OECD – Green Iron Project - Australia Case Study – Survey

Completed by the Australian Steel Institute [ASI]

As part of the ongoing OECD Green Iron Project, the OECD is conducting a case study to analyse key developments in green iron production in Australia. This questionnaire has been designed to gather insights from informed stakeholders, whose knowledge and experience in this field are critical to shaping collective understanding of the Australian industry's current landscape and future prospects.

The questionnaire is divided into four key sections. The **first section** explores perspectives on the Australian iron ore industry's transition towards green iron, focusing on the challenges, opportunities, and readiness of the supply chain for adopting low-carbon technologies. The **second section** examines developments in the renewable energy sector, particularly in relation to how projects like wind and solar can meet the energy demands of green iron production. The **third section** addresses the state of energy and hydrogen infrastructure, investigating the necessary advancements to support large-scale green iron production. Finally, the **fourth section** assesses government policies at both federal and state level, analysing their role in fostering innovation and investment in green iron production.

We kindly request your response by 10 November to ensure your valuable input is included in the final case study report. Your contribution will help inform policy evidence on Australia, which is critical for the success of the case study.

Section 1: Perspectives on the iron ore industry in the green iron transition

- What are the main challenges and opportunities you see for the iron ore industry in Australia as it transitions towards green iron production?

The biggest challenge is that great majority of mine, rail and port infrastructure has been developed to exploit the plentiful hematite iron ore reserves, which are currently used for blast furnace feed. By contrast, the less plentiful magnetite reserves are relatively less accessible and higher cost to mine and transport. Magnetite can readily be beneficiated for use in direct reduction processes, which can utilise less greenhouse gas intensive reductants such as natural gas and hydrogen. The resultant DRI is then suitable for use as a charge material for an electric arc furnace.

A significant body of research is being undertaken to investigate the development of novel methods for beneficiation of hematite ores, but it is unclear whether these will prove to be financially and technically viable. The other less emissions intensive alternative for exploitation of hematite is to use it in an un-beneficiated state, refine it in a direct reduction *process, and then use an electric smelting process to remove the impurities contained in the resultant DRI. The product of an electric smelter is hot metal (similar to that produced from a blast furnace) that can used in an oxygen converter steelmaking process. This process route is currently used for exploitation of iron sands but the technical and financial viability for hematite hasn't been proven, although it is currently being investigated at pilot scale.*

Natural gas and ultimately hydrogen using renewables will need to be available at scale and at internationally competitive prices to enable green iron production in Australia.

- What is your assessment of the readiness of the Australian iron ore supply chain for green iron, including the adoption of technologies like direct reduced iron (DRI) using green hydrogen and renewables?

Assuming that the goal of the iron ore industry is to pivot from mining and shipping iron ore, to manufacturing and shipping DRI, there are some significant considerations relating to handling, transport, and storage of the DRI.

DRI is chemically reactive and therefore would normally be converted to HBI if it is to be transported or stored for any length of time. The briquetting process increases the density, reduces the surface area available for chemical reactions, and improves strength such that there is less breakage and fines generation during handling. Even though it is less reactive, HBI is still pyrophoric, with many recorded instances of stockpiles self-heating, and in some cases catching fire. Storage needs to be carefully managed so as to avoid self-heating, by giving consideration to height and shape of stockpiles, as well as the moisture content.

The longer that HBI is stored, the more it becomes oxidised or 'weathered', simply due to exposure to the elements. This oxidation reduces the metallisation, which in turn increases the energy required for melting in an EAF. The oxidation also contributes to fines generation, which further add to yield loss, and cause handling problems such as dust emissions during transport.

Trans ocean shipping of HBI needs to be carefully managed to avoid the potential for on board fire in the event that self-heating starts to occur. Additional monitoring of cargo temperature is required, as well as consideration of fire suppression capability via means such as nitrogen purge and forced ventilation. Use of water is typically counterproductive in the event of self-heating occurring. Given these considerations, the number of vessels that are available / suitable for shipping HBI may be considerably less than is currently the case for bulk iron ore.

Given the limited shelf life of HBI, and the fact that typically EAF steelmaking operations are designed for a smaller scale than BOF (e.g. 150 tonne heat weight for EAF thin slab casting mill vs. 300 tonne heat weight for BOF conventional slab mill), there is likely to a be changed requirement for shipping size and frequency. More, smaller ships may be better suited to supplying HBI to the EAF market.

HBI is both more dense and stronger than iron ore. Broken briquettes can be quite sharp and will likely cause more frequent damage to conveyor systems. Similarly, the higher density of HBI will likely result in more damage to transfer points and conveyor impact areas.

