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12 July 2024

To: Department of Industry, Science and Resources
RE: Unlocking green metals opportunities for a Future Made in Australia

Thank you for the opportunity for the Institute for Energy Economics and Financial Analysis (IEEFA) to provide input on the *Unlocking green metals opportunities for a Future Made in Australia* consultation paper. IEEFA is an energy finance think tank that examines issues related to energy markets, trends, and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy.

IEEFA has provided insights into developing **green iron and steel in Australia**, highlighting the nation's competitive advantages and its potential to be a major player in the green iron and steel transition.

Australia possesses all the essential ingredients to become a global leader in iron and steel production, including the largest iron ore reserves, and one of the best renewable energy sources in the world.

While Australia has the fundamental resources for a green iron transition, swift and decisive action is needed to stay ahead of competitors vying for a larger share of the emerging green iron and steel market.

IEEFA's responses to some of the questions are presented over the following pages.

Regards,

Soroush Basirat, Energy Finance Analyst, Global Steel

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1. What insights do you have on green metals markets?

c. Which countries/markets are green metals currently being sourced from and used in?

f. Which countries or markets will provide the greatest international competition, or demand for Australian produced green metals?

Australian iron ore – the nation's biggest export – risks losing ground to other nations in the accelerating global shift towards green iron and low-carbon steel if research and development projects are not sped up. The accelerating decarbonisation of the steel sector is creating increased demand in the global iron ore market for higher-grade ores.

A recent IEEFA study found Australia faces a distinct disadvantage due to the lower quality of its hematite iron ore compared with other nations. Steelmaking based on direct reduced iron (DRI) currently requires ores with a high iron content – typically 67% or more. Most of the Pilbara region's commercial deposits contain between 56% and 62% iron, currently suitable only for incumbent, highly carbon-intensive blast furnace technology.

Although Australia leads the world in iron ore exports, other nations and regions have the opportunity to combine their higher-grade iron ore and renewable energy resources to produce green iron for export in response to future demand growth.

Brazil

Brazilian iron ore miner Vale – the world's leading producer of direct reduction (DR)-grade iron ore – believes that it has an advantage over the other major iron producers when it comes to the steel technology transition towards DRI-based steelmaking. Its DR-grade ore can be used in standard and well-established DRI-EAF (electric arc furnace) steelmaking operations, without the need for an additional melting furnace step required to enable the use of blast furnace-grade ore (such as that produced in the Pilbara) in DRI processes. Brazil is in a position to produce green hydrogen at a competitive price compared with many other regions as hydrogen electrolyser costs come down.

Vale projects that by 2030, global production of DRI and hot briquetted iron (HBI) will increase 55% to 200 million tonnes per annum (Mtpa), and demand for seaborne DR-grade iron ore will more than double to 110Mtpa. Vale sees DR-grade ore demand continuing to rise beyond 2030 while demand for benchmark 62% (blast furnace-grade) iron ore has now entered permanent decline. Vale forecasts that a DR-grade demand-supply gap of around 70Mtpa could emerge by 2030. The company's target is to triple the high-grade iron ore pellets and briquettes production to 100 million tonnes (Mt) by 2030.

Vale will supply DR-grade pellets via its Tubarão facility in Brazil for the H2 Green Steel plant in Boden, Sweden. The two companies have also signed an agreement to study the development of

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green steel industrial hubs in Brazil and North America. The concept of the industrial hubs covers green hydrogen and HBI production using renewables and Vale's iron ore briquettes.

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. In September 2023 Vale signed a memorandum of understanding (MoU) with the Port of Açu to study the development of DRI facilities for the export of HBI as part of Vale's "Mega Hubs" concept.

Canada

Canada is currently a producer and exporter of high-grade iron ore pellets, and it is well-positioned to produce green iron due to its potential to generate low-emissions electricity from hydro and wind power.

IEEFA's research shows that in the short term, the need for non-stop zero-emissions electricity is enticing steelmakers to regions where lower-emissions grid electricity is already available, including locations in Norway, Brazil, northern Sweden, and the Canadian province of Quebec.

H2 Green Steel is exploring plans to build a new green iron facility in Quebec, which enjoys rich hydropower capacities. Quebec's power grid is 94% hydro and 5% wind power. H2 Green Steel is negotiating for hydroelectricity allocation to its potential green iron project in Quebec.

Green hydrogen developer CWP Global has signed an MoU with Corner Brook Port to produce green hydrogen using 5 gigawatts (GW) of wind power, which will be utilised in HBI production. Project Gwinya is located in Newfoundland and Labrador, a province blessed with world-class wind power resources.

Middle East

The Middle East is already a hub of DRI-based steelmaking based on the region's plentiful gas supply and has an opportunity to convert its steel industry from gas to green hydrogen utilising the region's abundant solar resources. This prospect is already drawing interest from steelmakers and miners, who are eyeing the region becoming a green iron hub based on growing DR-grade iron ore supply from Vale.

