Biocarbon / biochar / torrefied biomass production and applications

Stephen B. Harrison, Managing Director, sbh4 consulting

Energy Transition Speakers Corner, Essen

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Differentiation within biomass

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Biomass

- Wood chips, wood pellets, rice husks, straw, corn cobs, palm oil kernels etc
- Dried or green (unprocessed)
- High moisture content
- High volatiles content
- High-cost distribution per energy value

Torrefied biomass

- Biomass feedstock can be dried before or during torrefaction
- Torrefaction (mild pyrolysis, heating without oxygen) at between circa 200 and 350 °C
- Volatiles baked off to form combustible gases that provide heat energy for the torrefaction and drying
- Fixed carbon circa 50 to 80%
- Circa 80% mass yield torrefied biomass:feedstock

Biochar

- Biomass feedstock can be dried before or during pyrolysis
- Pyrolysis (heating without oxygen) at between circa 500 and 700 °C
- Pygas produced for heat for pyrolysis and export
- Liquid pyoil may also be produced
- Fixed carbon circa 80 to 90%
- Circa 30% mass yield biochar:feedstock

Biocarbon

- Biomass feedstock generally dried before pyrolysis
- High temperature pyrolysis (heating without oxygen) at between circa 600 and 900 °C
- Syngas produced for heat for pyrolysis and syngas export
- Fixed carbon up to circa 95%
- Circa 20 to 25% mass yield biocarbon:feedstock

Torrefied biomass

Torrefied biomass is a potential pulverised coal substitute for gasification, combustion or to replace PCI in a blast furnace (eg, Torero project).

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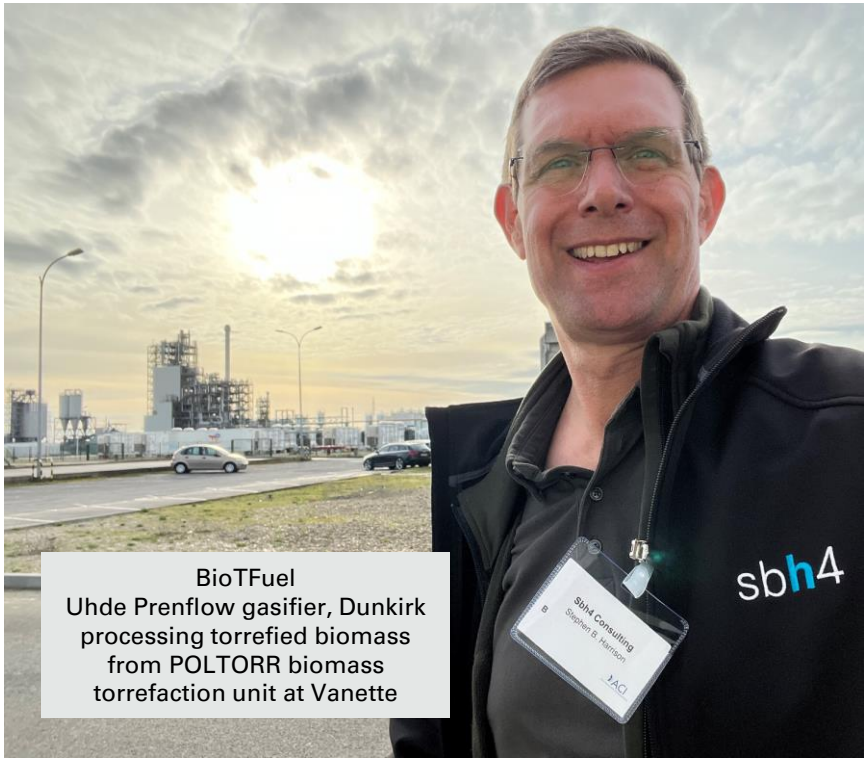
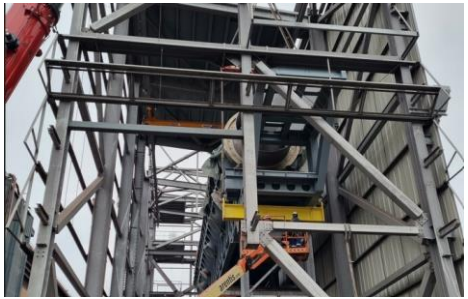
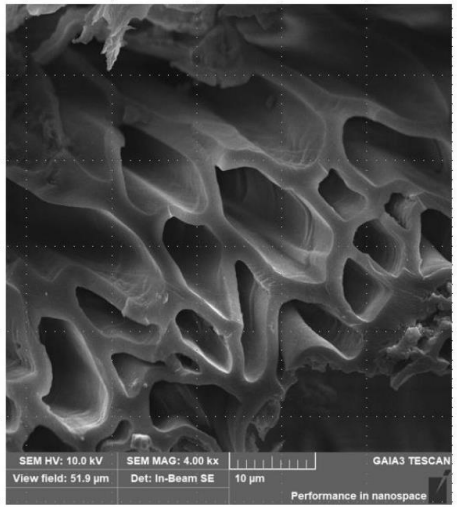


