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Soroush Basirat || Energy Finance Analyst, Global Steel
Simon Nicholas || Lead Analyst, Global Steel

Hydrogen holds great potential for Australia's onshore green iron production

- *As more global rivals turn to green iron and steel production, the government's Hydrogen Headstart funding and tax credits can help Australia compete.*
- *South Australia's new green iron EOI and Quinbrook's project highlight the growing push to bypass gas and shift straight to green hydrogen-based DRI in Australia.*
- *The Future Gas Strategy's notion that gas has a role in steelmaking directly contradicts the steel sector's growing global shift towards green hydrogen.*
- *Gas-based DRI has lower emissions than coal-fired blast furnaces, but still emits significant CO2. Carbon capture and storage technology (CCS) is unable to effectively decarbonise gas-based steelmaking.*

Steelmakers around the world are focusing on ways to reduce their significant carbon emissions in response to growing investor pressure and the implications of the EU's carbon border adjustment mechanism (CBAM), which looks likely to be replicated globally. The industry will need to shift away from fossil fuels towards alternative ways to reduce iron ore. Direct reduced iron (DRI)-based steelmaking using green hydrogen is the most promising near-term alternative. With excellent renewable energy resources available to produce green hydrogen relatively cheaply, there is growing interest in Australia's potential to process its iron ores into "green iron" onshore for export to steelmakers seeking emissions reductions.

Two pivotal strategic plans announced recently will shape the industrial and energy landscape for green iron and steel in Australia. The Future Made in Australia initiative, which aims to embrace the nation's renewable energy advantages and support Australian manufacturing amid the energy transition, and the Future Gas Strategy, which asserts that gas will remain a key element of the energy framework, including for iron and steel. These strategies present divergent and contradictory paths for the future of iron production in Australia. Continued reliance on gas presents risks to Australian manufacturing in a world that is transitioning away from fossil fuels.

Under the Future Made in Australia initiative, the Australian government has announced a Hydrogen Production Tax Incentive of $2 per kilogram of green hydrogen produced between 2027-28 to 2039-40, for up to 10 years per project and a further A$1.3 billion over the next decade in Hydrogen Headstart program funding to support green hydrogen production development. With hydrogen export looking prohibitively expensive, Australian green hydrogen should be used domestically, with ironmaking a key potential off-taker.

Conversely, the Future Gas Strategy stated, "Gas will support our economy during the transition to net zero and will remain a critical part of the energy landscape in 2050 and beyond", emphasising the use of gas in the steel sector. The Future Gas Strategy Analytical report also addressed the steel sector, stating, "Similarly, for heavy industry users of coal (such as steel manufacturing), gas can provide an intermediate step toward future use of hydrogen in production while lowering emissions."

The key to truly low-carbon iron and steel production in Australia lies in resolving this incongruity and choosing a path forward considering national competitiveness, with other countries now examining the green iron and steel opportunity.

Gas-based iron production is not low-carbon

Iron production via the DRI process is well established in the Middle East where cheap gas is available as a reducing agent to remove oxygen from iron oxide and produce iron. However, green hydrogen can be used instead of gas to achieve very low-emission iron production and ultimately green steel. The key providers of DRI shaft furnaces have made clear that their technology is hydrogen-ready.

