Three tangible areas where steel makers can slash Scope 3 emissions

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Scope 3 emissions are related to the upstream and downstream supply chain to the iron and steel making process. This presentation will examine three examples.

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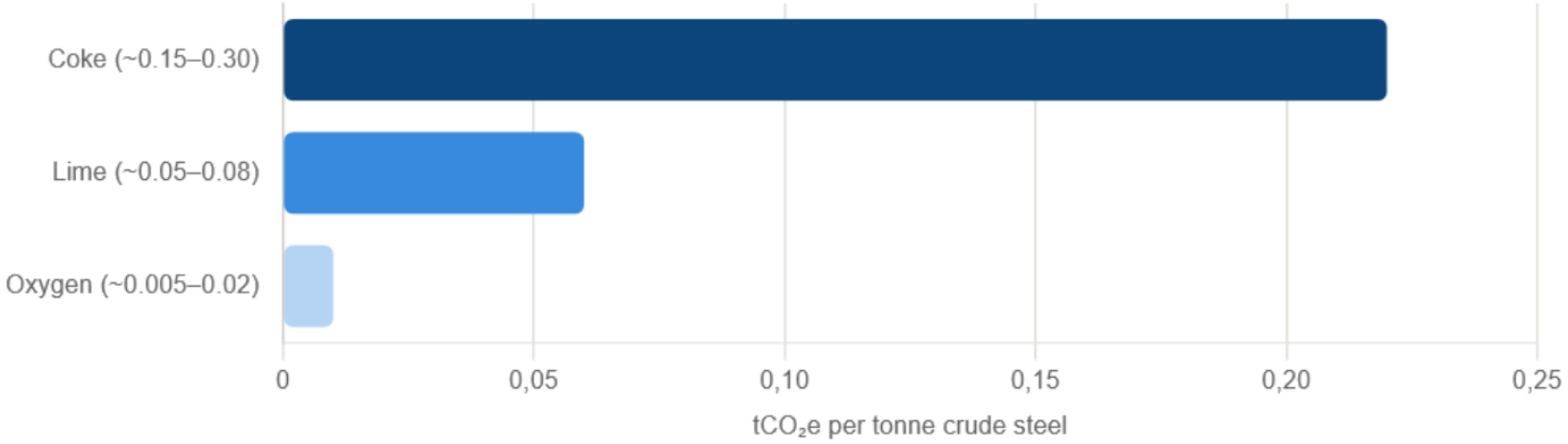
1. Biocarbon sourcing to replace fossil coke or coal
2. Sourcing green lime for slagging
3. Green oxygen sourcing for blast furnace and basic oxygen furnace operations



1. Biocarbon sourcing to replace fossil coke or coal.

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Torrefied biomass is a potential substitute to PCI in a blast furnace (eg, Torero project).

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

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

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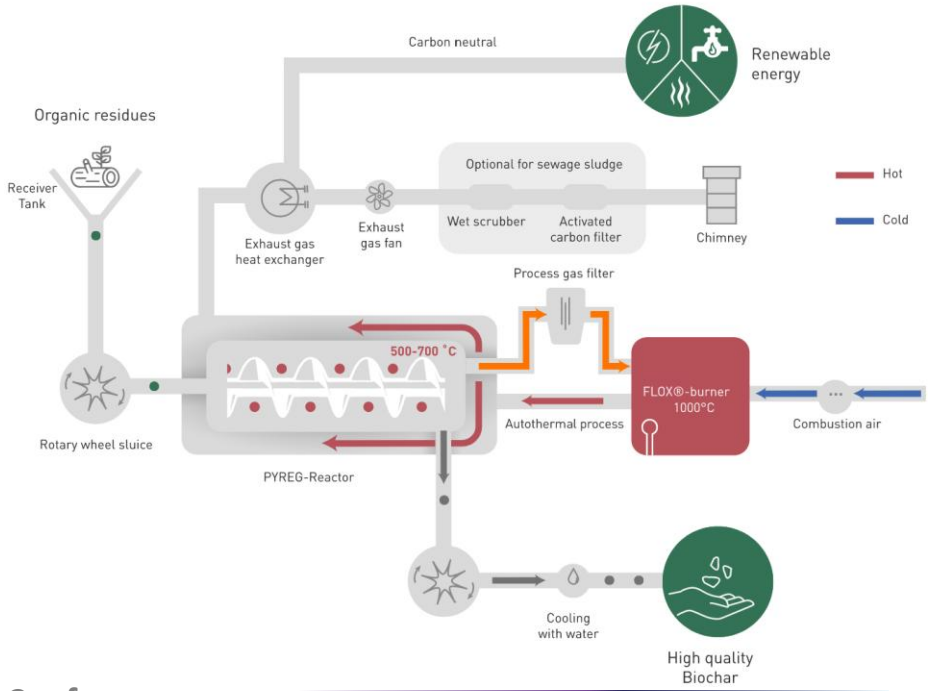
TorrCoal Rotary kiln