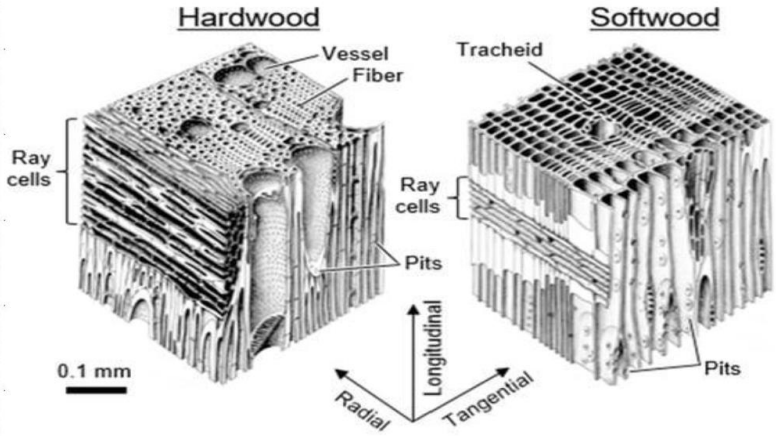
BioTFuel
Uhde Prenflow gasifier, Dunkirk processing torrefied biomass from POLTORR biomass torrefaction unit at Vanette

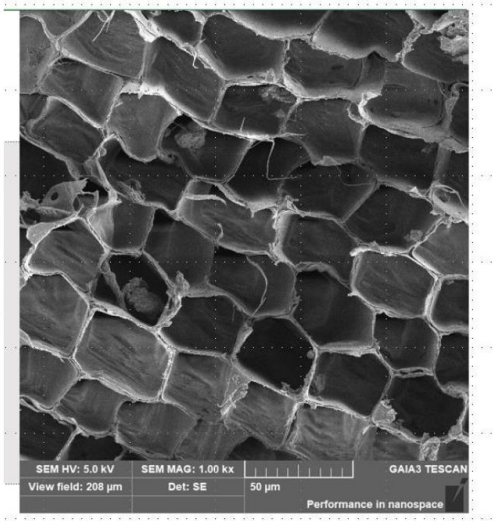
Torero
Torrefied biomass to replace coal for PCI at ArcelorMittal, Ghent



Torrefied biomass has a very large surface area. It will be more reactive than coal or petcoke dust. Larger particle sizes than would be required for coal / petcoke may be appropriate.

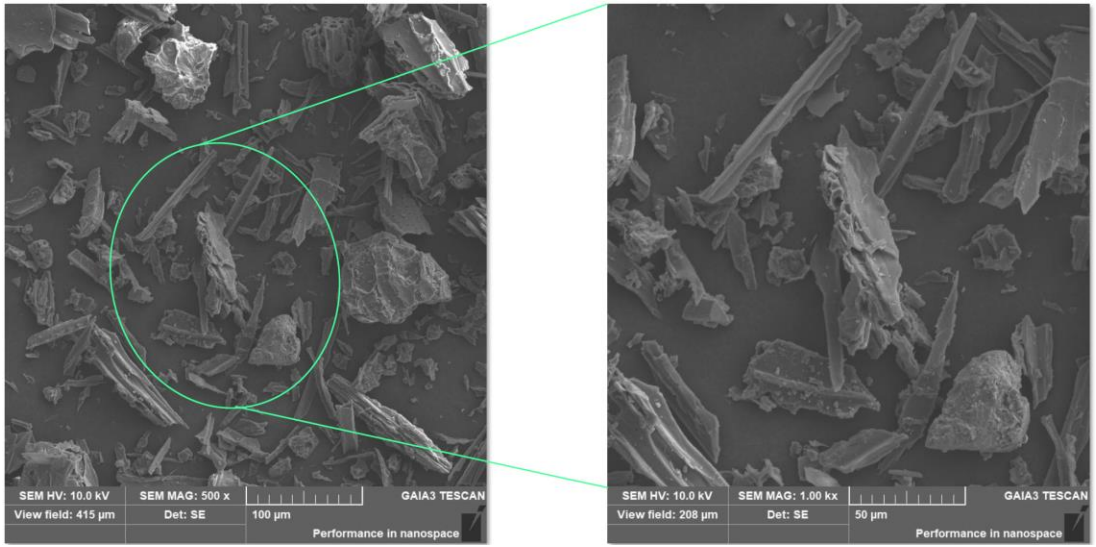






SEM pictures on Perpetual Next Torrefied Material

Milling results in needle-like particles, unlike coal or petcoke that form more spherical particles. Pneumatic conveying, flow and agglomeration properties must be considered.