Vale has already begun developing Mega Hubs in three countries in the Middle East: Saudi Arabia, Oman and the United Arab Emirates (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 exports as HBI in Oman. Their target is to produce 5Mt of DRI from 2027, and a switch to hydrogen or carbon capture and storage (CCS) is being considered. It is expected that the project will export HBI to Europe and Asian markets.

In the UAE, Emirates Steel Arkan has partnered with Japanese steelmaker JFE Steel and trading house Itochu Corporation to investigate the production of 2.5Mtpa iron in Abu Dhabi for shipping

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to Asia for use in steelmaking by JFE Steel and other steelmakers from 2027. Itochu is establishing a value chain for transporting high-grade iron ore from Brazilian company CSN Mineração, which is set to build a new plant in Brazil to produce pellet feed iron ore. The iron ore pellets will then be processed in the UAE to produce reduced iron, which will ultimately be used in steel mills in Japan, including JFE's new EAFs in Kurashiki.

Africa

Although a smaller iron ore producer, Africa already produces grades of higher quality than Australia, and there is the prospect of much more to come, including from Australian companies that are now shifting into the continent.

In the coming years, Guinea looks set to become the third-largest iron ore producer in the world after Australia and Brazil, with a quality significantly higher than Australia's. If Simandou projects led by Rio Tinto and Chinese companies run smoothly, the deposits could produce 200Mtpa of high-grade, 65-66% Fe ore by 2030. Rio Tinto has stated that the deposit is estimated to have 40% of high-quality iron ore resources that are "well suited to meet DRI specification and could be processed using the DRI-EAF route".

In a sign of the growing competition Australia faces, some steelmakers are considering offshoring green iron production. CWP Global has announced plans to use hydrogen from its 30GW Aman project in Mauritania to produce green iron in the form of HBI for export to Europe. Aman Green Energy has also signed an MoU with SNIM, Mauritania's largest iron ore producer, to collaborate on this project and produce the first green iron by the end of this decade.

Earlier this year, European Commission president Ursula von der Leyen mentioned Mauritania as a key supplier not only for green hydrogen but also for green iron, stating: "… Mauritania is blessed with resources, that is space, sun and wind. With the right investment and infrastructure, this country can harness over 350GW of renewable energy only from wind and sun. But if we have clean energy coming into the game, the processing into green steel could stay here in Mauritania."

Namibia's Oshivela Green Iron project, backed by the German government, is the first of its kind in Africa. The plant will deploy HyIron technology to produce 15,000 tonnes of green iron, which will be used in steel mills in Germany. Production is set to begin in the last quarter of this year and the final capacity will reach 1Mtpa.

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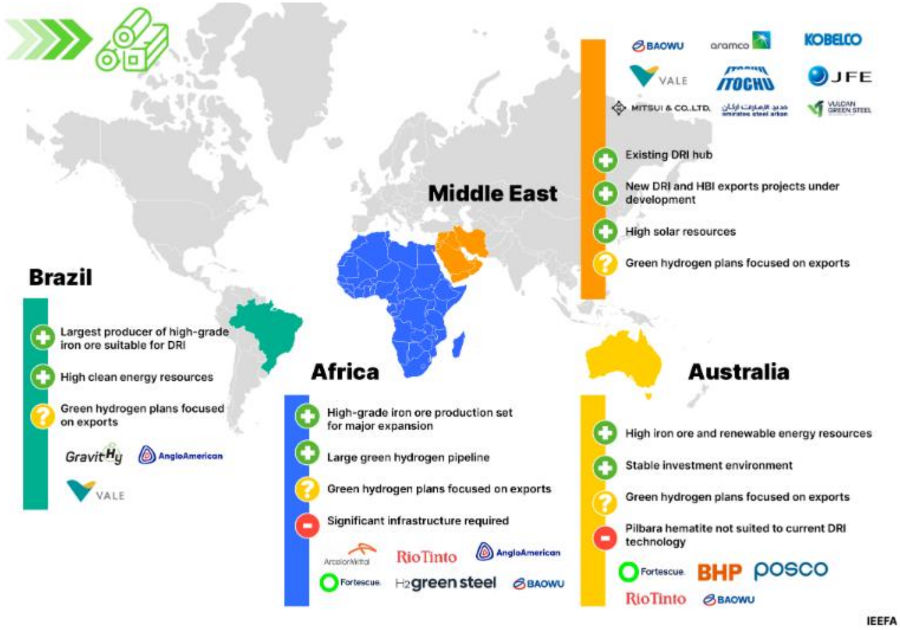
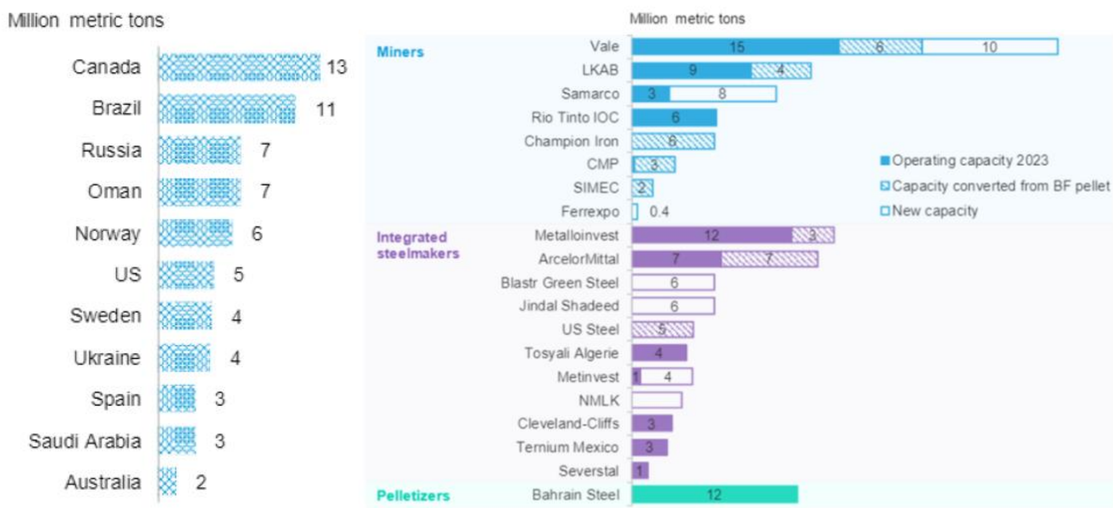
Figure 1: Australia needs to step up if it wants to compete in the green steel race



