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South Australia leads nation towards green iron as global competition grows

- *As the hype over green hydrogen's potential uses undergoes a reality check, its future role in the production of green iron and steel is firming up.*
- *Australia faces growing international competition in the emerging "green iron" space from the likes of Brazil, Canada, the Middle East and North Africa.*
- *As Australia's attention turns towards the green iron opportunity, South Australia has taken a nation-leading position, greatly helped by its rapidly decarbonising power grid.*
- *Australian governments may need to work with overseas partners to ensure there is a market for future green iron exports, and overcome any reluctance among some steelmakers to import iron instead of making it domestically.*

Introduction

There has been a considerable over-reaction to the news that Fortescue is extending its green hydrogen production timeline and cutting jobs. Some reports have somehow interpreted this to mean that green hydrogen's decarbonisation role has failed before it has even begun. Fortescue remains focused on four green hydrogen projects, in Australia, Brazil, Norway and the US, and is eyeing four more across the Middle East and North Africa.

The hype around the ambitious production timelines and potential uses for green hydrogen were due for a reality check. Some prospective uses for green hydrogen, such as household heating, never made much sense, and hydrogen fuel cell cars have lost the race to electric vehicles (EVs). Exports of hydrogen look structurally expensive.

However, green hydrogen's role in some industrial processes is firming up. Iron and steel is one such sector, although there are also other routes to reduce its emissions, including significantly more scrap steel recycling in electric arc furnaces (EAFs).

This has recently been clearly demonstrated in South Australia with the state's new Green Iron and Steel Strategy, and the launch of its expressions of interest (EoI) process as it targets the development of a hydrogen-based green iron industry with corporate partners by 2030.

Domestically produced green hydrogen can be used to process South Australian high-grade iron ore into green iron, which can be exported to steelmakers overseas for processing into low-carbon steel.

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Although green hydrogen production is still often relatively expensive, there is potential for a first wave of locations to usher in green iron production using competitive green hydrogen. It has been suggested that future green iron production will be located where there are excellent renewable energy resources and reserves of the high-grade iron ore needed for direct reduced iron (DRI) processes that can produce low-carbon steel. DRI can run on green hydrogen. Coal-consuming blast furnaces can utilise lower grades of iron ore. The first wave of truly green iron projects will likely be located where there is high-grade iron ore and a power grid that is already decarbonised.

Most low-carbon power grids are dominated by hydro power. Where such locations have direct reduction-grade (DR-grade) iron ore reserves they have the potential to produce and export green iron. Start-up H2 Green Steel is located in northern Sweden, where hydro dominates power generation. Its first green iron and steel plant is already under construction, and will use green hydrogen from day one. Parts of Canada and Brazil have similar opportunities. South Australia is unique in that it has decarbonised its power grid through a rapid switch from fossil fuels to wind and solar, giving the state the potential to produce green hydrogen using renewable power that would otherwise be curtailed.

Global green iron competition intensifies

Momentum in the green iron space is building in Australia. Apart from South Australia, Quinbrook Infrastructure Partners announced a green iron project in Queensland in May 2024. Western Australia – the world's biggest iron ore exporter – is alive to the opportunity that could come from switching to more high-grade iron ore mining in the state. The federal government has announced a A$2/kg green hydrogen production tax credit.

However, momentum in Australia needs to intensify. Australia faces global oversupply of its biggest export as new iron ore production starts to open up overseas and Chinese demand enters permanent decline. Australia also faces growing international competition in the emerging green iron export space – a future market that could allow Australia to add considerable value to its exports.

H2 Green Steel's first steel plant will also produce green iron (in the form of hot briquetted iron – HBI) for export. The company is already planning further green hydrogen and DRI-based steel plants in other countries – Canada, Portugal, the US and Brazil. Blastr Green Steel in Finland also plans to be an HBI exporter.

Canada is already an exporter of DR-grade iron ore, and some provinces have power grids based largely on hydro power. CWP Global has signed a memorandum of understanding (MoU) with the Port of Corner Brook in Newfoundland and Labrador for a 5 gigawatt (GW) green hydrogen hub that would include the production and export of green iron as HBI. Meanwhile, Canada's own clean hydrogen investment tax credit has become law, and will offer tax credits of up to 40% on the purchase and installation of eligible equipment.

Meanwhile, Brazil's clean hydrogen tax credit proposal is about to become law. The largest producer of DR-grade iron ore in the world, 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. Fortescue's Brazilian green hydrogen project has progressed to the Front End Engineering Design (FEED) process.