SEM pictures on Perpetual Next Torrefied Material

TORREFACTION ENABLES ENTRAINED FLOW GASIFICATION, Perpetual Next, Presented at ACI Gasification Conference, Ghent Feb 2024

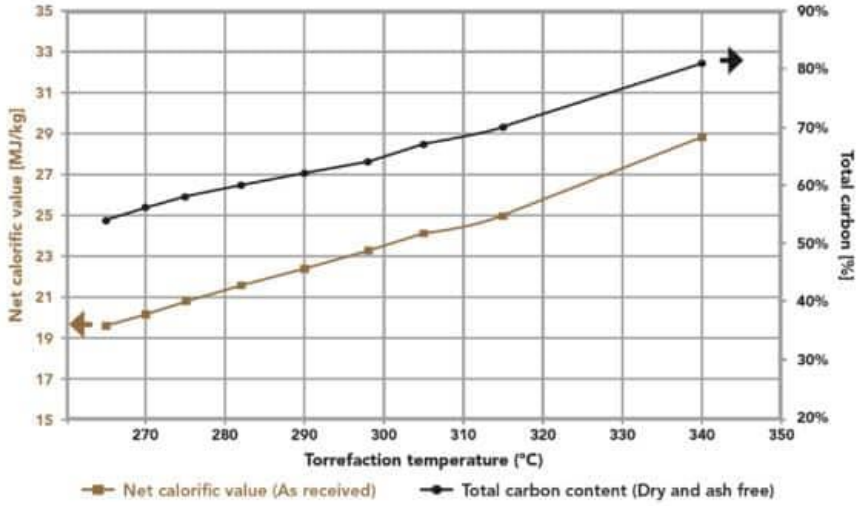
Technology providers offer tower kilns with a rotating belt, or near-horizontal rotating auger kilns.

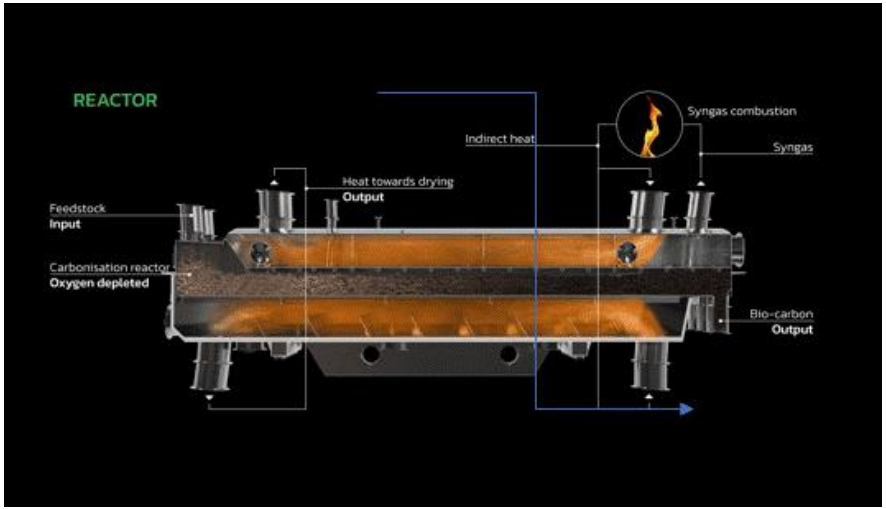
TorrCoal Rotary kiln

Nesa Solution® Multiple Hearth Furnace, John Cockerill

https://www.torrcoal.com/
https://johncockerill.com/en/environment/thermal-treatment-of-solids-minerals-biomasswaste-sludge/

Residence time, particle size handling, mixing, pressure and temperature are key considerations.