Nesa Solution® Multiple Hearth Furnace, John Cockerill

https://www.torrcoal.com/

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

Torrefaction and pyrolysis technologies can either use autothermal heating from the liberated gas or apply external heat from renewable electrical power or biomethane burners.



2. Sourcing green lime for slagging

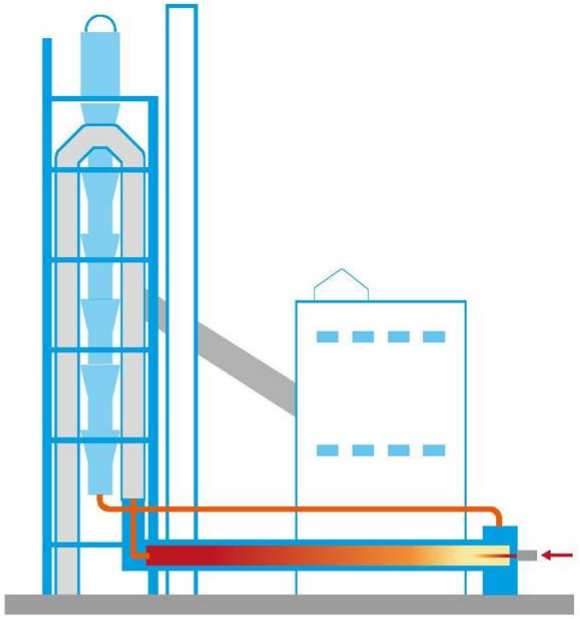
Lime making converts $CaCO_3$ to CaO in a calciner kiln and liberates geogenic CO_2.

Notes:

Unavoidable CO_2 emissions occur from the lime stone calcination process and are also associated with the energy and power require-ments.

Heat for calcination can be decarbonised with renewable power for electrical heating, or biofuels.

CO_2 capture from the process is essential for decarbonised lime production.



Calciner tower & rotary lime kiln

	Lime making
Main CO_2 source	Reduction of limestone to calcium oxide
Chemical reaction producing CO_2	$CaCO_3 \rightarrow CaO + CO_2$
Other industries with similar applications	– Cement making – Refractory materials, $MgCO_3 \rightarrow MgO + CO_2$

CCU/S is essential to directly reduce the geogenic CO2 emissions from lime making. The indirect alternative would be to use offsetting.

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3. Green oxygen sourcing for blast furnace and basic oxygen furnace operations.

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Oxygen is produced on a VPSA plant or cryogenic air separation unit. Both operate with electricity as the main energy source.

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VPSA Image (on left) courtesy APCI

Low-carbon and renewable electricity from nuclear, wind, solar and hydro-power can be used to drive the motors for gas compression to generate oxygen.

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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 industrial decarbonisation and GHG emissions reduction. Green steel production, hydrogen, and CCU/S are fundamental pillars of his consulting practice.

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

In 2023, 2025 and 2026 Stephen evaluated submissions to the CINEA Large-Scale Net-zero technologies Innovation Fund. He also supports the European Commission with venture capital investment due diligence and Horizon grant application assessments.