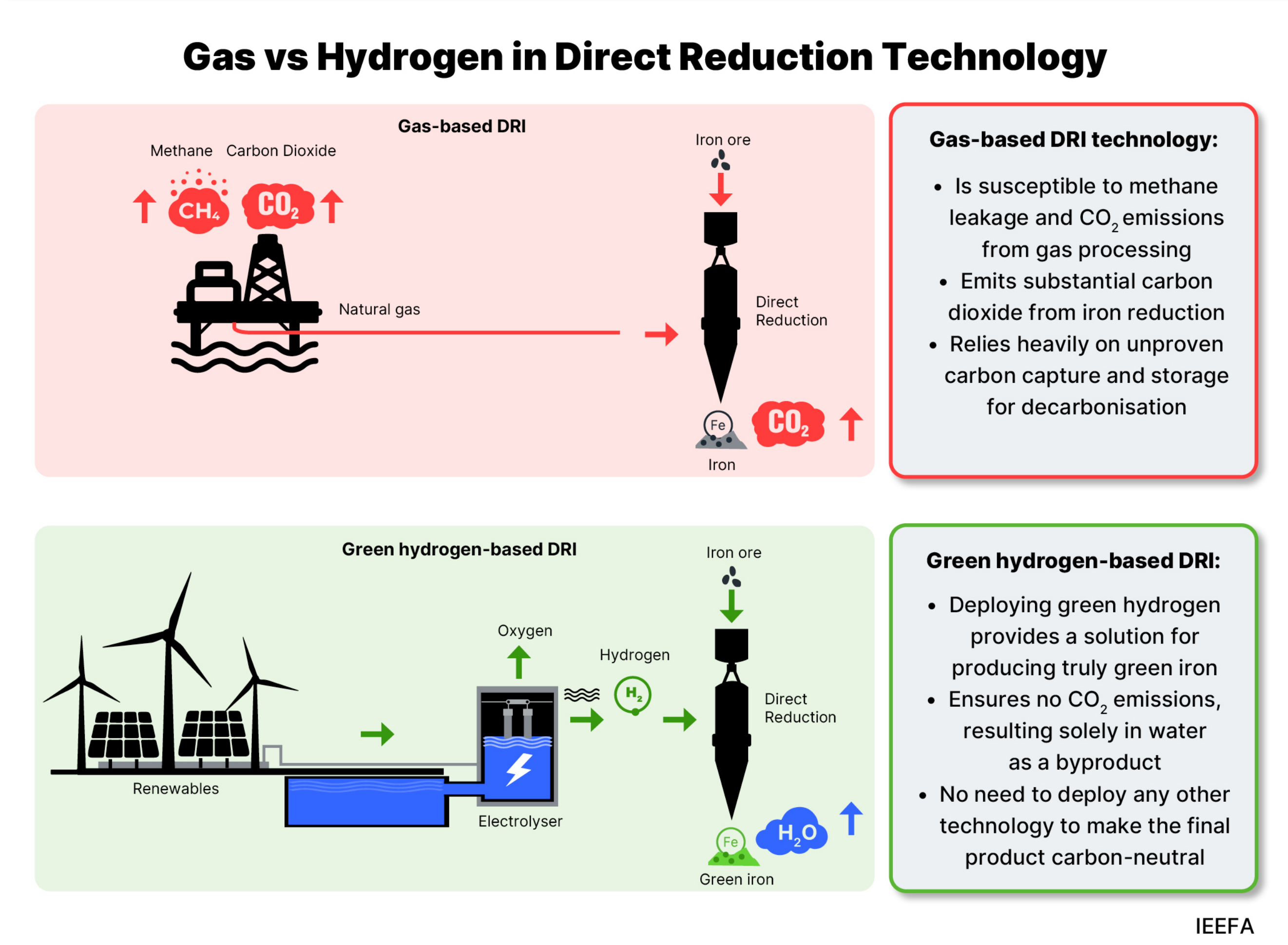
Gas-based DRI emits significant greenhouse gases. Direct emissions of 1 tonne of CO2 per tonne of crude steel primarily stem from the use of gas in direct reduction, pelletising and lime calcination processes. Without an effective method to counteract these emissions, gas cannot be used to make truly low-carbon or "green" iron and steel.

Carbon capture and storage (CCS) cannot make iron and steel produced via gas-based DRI green. CCS looks unlikely to play a significant role in steel decarbonisation due to its low rates of capture, high cost, uncertainty over the effectiveness of long-term storage, lack of suitable storage sites, CO2 transportation issues, long track record of failure and underperformance in other sectors. The uniqueness of each CCS project limits technological learning and cost reductions.

There is only one commercial-scale CCS facility in the steel sector globally. The Al Reyadah CCS project captures emissions from Emirates Steel Arkan's DRI-based steelworks but has only been able to capture 19-26% of the plant's emissions in recent years. As such, this plant cannot be considered decarbonised. Since the Al Reyadah project came online in 2016, no other commercial-scale CCS projects in the steel sector have been established anywhere.