Green iron metallics supply chain

There is significant competition in supplying iron ore metallics and agglomerates globally, particularly iron ore pellets required for ironmaking. Australia may not hold a prominent position compared with other competitors. Figure 2 shows the DR-grade pellet projects in the pipeline, and it is evident that Australia, despite being the largest iron ore producer globally, does not have a project of comparable scale. The report by BloombergNEF emphasises that there will be a significant gap between DR-grade pellet supply and demand due to the transition in the steel sector. Australia must act quickly to seize this opportunity among other contenders in the market.

Figure 2: DR-grade iron ore pellet capacity expansion across 2023-2030



Source: BloombergNEF, Direct Reduction Grade Iron Ore: A green Steel Bottleneck (18 April 2024).

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Vale has developed a new agglomeration technology – iron ore briquette – which uses a binder at a lower temperature. This technology offers several advantages over conventional methods, including 80% lower carbon dioxide (CO_2) emissions and no water consumption compared to iron ore pellets. Vale has signed various MoUs with different green iron and steel initiatives around the world, including Hydnum, GravitHy and Green Steel Arabia (GSA) to supply high-grade iron ore agglomerates.

Even the current pellet suppliers around the world are shifting to producing DRI with hydrogen and expanding their presence in the value chain.

In 2020, Swedish iron ore giant LKAB announced a strategic shift in its business. The company aimed to transition from being an iron ore pellet supplier to producing hydrogen-reduced sponge iron. This move represents a significant advancement for the EU's largest domestic supplier of high-grade iron ore. LKAB is also a key partner in the HYBRIT joint venture with SSAB and Vattenfall, which aims to replace coal with hydrogen in the steelmaking process.

In 2021, Rio Tinto's Canadian pellet producer IOC signed an MoU with Paul Wurth and SHS-Stahl-Holding-Saar to produce hydrogen-based iron from iron ore pellets. IOC has also signed an agreement with H2 Green Steel to supply pellets to the Boden plant and purchase and on-sell part of the extra green HBI while the steelmaking capacity is ramping up.

Australian iron ore miners Rio Tinto and Fortescue are shifting to provide high-grade iron ore compatible with DRI production. In contrast, BHP is lagging, remaining focused on blast furnace-grade iron ore and continued metallurgical coal production, as well as focusing on unproven technologies such as carbon capture utilisation and storage (CCUS) to justify continued consumption of coal in blast furnaces.

While Fortescue's 22Mtpa Iron Bridge magnetite mine is ramping up production of ore suitable for DRI-based steelmaking, the company is also targeting high-grade iron ore in Africa. Fortescue signed a Mining Convention in February 2023 with Gabon for the Belinga Iron Ore Project in the north-east of the country. The Belinga project delivered the first shipment of iron ore in December 2023. Former Fortescue CEO Fiona Hick has stated that "every indication we have, shows the project has the potential to be significant scale and very high-grade", and that, "initial indications are that it could be similar in scale and size to Simandou in Guinea."

There is an accelerating shift towards the production of higher-grade iron ores and green iron using green hydrogen globally. Australia is at risk of being left behind this trend.