Iron ore giant Vale signed an MoU with Brazil's Port of Açu in September 2023 to study the development of DRI facilities for the export of HBI as part of the company'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 begun developing Mega Hubs in Brazil and the US as well as three countries in the Middle East (Saudi Arabia, Oman and the UAE).

Already an established DRI-based steel producer, the Middle East plans to expand capacity, HBI exports and green hydrogen-based steelmaking using DR-grade iron ore imported from Brazil. Kobe Steel and Mitsui have signed an 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 an annual capacity of 5Mt. The plant will be in the Special Economic Zone at Duqm, adjacent to green hydrogen facilities that can directly supply the DRI plant, 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 trading house Itochu Corporation to investigate the production of iron in Abu Dhabi to ship to Asia for use in steelmaking by JFE Steel and other steelmakers from 2027. 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. Turkish steelmaker Tosyali intends to build a hydrogen-ready DRI-based steel plant in Saudi Arabia. Essar Steel is also planning DRI-based steelmaking in the country.

Green iron developments are also 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 when she highlighted the opportunity for the country to use some of its planned green hydrogen production to make and export green iron.

Then in July 2024, Tosyali announced its intention to build the world's largest DRI-based steel plant in Libya – with a capacity of more than 8Mtpa – that will export HBI to the region and

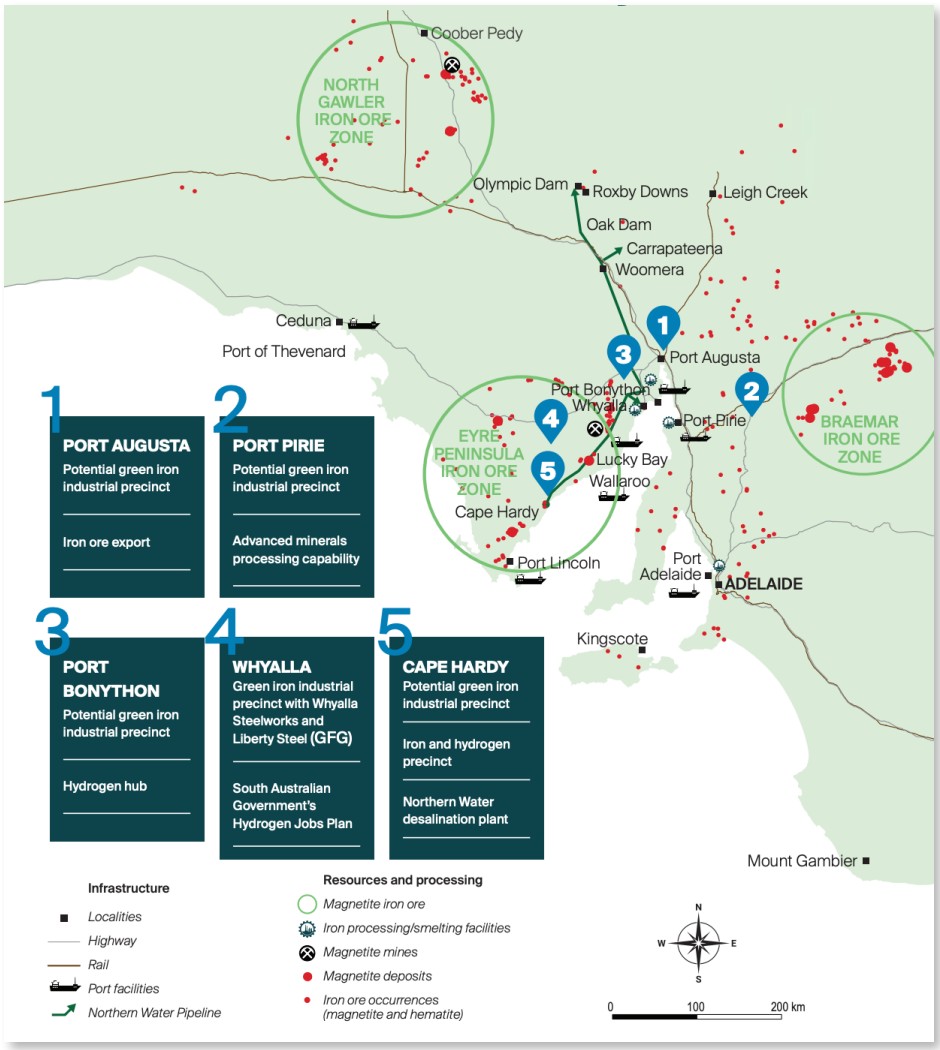
Europe. Tosyali will employ hydrogen-ready MIDREX Flex DRI technology. The company's chairman Fuat Tosyali has stated that, "We aim to be the first steel company in our region and one of the few steel companies in the world that produces with hydrogen."