Despite this, Liberty Steel – which is planning a switch from blast furnace-based steelmaking to DRI at Whyalla in South Australia – has signed a memorandum of understanding (MoU) with Santos to supply gas to the new DRI plant. Liberty intends to start the DRI plant running on a mixture of gas and green hydrogen, and has signed an agreement with the South Australian government for the supply of green hydrogen from the state's 250MW green hydrogen electrolyser project at Whyalla.

The Santos MoU includes a joint pre-feasibility study on using CCS to abate the steel plant's emissions. This would link the Whyalla steelworks as a customer to Santos' "flagship"



Moomba CCS project. In common with the global experience, Australian CCS projects have a poor track record with the notable example being the major underperformance of CCS at the Gorgon gas processing and LNG facilities in Western Australia.

Car makers are already signing purchase agreements for green steel made using green hydrogen with virtually no emissions. Tighter definitions of what exactly constitutes "green iron" and "green steel" can be expected in the near future. There is a significant risk that steel produced using gas – with or without CCS – won't meet such definitions. Steel and iron makers will be increasingly exposed to the risk that steel consumers will not want fossil fuels involved in their supply chains at all.

Considering all emissions associated with gas supply and consumption, and the absence of technologies capable of capturing and safely storing emitted CO2, the future of nascent iron production in Australia cannot rely on gas, particularly in the face of moves overseas towards production of truly green iron.

Global green iron competition is growing

Start-up H2 Green Steel's first plant, which will run on green hydrogen, is already under construction in northern Sweden, and expected to begin operations in 2026. As well as producing steel, the plant will also produce green iron (in the form of hot briquetted iron – HBI) for export. Rio Tinto has signed an agreement to offtake and on-sell the green HBI produced. H2 Green Steel is already planning further green hydrogen and DRI-based steel plants in Canada, Portugal, the US and Brazil.

Brazil is the largest producer of direct reduction-grade (DR-grade) iron ore in the world. DR-grade iron ore has a higher iron content (and lower impurities), making it suitable for DRI-based steelmaking. As such, Brazil is in a strong position to become a green iron exporter using its high-grade ore and green hydrogen produced from its hydro and wind power resources. In June 2024, the Brazilian Senate approved a new clean hydrogen bill that will provide billions of dollars in subsidies and tax benefits to green hydrogen producers. Iron ore giant Vale signed an MoU with the Port of Açu in September 2023 to study the development of DRI facilities for the export of HBI as part of Vale's "Mega Hubs" concept.

Mega Hubs are industrial complexes to which Vale will supply DR-grade iron ore for processing into low-carbon iron and steel. Vale has already begun developing Mega Hubs in three countries in the Middle East (Saudi Arabia, Oman and the UAE). Already an established DRI-based steel producer, the Middle East is now eyeing expanded capacity and green hydrogen.

Kobe Steel and Mitsui have signed a MoU to explore the feasibility of DRI production and iron export as HBI in Oman. Their target is to produce 5 million tonnes (mt) of DRI from 2027, and a switch to hydrogen or CCS is being considered. It is expected that the project will export HBI to Europe and Asian markets.

This is not the only low-carbon DRI project in Oman. Vulcan Green Steel plans to invest US$3 billion in an integrated greenfield H2-DRI-EAF plant with a capacity of 5mtpa. The plant will be in the Special Economic Zone at Duqm, adjacent to green hydrogen facilities that can directly supply the DRI plant with green hydrogen, reducing transportation costs, although the plant will initially be based on gas. The company is targeting low-carbon steel demand in the Middle East, Europe and Japan. In June 2024, Volkswagen Group announced it was entering into a partnership with Vulcan Green Steel for the purchase of low-carbon steel from the Oman plant.