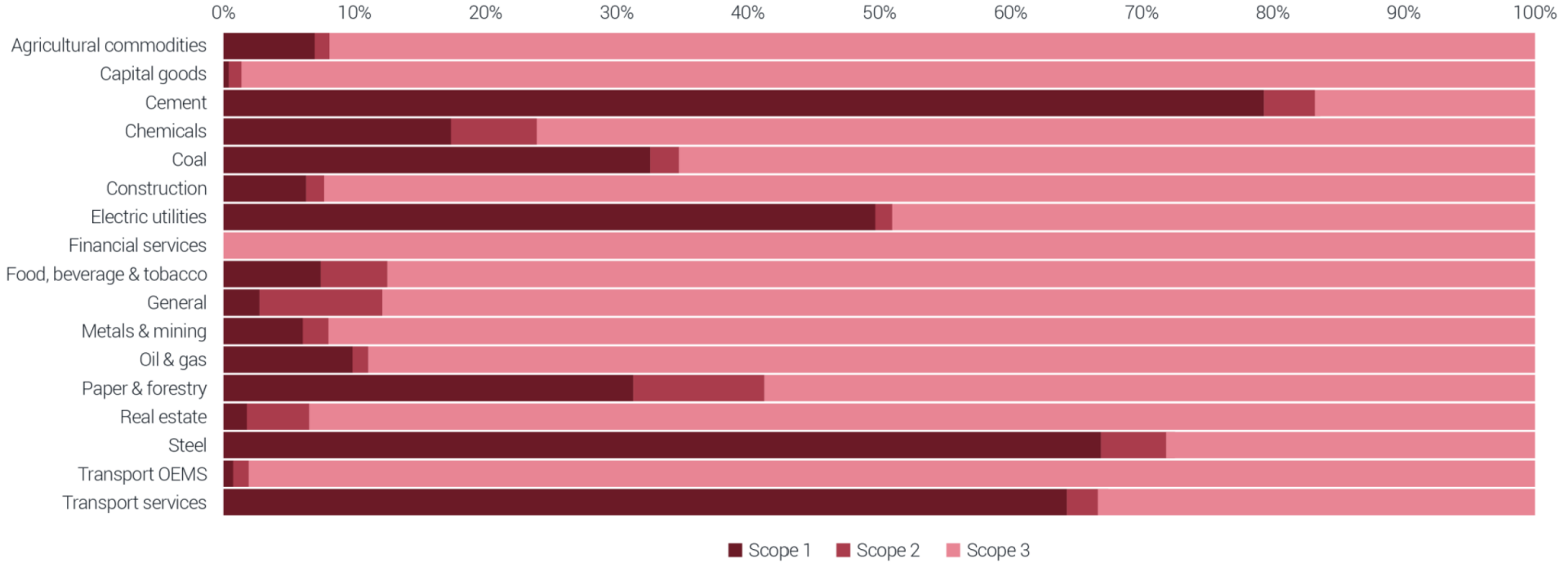
Stephen has served as the international expert and team leader for three ADB projects related to CCU/S and renewable hydrogen deployment in Pakistan, Palau and Viet Nam. He has also supported the IFC and world bank on e-fuels and green hydrogen projects.

With a background in industrial gases, including 27 years at BOC Gases, The BOC Group and Linde Gas, Stephen has intimate knowledge of the core aspects of iron and steel making from commercial, technical and operational perspectives. For 14 years, he was a global business leader in these FTSE100 and DAX30 companies.

