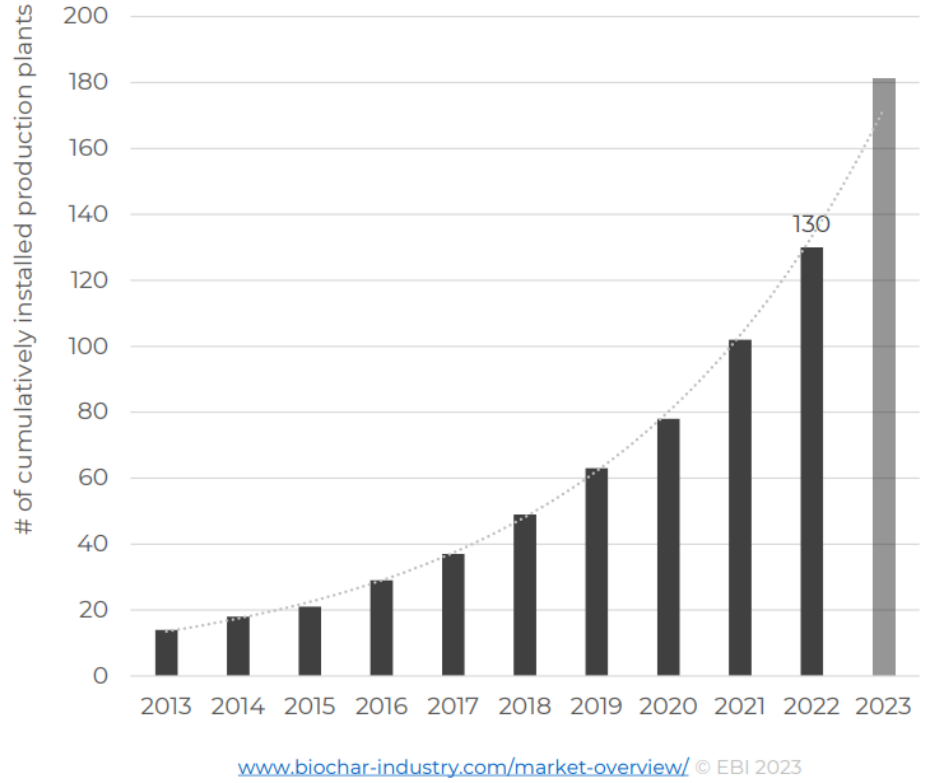
Estimated CO_2 abatement costs for biochar in the UK



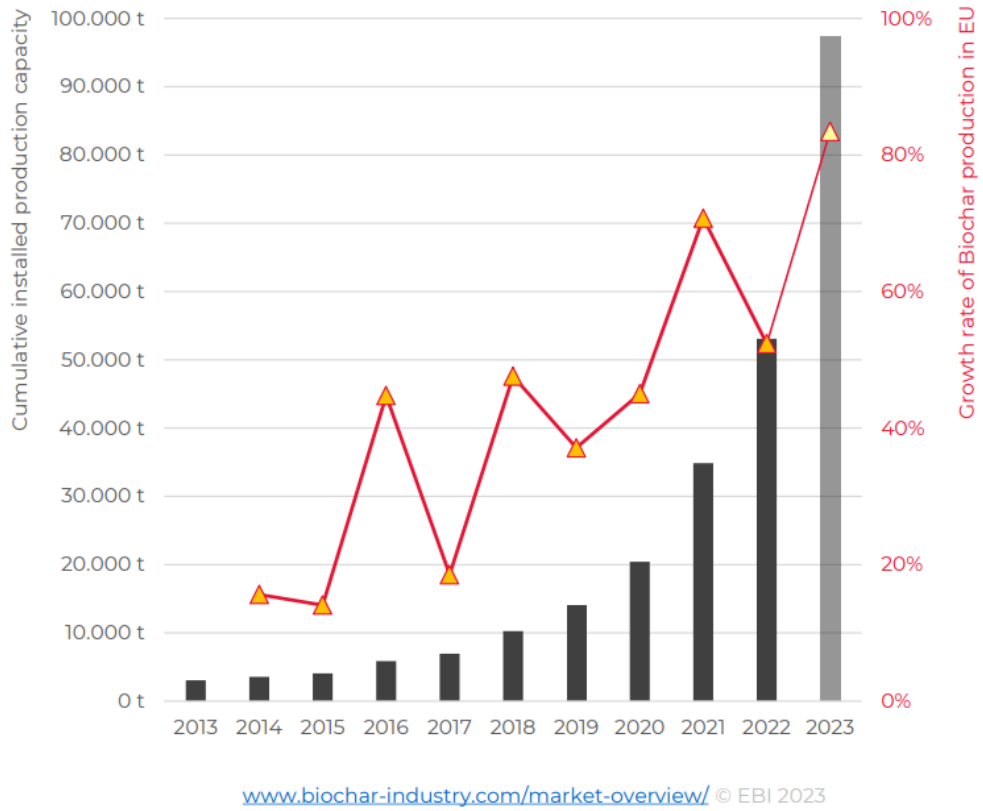
Shackley et al. 2011. https://doi.org/10.4155/cmt.11.22

The biochar market

- The market is growing at annual growth rates of +50% [by volume]
- +130 production plants currently in operation in the EU



Operational production plants [EU]



Production capacity [EU]