In the UAE, Emirates Steel Arkan has partnered with Japanese steelmaker JFE Steel and trading house Itochu Corporation to investigate the production of iron in Abu Dhabi for shipping to Asia for use in steelmaking by JFE Steel and other steelmakers from late 2025. The plan will consider a later switch to hydrogen-based steelmaking. Separately, Emirates Steel Arkan is advancing efforts to use green hydrogen in DRI-based steelmaking by establishing the region's first green hydrogen-based DRI pilot plant in collaboration with Masdar.

Meanwhile, steel giant China Baowu Group has signed an agreement with Aramco and the Saudi Arabian Public Investment Fund (PIF) to set up a hydrogen-ready DRI-based steelmaking plant in Saudi Arabia to supply the domestic and regional market with steel.

Green iron developments are also now under way in Africa despite the significant infrastructure issues often faced across the continent. Construction of Africa's first green iron plant – using green hydrogen from day one - is under way in Namibia. The plant is expected to begin export of green iron at a small scale to Germany in late 2024 before ramping up to 1mtpa. In Mauritania –Africa's second largest iron ore exporter – CWP Global has signed an MoU with national iron ore miner SNIM to collaborate on plans to use green hydrogen to produce green iron for export to Europe. European Commission president Ursula von der Leyen was in Mauritania in February 2024 where she highlighted the opportunity for the country to use some of its planned green hydrogen production to make and export green iron.

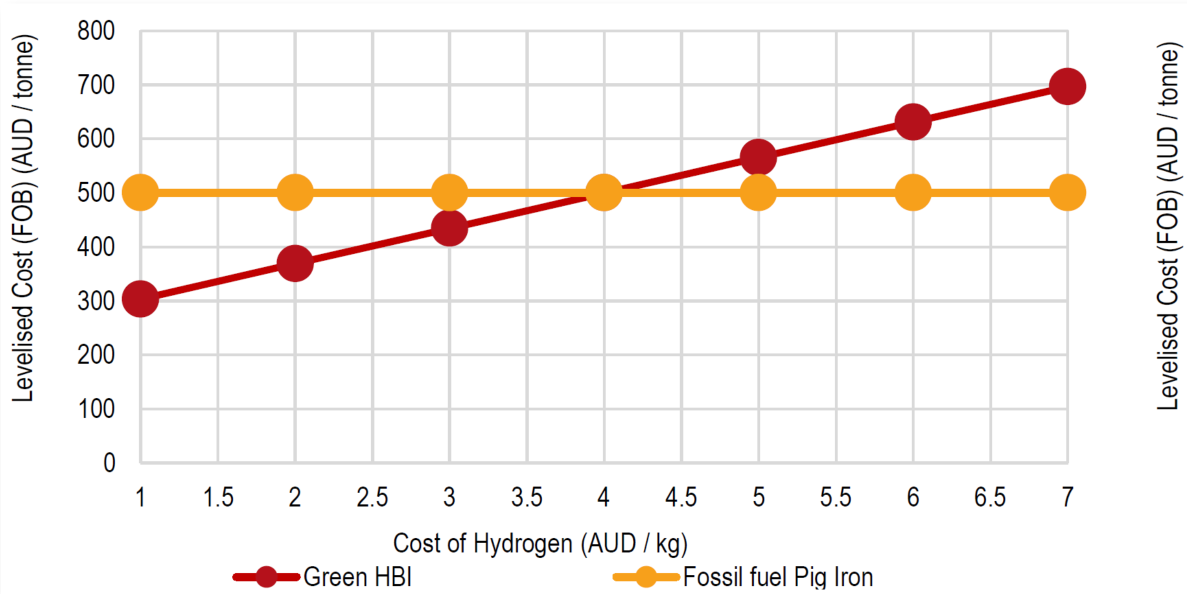
Australia's green iron opportunity

Iron ore is Australia's biggest export, which means that a truly low-carbon makeover of this sector using green hydrogen is potentially the most impactful part of the Future Made in Australia plan. Although the tax credit may not be as generous as the IRA's hydrogen support, which can reach up to US$3/KgH2(≈A$4.5), it still has the potential to drive Australia's industrial transition by making green hydrogen prices more competitive.