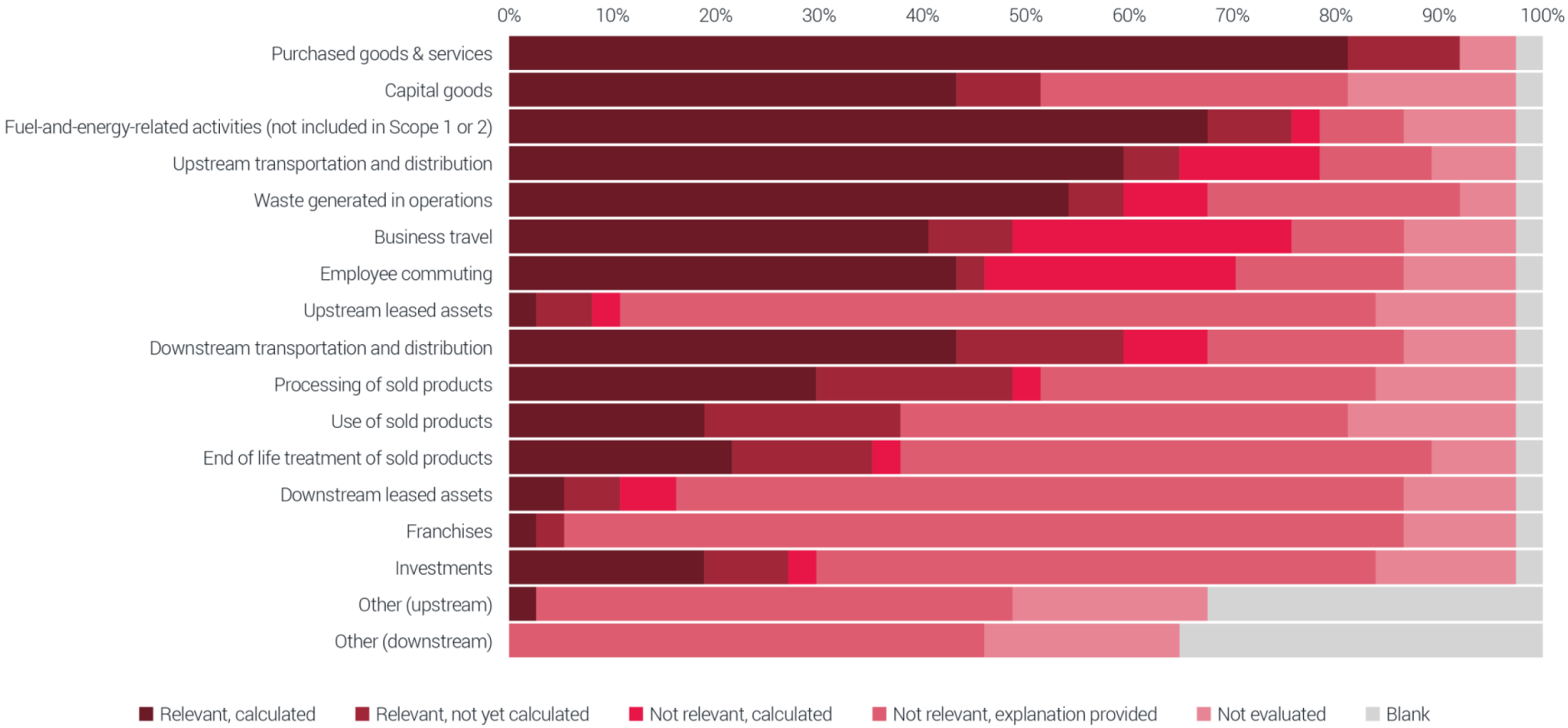
As a member of the H2 View and **gas**world editorial advisory boards, Stephen advises the direction for the leading international publications. Through H2 VIEW, World Hydrogen Leaders and Sustainable Aviation Futures, he has led Masterclasses covering many themes in virtual and live sessions.

Stephen was session chair for the e-fuels and hydrogen propulsion track at the Bremen Hydrogen Technology Exhibition in September 2023 and chaired the same stream at that conference in Hamburg in 2024. He was also conference chair for the CO2 utilisation Summit in Hamburg in 2023 and the same event in Berlin in 2024.

Scope 1, 2 and 3 Emissions by Sector



Reported Relevance of Scope 3 Categories - Steel Sector (37 Companies)



Differentiation within thermally processed 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