Biochar carbon removal certificate market

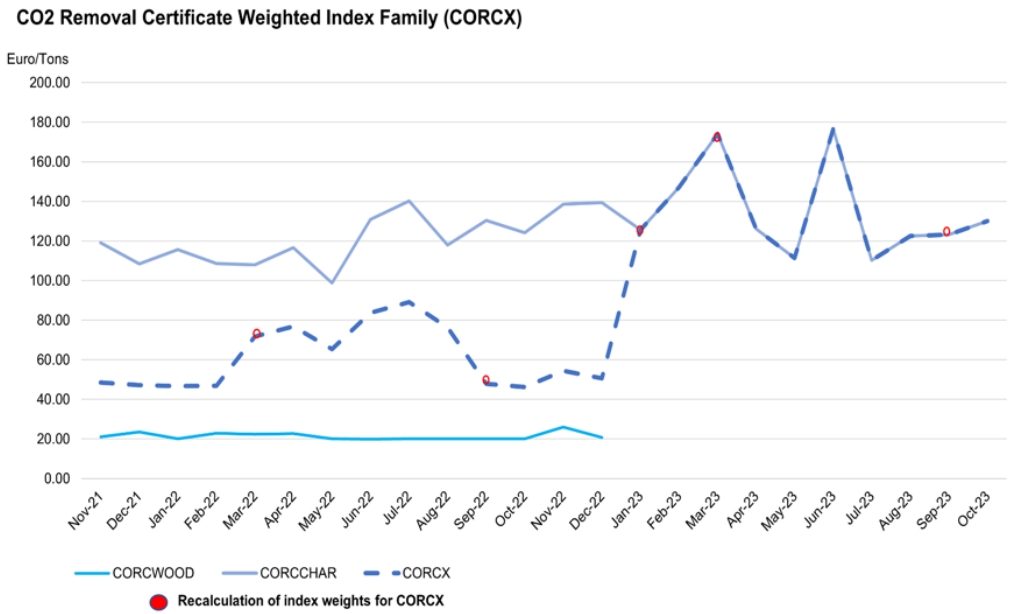
- Biochar is the main technology **delivering** permanent carbon dioxide removal to date
- 9 out of top 10 CDR suppliers
- Current CO_2 certificate price at ~£115 per ton

CDR.fyi Top 10 Carbon Removal Suppliers

Ranked by tonnes of CDR delivered

	Name	Method	Total Sales
1	Wakefield Biochar	Biochar	25,170
2	Douglas County Forest Products	Biochar	11,403
3	Aperam BioEnergia	Biochar	7,300
4	Freres Biochar	Biochar	7,193
5	Charm Industrial	Biooil	6,416
6	Oregon Biochar Solutions	Biochar	5,689
7	Carbofex	Biochar	3,976
8	GreenSand	Enhanced Weathering	2,383
9	NovoCarbo	Biochar	2,209
10	Carbon Cycle	Biochar	1,782

https://carboncredits.com/carbon-dioxide-removals-cdr-purchases-jump-437-in-first-half-of-2023/



https://www.nasdaq.com/solutions/carbon-removal-platform [27.11.2023]

UKBRC

Biochar business in Scotland/UK

UK Technology providers:

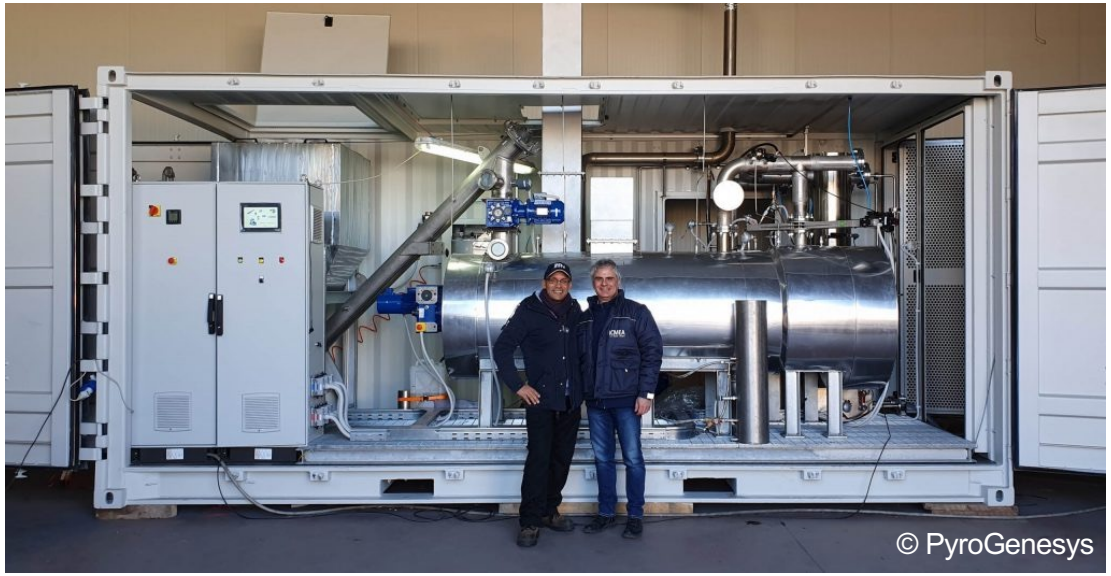
Standard Gas, PyroGenesys, Pyrocore, Perpetual Next, *Woodtek*…

UK Biochar businesses:

Carbogenics, Black Bull Biochar, Carbon Gold, Onnu,…

Business strategies:

- Integration into existing industrial value chains
- Decentralised, carbon negative energy production
- Production of carbon-negative materials
- Waste treatment option



PyroGenesys (UK) technology – a demonstrator in the central belt

Biochar carbon removal

- Biochar is already commercially deployed (TRL9)
- Carbon negative material production
- Co-production of energy
- +130 European producers currently active
- Current CO_2 credit price of ~ £ 115 t^{-1}
- The regulatory framework is still an obstacle

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Thank you

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CO_2

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