Fortescue executive chairman Andrew Forrest described the tax incentives as a "historic moment", stating, "This incentive will fast-track the development of a green iron industry in Australia." Fortescue is targeting net zero by 2040 including Scope 3 emissions primarily generated from using the company's iron ore to produce steel and is already developing the technology to enable it to become a green iron supplier, including high-grade iron ore and green hydrogen. Fortescue's 22mtpa Iron Bridge magnetite mine is ramping up, production of ore suitable for DRI-based steelmaking. The company also has several green hydrogen projects globally, including the Christmas Creek green iron pilot plant in the Pilbara. Fortescue is in preliminary negotiations with China to supply 100mtpa of green iron while pointing out that very large volumes of green hydrogen will be required to achieve this output.

A Minerals Research Institute of Western Australia (MRIWA) study showed that producing green iron in Western Australia using magnetite ore and green hydrogen costs about A$712/tonne, assuming A$7/kg for hydrogen. The report suggested that green iron (as HBI) can be economically competitive with blast furnace-produced pig iron when the hydrogen price reaches A$4/kg. With the new A$2 tax credit, competitive steelmaking using green hydrogen moves closer.

HBI from green pellets using renewable hydrogen green



Source: MRIWA

Western Australia Premier Roger Cook – aware of the state's vulnerability to an iron ore downturn now China has moved past peak steel demand – is eyeing the green iron opportunity. The great majority of the state's iron ore export is hematite. Now, the WA government is looking at increased DRI-suitable magnetite mining, with Cook stating, "What's more exciting is the opportunity to process the magnetite, utilising renewable energy to create green steel precursor products, briquettes, things like that, and exporting that, which is a much higher-value product that creates many more jobs."

New green iron projects utilising green hydrogen from day one are now emerging in Australia. Quinbrook Infrastructure Partners, a renewable energy investor, has announced a major A$3.5 billion (US$2.3 billion) green iron project in Queensland. This project aims to utilise green hydrogen from the nearby CQ-H2 facility, which is one of the six shortlisted projects earmarked for Hydrogen Headstart funding and slated to begin production in 2028. Quinbrook has secured land adjacent to the CQ-H2 green hydrogen project, and partnered with Central Queensland Metals, which holds exploration permits for the largest known magnetite deposit in Queensland.

In June 2024, the South Australian government commenced the search for partners through an expression of interest (EoI) process to establish a new green hydrogen-based DRI facility in the state before 2030. The state relies on two main factors for its green iron transition: abundant renewable energy sources (solar and wind), and vast reserves of high-quality magnetite iron ore suitable for DRI production. A Monash University study shows that the cost of steel production in Germany with locally made DRI can be 21% higher compared with importing HBI from South Australia.

There are significant opportunities in South Australia for producing green hydrogen, given the high and growing share of renewables in its power generation fleet. The state recently achieved 75% power generation from wind and solar over the twelve months leading up to March 2024, and aims to reach net 100% renewable energy by 2027, three years earlier than its previous target. South Australia is also establishing its green hydrogen and battery infrastructure, and developing its network to stabilise the grid electricity supply. The state has already agreed to supply green hydrogen from its green hydrogen project to the existing Whyalla steelworks as it transitions away from blast furnace-based steelmaking.

With its abundant renewable energy potential, magnetite reserves and significant state government support, including the release of the state government's Green Iron and Steel Strategy in June 2024, South Australia is poised to play a leading role in the future of green iron and steel production in Australia.

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About the Authors

Soroush Basirat

Soroush Basirat is an Energy Finance Analyst with IEEFA Australia, examining the global steel sector with particular focus on green technology transition and the opportunities and barriers for different nations and companies. Soroush analyses the feasibility of green steel solutions and their requirements for the whole value chain. sbasirat@ieefa.org

Simon Nicholas

Simon Nicholas is IEEFA's Lead Analyst for the global steel sector. Simon's focus is on the long-term outlook for steel production, as well as on the implications for the global iron ore and metallurgical coal markets. snicholas@ieefa.org