While green ironmaking technology is available and some pioneering companies have already initiated projects, most efforts in Australia remain small-scale (pilot plants) or are limited to collaboration announcements and MoUs, with almost no significant large-scale projects in the pipeline.

Australia must act swiftly to establish the value chain for green iron production. This requires developing more magnetite mines and increasing iron ore concentration and pelletising capacity to feed DRI facilities. Further development of technology that allows the use of blast furnace-

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grade iron ore – of the type that dominates Pilbara production – in DRI-based steelmaking is also required.

Read More:

Australia faces growing green iron competition from overseas

Big iron ore's long-term strategies diverging in the face of steel decarbonisation

2. How does metal recycling contribute to Australia's green metals industry in Australia?

b. What are the opportunities to increase metal recycling in Australia? How could this be achieved?

c. What impact does the export of scrap metal have on Australia's ability to develop a green metals industry and reduce emissions from existing industry?

IEEFA's research has shown that producing low-emission steel through a scrap-based pathway (secondary steelmaking) is the quickest way to decarbonise the steel sector. Scrap-based steelmaking has the lowest carbon emissions and the lowest energy intensity compared with other ore-based steelmaking technologies.

Australia currently has three large-scale scrap-based steel facilities with a total capacity of around 1.75Mtpa, including InfraBuild's two EAFs in Victoria and New South Wales (NSW), and the Molycop plant in NSW. Recently, Green Steel WA announced another EAF project, the Collie Green Steel Mill, with a 0.4Mtpa capacity planned to be operational by 2026. This project will bolster Australia's position in the emerging low-emissions steel market.

Globally, many scrap-based steelmakers are advancing towards low-emission steel production by using renewables to power EAFs and also enhancing their scrap recycling and treatment capacity. This ensures the scrap is free from detrimental contaminants and suitable for producing high-quality flat steel grades required by the automotive industry.

Ovako is a Swedish scrap-based steel producer – more than 97% of all iron and alloys it uses as input material are recycled. Its electricity comes entirely from fossil-free sources. In 2022, Ovako reported carbon emissions for Scope One and Two of 0.18 tonnes of CO_2 (tCO_2), equating to approximately $0.3tCO_2$ per tonne of external deliveries. In 2023, the company began using hydrogen instead of gas as a source of heat for reheating furnaces before rolling, marking a first in the steel industry.

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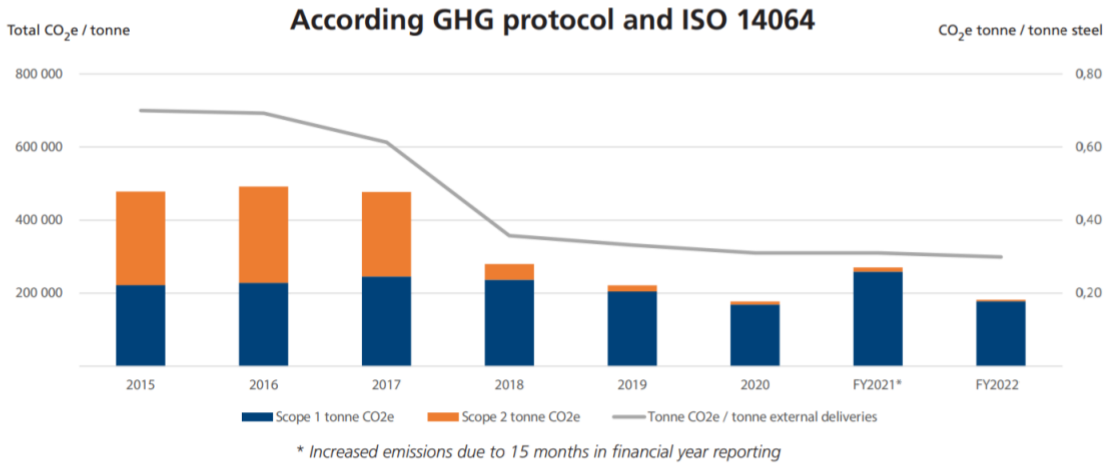
Figure 3: Ovako's greenhouse gas emissions



Source: Ovako.

Arvedi is an Italian scrap-based steel producer. The carbon intensity of the flat rolled steel produced at its Acciaieria Arvedi steelworks using an electric furnace and its ESP technology is 0.133tCO_2 per tonne of steel produced.

Japanese scrap-based steelmaker Tokyo Steel has recently launched its new green steel brand for the domestic market, claiming to have reduced carbon emissions from 0.4tCO_2 per tonne of steel to 0.1tCO_2 per tonne of steel. In June, the company also introduced a new brand named enso in partnership with Stemor to strengthen its presence in the EU low-emissions steel market.