South Australia's green iron advantages

Key among South Australia's numerous tailwinds as it targets the green iron sector is government support. On top of federal government backing for green iron as part of the Future Made in Australia policy, state government support has placed South Australia at the forefront of green iron development nationally and globally.

In the state's Green Iron and Steel Strategy, Premier Peter Malinauskas states, "South Australia's unique combination of sun, wind and iron ore provides us with a once-in-a-generation opportunity to lead the world in green iron and steel." The strategy encompasses the transition of Liberty Steel's Whyalla steelworks from coal-consuming blast furnace-based operations to DRI-EAF and the establishment of another green iron plant in the Upper Spencer Gulf. It also targets production at a new magnetite mine, first shipment of green iron, construction of a new DRI plant and an end to coal imports – all by 2030. An EoI process was launched in June 2024, seeking industry partners to jointly investigate the establishment of a green iron industry in the state by 2030.

Figure 1: South Australia's green iron and steel ecosystem



Source: South Australian government – Green Iron and Steel Strategy

Making green iron in DRI-based facilities will require competitive green hydrogen. South Australia's rapidly decarbonising power grid gives the state an added advantage to meet this need.

Wind and solar provided a world-leading 70% of South Australia's power generation over the past year. The state's target to reach 100% net wind and solar power has been brought forward from 2030 to 2027. Already there is more power than the state can use in the middle of sunny and windy days. As a result, the state government is developing a 250 megawatt (MW) green hydrogen plant to use this excess renewable energy. Some of the planned hydrogen production has already been earmarked for iron and steelmaking. The state government has reached a provisional agreement with Liberty Steel for offtake from the state-owned green hydrogen project.

This project and a separate development – the Port Bonython Hydrogen Hub – are led by the South Australian government's Office of Hydrogen Power. The Port Bonython hub will also include green hydrogen exports. Given the structural expense of shipping hydrogen, the project may be better focused on domestic uses, including green iron and steel.

High-grade iron ore is needed for DRI-based steelmaking using green hydrogen, and South Australia has plenty of it. The state's iron ore is mostly magnetite, which can be processed into concentrates with the necessary 67% iron content to meet DR-grade. South Australia has nearly 19 billion tonnes of JORC-compliant magnetite iron ore, with 7.4 billion tonnes of Economic Demonstrated Resources. SIMEC Mining – a subsidiary of the GFG Alliance along with Liberty Steel – aims to increase magnetite ore production to 30Mtpa by 2030.

There are further opportunities to expand South Australian magnetite production suitable for green iron and steel production. Magnetite Mines is developing its DR-grade Razorback Iron Ore Project, targeting the state's green iron opportunity. In July 2024, the company signed an MoU with Zen Energy covering renewable energy offtake and potential participation in future green iron projects. In the same month, Magnetite Mines signed a heads of agreement with JFE Shoji – part of Japan's JFE Group that includes the country's second-biggest steelmaker, JFE Steel. The agreement forms the basis of negotiations to fund a Definitive Feasibility Study for the Razorback project and offtake rights for DR-grade magnetite concentrate.

Is there a market for green iron exports?