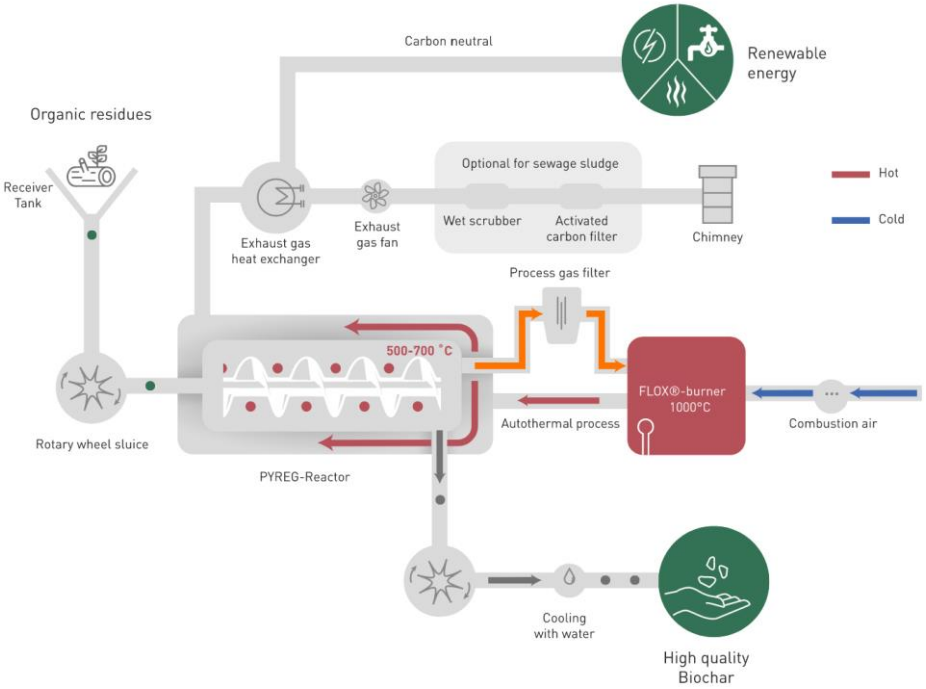
https://www.torrcoal.com/torrefaction-technology/
https://perpetualnext.com/en/solutions/carbonisation-technology/

Biochar and biocarbon

Biochar and biocarbon production leverages established technologies to produce barbeque charcoal.

https://shop.profagus.de/produkte/buchen-grill-holzkohle-briketts/38/der-sommer-hit-tischgrillkohle-1-kg

Technology providers offer continuous rotary kilns with autothermal heating from the pyrolysis gas, or an allothermal processes with external heat input from power or gas.



Vertical batch reactors are also common. Some operate at pressure to influence the pyrolysis process. Reduced particle movement can produce larger lumps of biocarbon / biochar.

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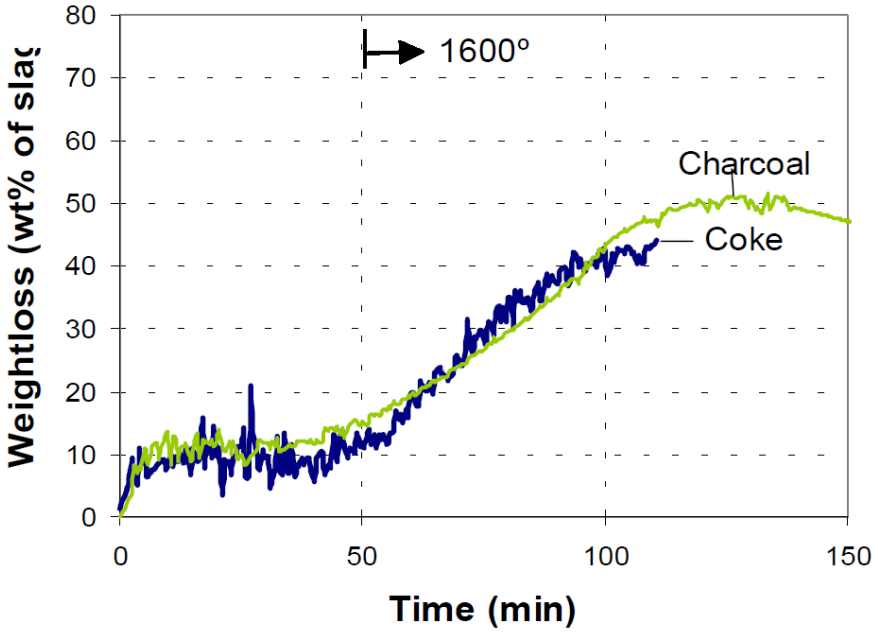
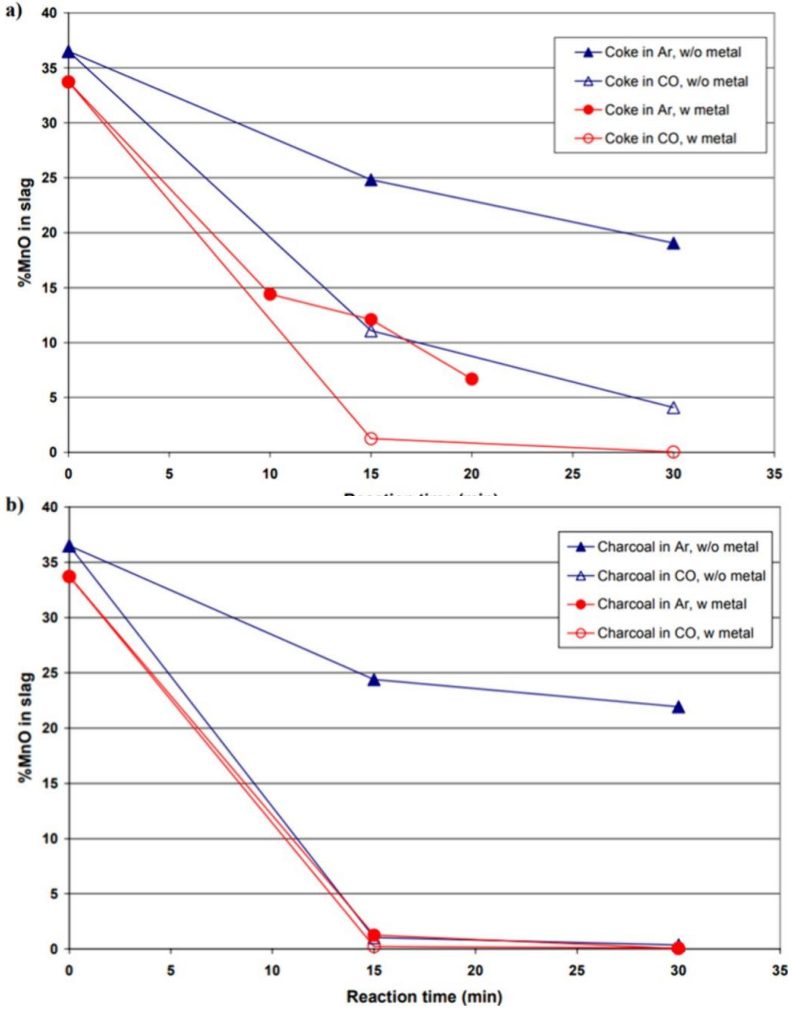
Carboculture Carbolysis reactor, Finland