While some scrap-based steelmakers around the world have achieved low-emissions steel, Australian producers are lagging. In its 2022 sustainability report, InfraBuild mentioned that the carbon intensity of its operations in Laverton and Sydney was respectively around 0.8tCO_2 and 0.6tCO_2 per tonne of crude steel. More than 75% of the company's emissions originated from electricity (Scope Two) and over 15% came from using gas in reheating furnaces. InfraBuild has pledged to reach carbon neutrality by 2030.

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Figure 4: InfraBuild Greenhouse Gas Emissions Intensity FY2018-22

Source: InfraBuild

Opportunities for processing scrap in Australia are significant. More facilities for scrap collection, sorting, separation and shredding must be developed to ensure an efficient scrap supply in the country. Going forward, with increased pressure on steelmakers to reduce their emissions, a scrap shortage may occur as competition surges to secure more supply from the global market. This makes self-sufficiency critical for countries heavily dependent on scrap-based steelmaking.

To successfully reduce emissions from secondary steelmaking, Australia must increase the supply of renewable energy to power electric furnaces, replace gas with alternatives such as hydrogen or electric heaters, and establish a reliable recycling value chain that ensures the supply of high-quality scrap with minimal contamination.

Read More:

New From Old: The Global Potential for More Scrap Steel Recycling

IEEFA: Is there scope for faster decarbonisation of Australian steel?

12. What are the key barriers to investing in new green metals facilities or decarbonising existing facilities?

Based on IEEFA's recent research on the competitiveness of different regions in green steel production, the most important challenges are: consistent supply of green hydrogen and clean electricity for steel mills; and the supply of high-grade iron ore.

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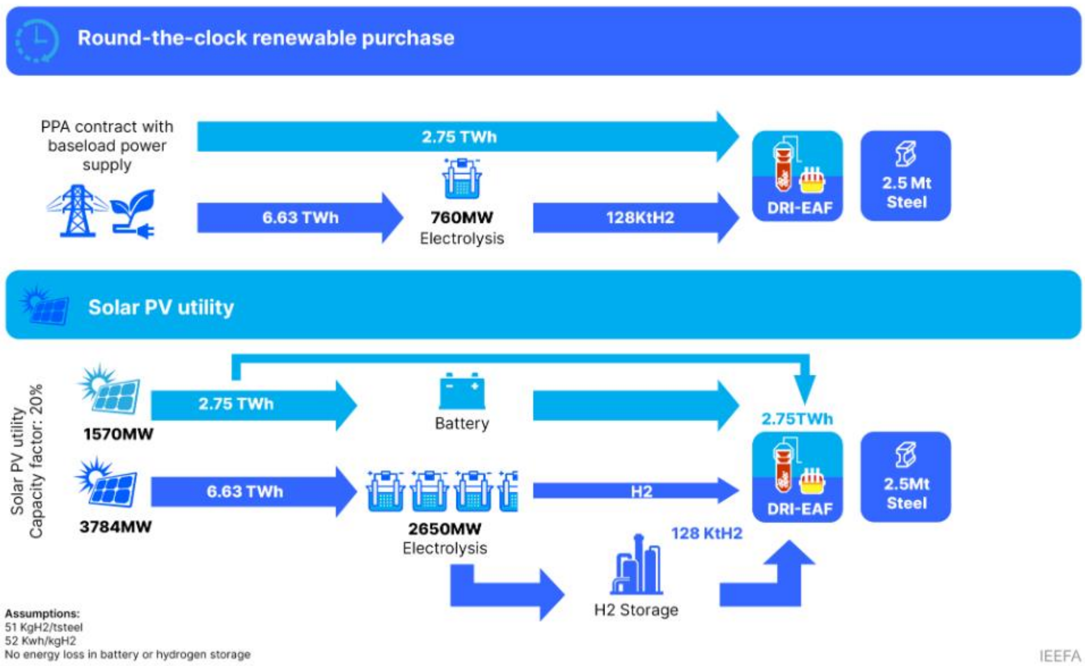
Supplying green hydrogen and clean electricity round the clock for steel mills

The magnitude of renewable power required for steel production, along with the additional investment needed to strengthen the value chain with hydrogen storage and/or battery storage to provide a round-the-clock power supply, is significant.

Producing green steel is an energy-intensive process, posing a challenge for steelmakers striving to embrace low-emission technologies like H_2-DRI-EAF (hydrogen-based DRI-EAF) steelmaking. The shift toward truly green steel using green hydrogen is expected to start in regions where the power grid is already dominated by clean electricity production.

The variability of renewable energy sources, such as solar and wind, necessitates oversizing of capacity and the implementation of energy storage solutions to ensure a continuous energy supply for steel mills. For one tonne of steel produced via H_2-DRI-EAF, nearly 3.6 megawatt-hours (MWh) of electricity is required. To produce green steel on the same scale as the H2 Green Steel project using a solar photovoltaic (PV) utility with a 20% capacity factor – irrespective of the plant's location, and without relying on battery storage for hydrogen production – the electrolyser's size should be increased by a factor of 3.5, and this augmentation must be supported by solar utility oversized by a factor of five. In this configuration, hydrogen storage and batteries are essential to ensure seamless operation. This inevitably requires increased capital expenditure.