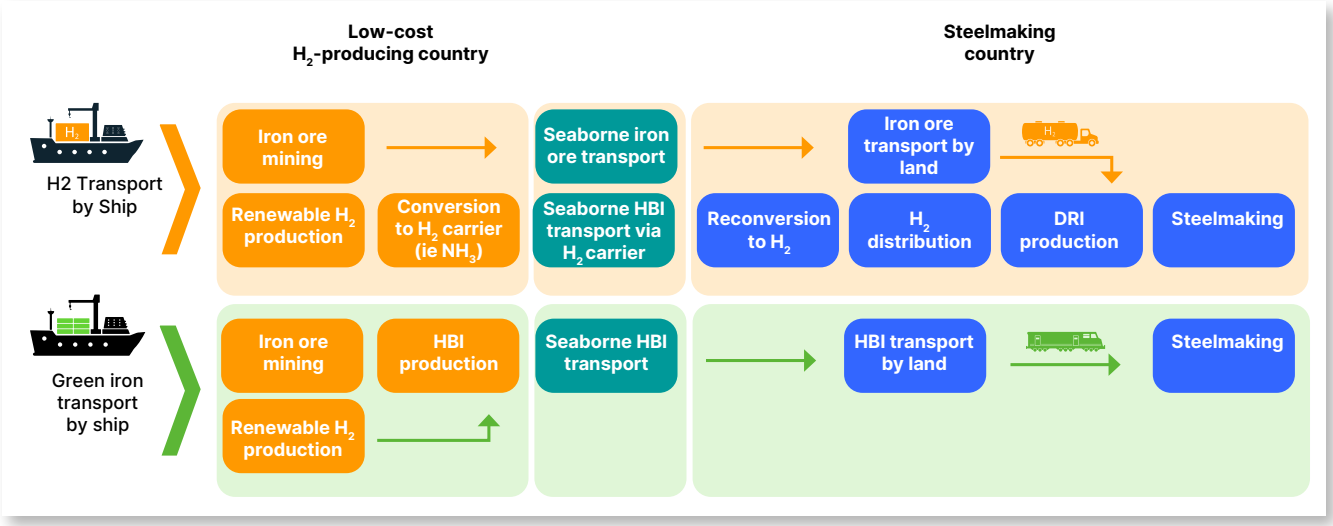
Australian governments are starting to focus on the prospect of exporting green iron, but they need to ensure a market for such exports exists.

Major steelmakers are often resistant to the idea of importing iron from overseas instead of making it themselves. European governments are subsidising their steelmakers to transition their operations from blast furnaces to DRI domestically, not to see ironmaking relocated overseas. The EU's Carbon Border Adjustment Mechanism (CBAM) is as much about protecting European industry as reducing emissions. Asian governments may also be reluctant to see their steelmakers relocate ironmaking offshore.

However, some European steelmakers are concerned about running their planned DRI plants on green hydrogen due to the higher cost of either producing green hydrogen domestically or importing it. Despite government subsidies committed to produce low-emissions steel, steelmakers may delay plans to run DRI shaft furnaces on green hydrogen, and instead persist with gas. Some companies, such as ArcelorMittal and iron ore major BHP, insist that carbon capture utilisation and storage (CCUS) will play a role in decarbonising fossil fuel-based steelmaking, despite growing evidence to the contrary.

As a result, it can be in steelmakers' interests to import green iron from locations where green hydrogen production is cheaper. Agora Industry found that green iron trade can lower the cost of the global steel technology transition, particularly for countries that have higher green hydrogen production costs. Agora also found that shifting iron production overseas would affect relatively few domestic ironmaking jobs, and the lower transition cost would help safeguard 90% of domestic steel sector jobs.

Figure 2: Comparison of two cross-country low-carbon steelmaking chains



Source: Agora Industry and Wuppertal Institute (2023). HBI = hot briquetted iron, DRI = direct reduced iron

There are already signs of a global HBI trade emerging. Rio Tinto has signed an agreement to offtake and on-sell the green HBI produced by H2 Green Steel at its under-construction plant in Sweden. Many of the global projects noted above are for the production and export of HBI rather than steel production. Importantly, some of these involve steelmakers that are considering importing HBI, such as JFE Steel and Kobe Steel's projects in the Middle East. In addition, South Korean steel giant POSCO is considering an HBI production and export project in Western Australia.

According to Global Energy Monitor, 93% of global steelmaking capacity developments announced since 2023 are EAF, indicating an accelerating technology shift away from blast furnace-basic oxygen furnace steelmaking. As significantly more scrap steel is recycled in EAFs, particularly in China, the supply will not be sufficient to meet demand. So there is a clear opportunity for increased HBI trade to supplement scrap in the growing global fleet of EAFs.

With Chinese iron ore demand past its peak, developing Asian countries are unlikely to pick up the slack. Significant iron ore oversupply is predicted towards the end of this decade, so it is a good time for Australia to position its iron ore (or iron) industry for the longer term.

Australia is well placed to become an exporter of green iron in the form of HBI in addition to iron ore, but federal and state governments need to make sure there are markets for it overseas. This may require working with the governments of major steelmakers such as China, Japan and South Korea, but also those of emerging Asian nations.

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