Soler Group, France

https://sifted.eu/articles/carbo-culture-biochar-plant-news
https://soler-group.com/press-figaro-soler-decarbonate-industry/

Biocarbon with a high fixed carbon content can replace metallurgical coke for steel making.





https://pubs.acs.org/doi/10.1021/acsomega.4c00866

Biocarbon can also be used as a fuel or reducing agent in other metallurgical and mineral processing applications such as lime or cement making and zinc or lead oxide reduction.

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Introduction to Stephen B. Harrison

Stephen B. Harrison is the founder and managing director at sbh4 GmbH in Germany. His work focuses on decarbonisation and greenhouse gas emissions reduction. E-fuels, hydrogen, ammonia and CCTUS are fundamental pillars of his consulting practice.

In support of the European Commission through CINEA in 2023, Stephen evaluated seven CCS, hydrogen and e-fuels submissions to the Third Innovation Fund. The fund allocated €2 billion to large-scale decarbonisation projects in Europe.

Stephen has served as the international expert and team leader for three ADB projects related to CCTUS and renewable hydrogen deployment in Pakistan, Palau and Viet Nam. He has also supported the IFC and work bank on e-fuels and green hydrogen strategy development projects in Namibia and Pakistan. In 2021, he specified more than 2GW of electrolyser capacity for green hydrogen projects.

With a background in industrial and specialty gases, including 27 years at BOC Gases, The BOC Group and Linde Gas, Stephen has intimate knowledge of e-fuels, hydrogen, ammonia and carbon dioxide from commercial, technical and operational perspectives. For 14 years, he was a global business leader in these FTSE100 and DAX30 companies.

Stephen has extensive buy-side and sell-side M&A due diligence and investment advisory experience in the energy and clean-tech sectors. Private Equity firms and investment fund managers and green-tech start-ups are regular clients. He also supports operating companies in their mission to decarbonise their scope 1, 2 and 3 GHG emissions.

Stephen served on the Scientific Committee for CEM2023 in Barcelona and chaired the session related to CEM from clean energy systems. Stephen was session chair for the e-fuels and hydrogen propulsion track at the Bremen Hydrogen Technology Exhibition in September 2023. He was also conference chair at the CO2 utilisation Summit in Hamburg in 2023. Stephen also served on the Technical Committee for the Green Hydrogen Summit in Oman in December 2022 and the Advisory Board of the International Power Summit in Munich in September 2022.