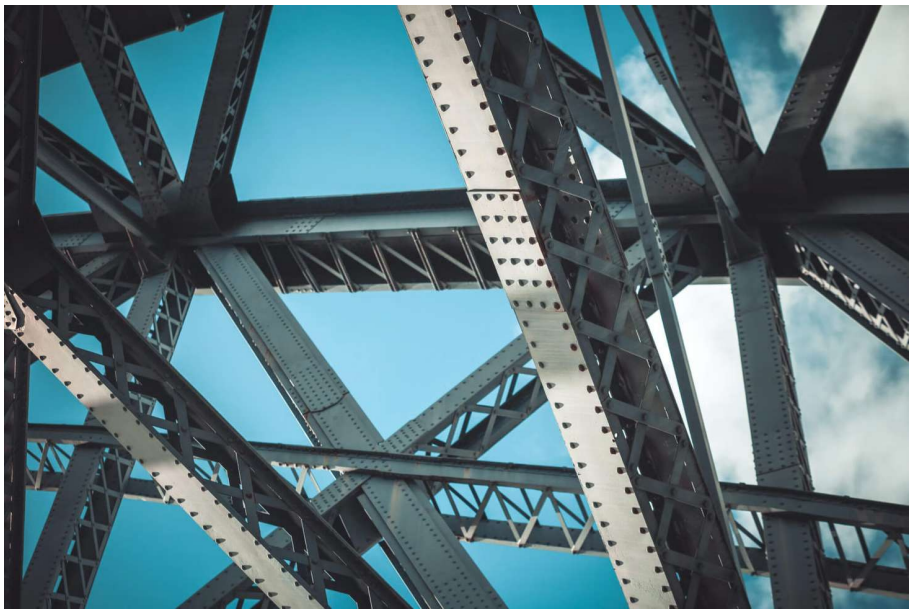
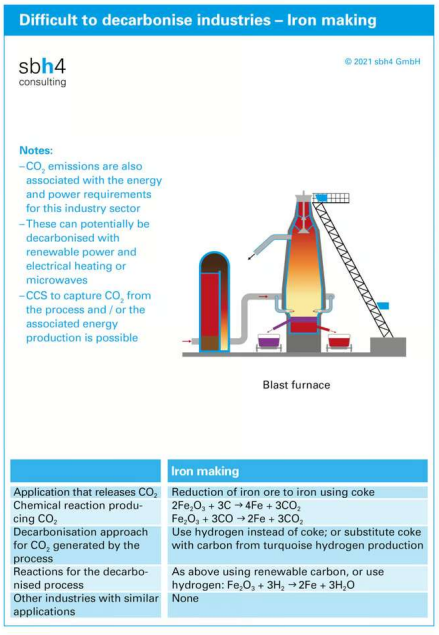


Green iron and steel: A diversity of routes to decarbonisation

By Stephen B. Harrison on Aug 14, 2023 | 0 NEWS | DECARBONISATION

Let's face it, steel is here to stay. Finding a cost-effective alternative to steel with a low CO2-intensity and similar mechanical properties would be as likely as finding the Loch Ness monster.

The future of iron and steel making is of paramount importance to the fortunes of the industrial gases sector. Thousands of tonnes of oxygen are produced on air separation units (ASU) all around the world daily to feed blast furnaces for iron making and basic oxygen furnaces for steelmaking.



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Scrap re-processing in electric arc furnaces also uses oxygen. Hydrogen is also required for steel processing and argon is used to make high grade stainless steel. Nitrogen is used to create a non-oxidising atmosphere over steel melts.

Structural steel forms the skeleton of many high-rise buildings. It is also the material used to build electricity transmission grid pylons and wind turbine towers that make renewable power to flow through the grid.

Iron and steel making generates many thousands of tonnes of carbon dioxide (CO2) per year. The emissions predominantly come from blast furnace gas (BFG) and basic oxygen furnace gas (BOFG). These flue gases contain carbon monoxide, hydrogen, and methane.

To avoid pollutant gas emissions, BFG and BOFG can be flared to convert these gases into CO2 and water vapour. On some facilities, the energy value from the BFG and BOFG is captured by burning these gases in a gas engine to generate heat and power. In this case, the exhaust from the gas engine will be rich in CO2 and water vapour but the heat and power generation may have avoided the use of additional fossil fuel.

Many large and small iron and steel producers are piloting processes for decarbonisation in research programmes with emerging technology providers. Perhaps more than any other heavy industrial sector, there is a wide diversity of decarbonisation options in iron and steelmaking.

DECARBONISATION PATHWAY	APPLICATION IN IRON AND STEEL MAKING	CO2 EMISSIONS AVOIDANCE ROUTE
Replacement of blast furnace with DRI using blue hydrogen	Iron making	CO2 capture during hydrogen production
Replacement of blast furnace with DRI using green hydrogen	Iron making	Renewable or nuclear power for water electrolysis to hydrogen
Substitution of fossil coke/coal in the existing blast furnace with biocarbon	Iron making	Sustainable biogenic CO2 emissions*
Increased use of electric arc furnaces	Steel making, scrap re-processing	Renewable or nuclear power for the electric arc furnace
Plasma decomposition of CO2 to syngas	Iron and steel making	Renewable or nuclear power for the electrical plasma
Reheating using electricity, blue or green hydrogen	Steel processing	Displacement of fossil fuel in steel reheating furnace
Fermentation of BFG, BOFG to ethanol and then synthetic fuels production	Iron and steel making	Avoidance of CO2 emissions from flue gas combustion*, substitution of fossil fuel by ethanol-derived fuels
BFG, BOFG combustion for heat and power	Iron and steel making	Avoidance of CO2 emissions from fossil fuel combustion for heat and power*
BFG, BOFG conversion to hydrogen using Water Gas Shift	Iron and steel making	Avoidance of CO2 emissions from fossil fuel use in hydrogen production*
Iron oxide chemical looping BFG, BOFG flue gas conversion to hydrogen	Iron and steel making	Avoidance of CO2 emissions from fossil fuel use in hydrogen production*

*CO2 emissions can further be reduced if CO2 from these processes is captured.

Per tonne of product, steel is one of the most carbon-intensive materials used in construction. So, if the case for steel is clear, then green steel is an imperative.

Process changes will mean product shifts for industrial gases producers. Less oxygen will be required in blast furnaces as they switch from coke to direct reduction of iron (DRI). On the other hand, hydrogen will be required to feed the DRI furnaces.

Other opportunities will emerge for industrial gases operators that are able to provide CO2 capture and processing technologies and services.

Decarbonisation of this sector is not a choice. The questions are not ‘why and if’. The questions are who, where, when, and how?