Figure 5: Grid-connected versus Solar PV-supported green steel plants



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The forthcoming wave of green steel initiatives can be strategically situated in areas with access to very low-cost renewable energy sources. Even presently, several areas in Australia have the capacity to meet most of their energy needs through renewable sources – such as South Australia and Tasmania.

IEEFA recently identified 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 12 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. South Australia has already agreed to supply green hydrogen from its state-owned green hydrogen project to the existing Whyalla steelworks as it transitions away from blast furnace-based steelmaking.

Australia's first green hydrogen-based steelmaking is emerging in regions with available renewables, alongside the initial development of green hydrogen projects. Further investment is necessary to stabilise variable electricity sources with storage solutions for both energy and hydrogen to enable steelmakers to produce true green steel.

Read More:

Competing for Green Steel: National advantages and location challenges

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

High-grade iron ore supply

Switching from blast furnaces that consume coal to green hydrogen-based DRI processes is widely considered a key step in the global steel sector's decarbonisation pathway. However, insufficient supply of suitable iron ore is a potential challenge to a global shift towards zero-emissions DRI processes.

IEEFA's previous analysis found that Australia is challenged with the task of making its lower-grade iron ore suitable for DRI-based iron and steelmaking operations. This could include beneficiating Pilbara hematite iron up to DR-grade, and a switch to more magnetite mining, which is more amenable to beneficiation up to a higher grade.

Australian miners have concentrated their efforts on the Pilbara region for many years, and more than 96% of the nation's iron ore exports come from this area. The Pilbara's lucrative mining operations are a reason that Australian miners have been deterred from investing more in magnetite mines, which typically need more investment compared with hematite direct shipping ore (DSO) mining. Magnetite ores represent 38% of Australia's economic demonstrated resources of iron ore, of which 81% are in Western Australia, while only 3% of the state's exports come from magnetite ores.

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New announcements from South Australia's government – on the state's green iron Expression of Interest (EoI), and on Quinbrook Infrastructure Partners' green iron project in Queensland – reflect the momentum in the deployment of magnetite ores in green iron production in Australia. However, much more remains to be done in this area, and more Western Australian miners must join the growing trend of magnetite mining.

In addition, steel technology developments will likely be part of the solution. Iron ore miners and steelmakers are investigating technology solutions that would allow the use of their blast furnace-grade Pilbara iron ore in DRI-based processes. IEEFA's previous analysis found that a melting stage can be added to melt the DRI before being charged in a basic oxygen furnace (BOF) instead of an EAF to produce high-quality steel. These technologies enable steelmakers to utilise mid-grade iron ore with higher gangue. The new pathway of DRI-Melter-BOF is being developed by various steelmakers including Thyssenkrupp, ArcelorMittal, BlueScope and Tenova.

Earlier this year Rio Tinto, BHP and BlueScope Steel announced they are working together on making Pilbara iron ore suitable for DRI processes. While developing this technology could revolutionise iron production, Australia must also focus on existing technologies in the green steel transition. It is not advisable to concentrate solely on one technology and neglect the potential of commercially ready solutions such as magnetite iron ore in Australia.

Read More:

Solving iron ore quality issues for low-carbon steel

Iron ore quality a potential headwind to green steelmaking – Technology and mining options are available to hit net-zero steel targets

Unlocking the potential of magnetite ore for Australia's iron and steel transition

16. Are these technologies being developed or commercialised?

a. If yes, when do you expect these to be ready for commercial scale deployment?

b. If not, why not?

While there are various technologies available in the market with lower carbon intensity compared with conventional steelmaking, and even more innovative solutions in the pipeline, technologies such as CCUS have been around for decades without significantly impacting climate change. IEEFA's research has shown that CCUS looks unlikely to play a major role in decarbonising the global steel sector. It is increasingly obvious to many, including the International Energy Agency (IEA), that the uptake of DRI-based steelmaking – which can run on green hydrogen with very low emissions – is accelerating. This technology – along with EAFs associated with renewable electricity – offers steelmakers a far more promising pathway to reduce their emissions than CCUS.

Despite this, many major steelmakers around the world maintain that CCUS will play a role in decarbonising their operations. Their plans for CCUS tend to push commercial-scale implementation of the technology off into the 2040s and lack detail. There are no commercial-scale CCUS plants for blast furnace-based steelmaking in operation anywhere in the world. The few pilot projects that exist have not proven the technology's feasibility.