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

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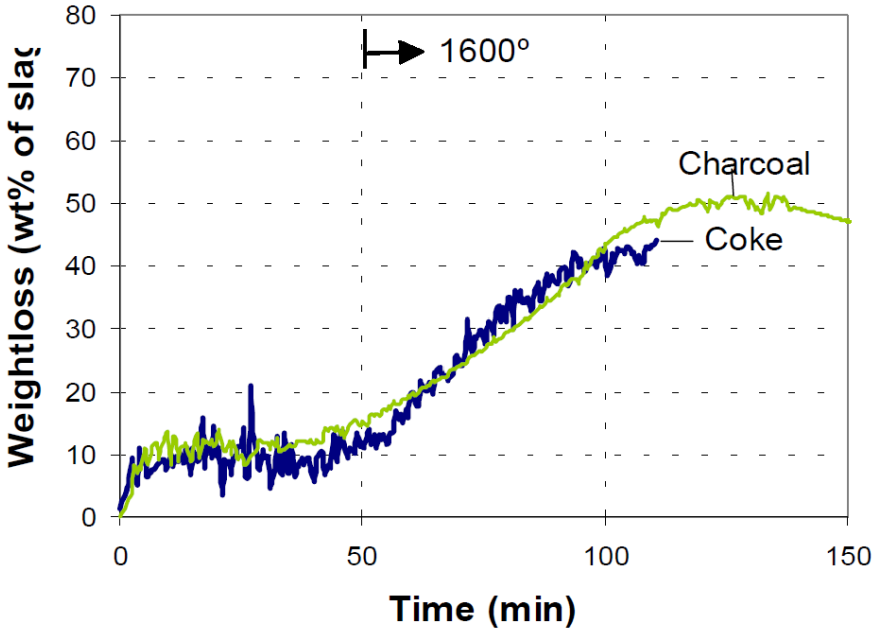
Vertical batch reactors are also common. Some operate at pressure to influence the pyrolysis process. Reduced particle movement can produce larger lumps of biocarbon / biochar.

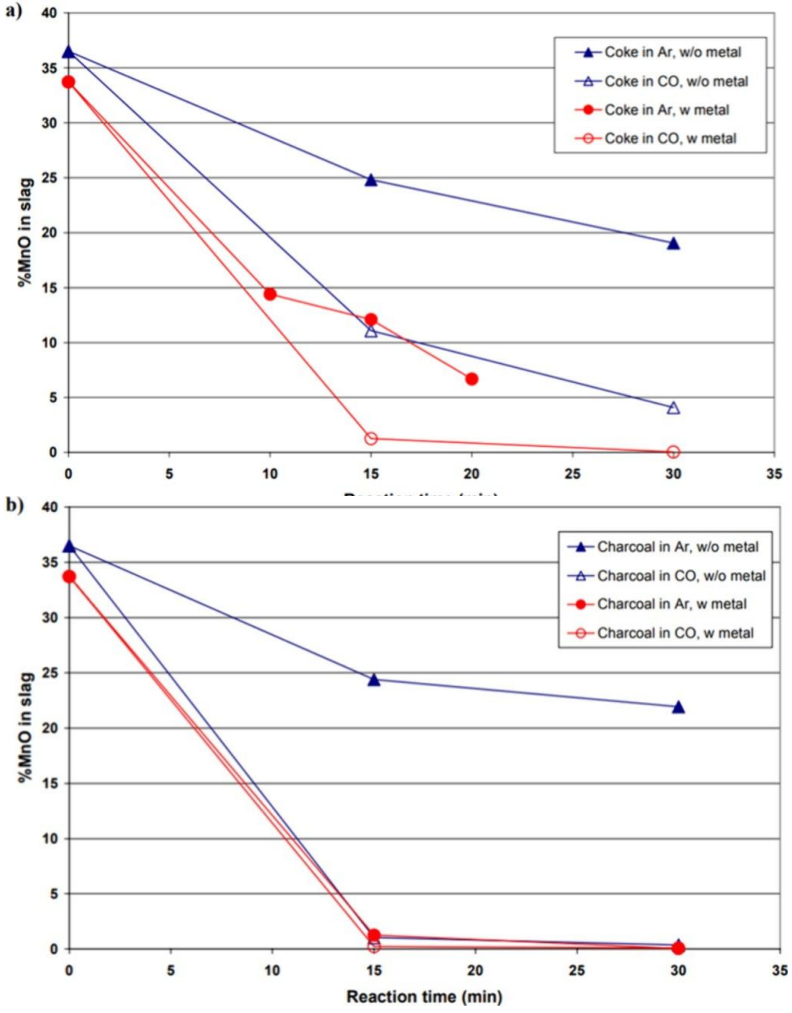
Carboculture Carbolysis reactor, Finland

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