CCUS has been around for nearly 50 years and has accumulated a history of significant underperformance. According to BloombergNEF, CCUS currently captures just 0.1% of global emissions despite decades of implementation efforts. The IEA's updated 2023 Net Zero Roadmap report noted that: "The history of CCUS has largely been one of underperformance."

In 2022, IEEFA research showed that out of 13 flagship, large-scale CCUS projects, five had materially underperformed, two were suspended, one was mothballed and two did not provide data that allowed performance to be assessed. The study found almost three quarters of captured CO_2 was being used for enhanced oil recovery (EOR), enabling more fossil fuel extraction and therefore more carbon emissions. One issue with CCUS that is often missed is its low rate of capture. CCUS projects have consistently struggled to reach targeted capture rates.

Figure 6: CCS Projects' report card

Carbon Capture and Storage (CCS) projects' poor report card

Project	Capacity (MtCO2 p.a.)	Performance
Natural Gas processing		
1986 Shute Creek	7	Lifetime under-performance of 36%
1996 Sleipner	0.9	Performing close to the capture capacity
2004 In Salah	1.1	Failed after 7 years of operation
2007 Snøhvit	0.7	Performing close to the capture capacity
2019 Gorgon	4	Lifetime under-performance of ~50%
Industrial sector		
2000 Great Plains	3	Lifetime under-performance of 20–30%
2013 Coffeyville	0.9	No public data was found on the lifetime performance.
2015 Quest	1.1	Performing close to the capture capacity
2016 Abu Dhabi	0.8	No public data was found on the lifetime performance.
2017 Illinois Industrial (IL-CCS)	1	Lifetime under-performance of 45–50%
Power sector		
2014 Kemper	3	Failed to be started
2014 Boundary Dam	1	Lifetime under-performance of ~50%
2017 Petra Nova	1.4	Suspended after 4 years of operation

The Gorgon project in Western Australia, part of Chevron's 15.6Mtpa Gorgon liquefied natural gas (LNG) venture and one of the largest CCS initiatives (focusing on storing captured CO_2 rather than utilising it in EOR) has consistently under-performed. Originally designed to store at least 80% of the gas reservoir CO_2, the project fell well short. The project has sequestered far less CO_2 than intended, storing only 34% of the CO_2 captured in the last fiscal year to 30 June 2023.

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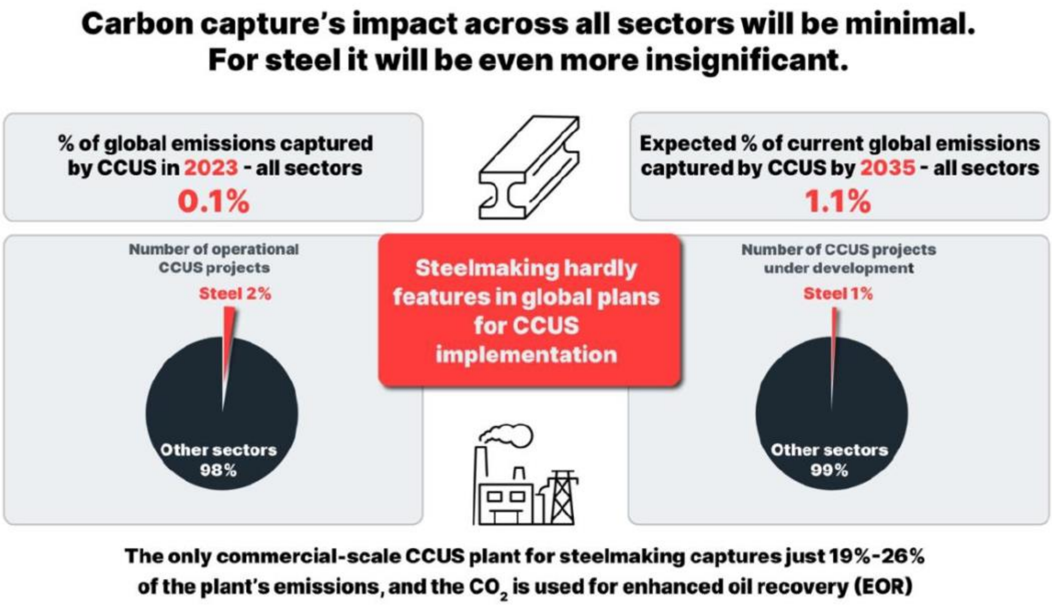
CCUS is also susceptible to significant financial, technological and environmental risks, made worse by uncertainty over the long-term effectiveness of geological CO_2 storage. Transportation and storage of CO_2 in secure, dedicated geological sites pose significant challenges, requiring detailed studies for each project individually. The uniqueness of each CCUS project limits technological learning and cost reductions. The cost of carbon capture implementation has hardly reduced in 40 years while the cost of alternative technologies like renewable energy and battery storage has plunged, with further reductions to come.

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.

The Global CCS Institute is tracking just 41 commercial-scale CCS projects in operation globally, with 351 in development. With the great majority of these categorised as being only in "early development" (i.e. a long way from final design or investment decision), IEEFA expects a large proportion to never reach commercial operation. Of the combined 392 projects, just four are in the steel sector, including the operational Al Reyadah project.

In its 2023 update to the NZE Scenario, the IEA sees CCUS-equipped processes' 2050 share of iron production down to 37%, from 53% reported in the previous report in 2021. The amount of CO_2 captured in the global steel sector has been downgraded to 399Mt, from 670Mt in the 2021 edition. At the same time, the share of hydrogen-based steelmaking has increased from 29% in 2021 to 44% in the 2023 update. IEEFA expects that the IEA will continue to decrease the role it expects CCUS to play in steel decarbonisation in future updates.

Figure 7: CCS in steel decarbonisation



Source: Bloomberg New Energy Finance, Global CCS Institute, IEEFA calculations

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The German think tank Agora Industry highlights that the 2030 project pipeline of DRI plants has grown to 94Mtpa, while the pipeline for commercial-scale CCUS on blast furnace-based operations amounts to just 1Mtpa. It is clear that CCUS for blast furnace-based steelmaking is already being left behind by alternative technology, just as has happened in other sectors such as power generation.

Besides the general challenges associated with CCUS technologies in other sectors, there are additional unique challenges in deploying this technology, as shown in the figure below.

Figure 8: CCUS challenges in the steel sector

Source: IEEFA

Read More:

Carbon capture for steel?

24. Are there parts of the value-chain that require particular support?

a. Should support be prioritised towards certain parts of the value chain in the first instance?

Australia must concentrate on specific areas where it holds a competitive advantage, starting with immediate opportunities. To play a significant role in the green steel transition, Australia needs to act swiftly and develop a comprehensive green iron value chain, spanning from mining operations to hydrogen production. This rapid development is essential for establishing Australia as a leader in the global green steel industry and ensuring the nation capitalises on its abundant natural resources and renewable energy potential. As IEEFA's previous research shows, support efforts must prioritise magnetite iron ore and hydrogen production.

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More magnetite production

According to IEEFA's research, the first step should be to open more magnetite mines, as there is no need to develop new technology for this pathway, unlike other routes such as deploying DRI+Smelters, which require more advancements to process mid-grade iron ore. With the current technologies available, higher-grade ores are key to the green steel transition, and producing iron ore concentrate is highly necessary. While seaborne ores have dominated Australia's iron ore sector, more iron ore concentrates like Fortescue's Iron Bridge plant are needed to foster this transition in Australia.

It's important to note that establishing the entire value chain for producing iron ore concentrate and pellets will be time-consuming. For instance, Fortescue took more than 13 years from the first step to commencing iron ore concentrate operations at its Iron Bridge project. Any delay in making final decisions on developing high-grade magnetite ores, in the hope of finding a solution for using mid-grade iron ore (as is happening now), will hinder Australia's ability to become a major player in this competition. Australia needs a significant revolution in its mining sector to meet climate change targets by 2050 and remain a leading player in both the iron ore trading market and the emerging green iron market.

Allocating more green hydrogen to the iron and steel sector

More green hydrogen projects must be developed around Australia, and green iron could be the key to securing long-term demand for green hydrogen. The think tank Agora Industry has emphasised that steel stands out as the sector with the greatest potential for carbon reduction among various hydrogen applications. Interestingly, even in sectors where direct electrification is not feasible, shifting from coal to hydrogen – as seen in steel sector – yields more benefits compared with transitioning from other fossil fuels, including oil and gas, to hydrogen.

Currently, almost all large-scale projects in Australia, including the six projects shortlisted for the Hydrogen Headstart funding, are focused on ammonia and e-fuels. While some pilot projects are developing green iron production, more large-scale green hydrogen initiatives are needed to transform the landscape of green iron production in Australia.

Australia is primarily focused on exporting hydrogen and its derivatives. IEEFA's research has shown hydrogen transportation is inefficient and costly due to its low volumetric energy density. However, there is a substantial opportunity to utilise green hydrogen domestically, particularly in sectors like green iron production, which can add significant value to Australia's resources. By shifting focus to domestic applications, Australia can enhance its resource value and lead in sustainable industrial practices.

Exporting green iron in the form of HBI has recently gained huge attention in the global steel decarbonisation race. Major steelmakers in key markets like Europe, China, Japan and South Korea are now weighing up whether to produce green DRI domestically or import it as HBI.

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The global steel sector is considering a future that involves shipping green iron rather than shipping both green hydrogen and iron ore separately. By allocating green hydrogen to domestic iron production, Australia can be one of the main exporters of green iron.

Read More:

Hydrogen unleashed: Opportunities and challenges in the evolving H2-DRI-EAF pathway beyond 2024

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