So, in summary, whilst HBI has been in widespread use for many years, and is well understood in terms of transport, storage and handling properties, it is a significantly different proposition to shipping iron ore. Detailed planning and investment in all aspects of the supply chain infrastructure will be required in order to avoid the types of issues described above.

Depending on the ultimate technology used for DRI it is likely that pelletisation of the ore will also be required. Hence significant capital expenditure is also required on this additional process between mining and DRI production.

- What role do you think collaborations between mining companies and renewable energy providers will play in accelerating the green iron transition?

It is the availability of natural gas, renewable electricity, then ultimately hydrogen that will ultimately determine the location of DRI production. Costs in the supply chain would be minimised if DRI production were able to occur along existing iron ore supply routes.

Investments in dedicated renewable energy & storage projects with shared transmission infrastructure will likely be necessary to develop capacity for competitive green iron

Section 2: Key developments in the renewable energy space

- To what extent do you believe that the current development of renewable energy projects in Australia, particularly solar and wind, will meet the energy demands of green iron production?

'Green iron' production using the DRI process requires extremely vast amounts of dedicated, firmed renewable energy for the ongoing manufacturing process, at globally competitive prices. This will require very significant investment in the required technology

facilities and infrastructure. Whilst increased renewable energy targets across both State and Federal governments provides some level of stimulus to the renewable energy industry, we appear to be at the 'chicken and egg' stage for green iron production whereby the significant private investment required is on hold pending targeted government policy developments and long term investment signals such as large grants and tax incentives.

The vast amounts of renewable energy required to build meaningful scale for green iron export will be challenged in a market competing with renewable builds to replace retiring coal generation and electrify existing industrials subject to increasingly stringent climate targets.

- What is your evaluation of the potential for large-scale renewable energy projects to provide cost-effective and consistent power for iron production processes in the coming decade?

Australia has some of the world's strongest natural competitive advantages in the production of large scale renewable energy projects, with highly ranked wind and solar resources, and world class engineering, manufacturing and fabrication skills and capabilities to produce and rollout infrastructure. Strong leadership, effective government policy and very significant private and government investment is required to catalyse this potential.

That said, while Australia has great advantages for production of renewable energy it has no particular advantage in long duration storage. Firming will be an essential element as the green iron production processes need largely continuous energy supply.

Australia's natural competitive advantages in renewables may not outweigh factors such as high labour costs, social licence issues and lower budgetary capacity to support development of new green sectors compared to international competitors. Lower emissions iron using natural gas may occur faster in other countries and adversely impact Australia's market share in iron ore if we await green hydrogen.

Section 3: Key developments in energy and hydrogen infrastructure

- What are the main gaps or challenges in Australia's electricity grid infrastructure that need to be addressed to support large-scale green iron production?

Australia has an antiquated electricity grid, which is aged and technologically inefficient. This instability at times causes blackouts and makes things difficult for large scale renewable energy connection. It has been often stated the Australian grid is not ideally fit for purpose of intermittent renewable energy transmission.

Highly sophisticated intelligent networks or smart grids such as those found in Europe allow intermittent renewable energy power generation and energy consumption to be optimally managed. This involves automated metering, two way communication and real time control of energy supply and demand.

Furthermore, Australia has geographical challenges across our vast continent, as compared to smaller compact nations. Electricity is distributed across enormously long distances which generates temperature increases and energy losses in the for of heat.

Perhaps heavy investment and planning into a massive upgrade of Australia's energy grid should have occurred before initiating the rollout of major renewable energy projects across the country. Which would include transmission infrastructure planning at a more more granular level to account for individual high demand facilities.

- What are the most critical developments needed in Australia's hydrogen infrastructure (production, storage, and transportation) to facilitate the shift to hydrogen-based green iron production?

The only brief comment we wish to make is that Hydrogen market and infrastructure development needs is complex and vexed with numerous issues, however green iron production using H-DRI technology requires enormous quantities of green hydrogen, provided continuously at very competitive prices, with some current indications being estimated at $3.60 kg or lower. The infrastructure required to produce and store hydrogen is extremely complex and expensive, and private first mover investors appear to be extremely reticent due to a lack of fixed long term incentive such as strong market demand, government policy and financial contributions.

Hydrogen will be most economic when it is produced close to the point of use, hence adjacent to where DRI will be made. Given that DRI will likely start on natural gas then transition to hydrogen the accessibility of both of these reductants needs to be considered in planning.

- What role do you see for private sector investments in accelerating the build-out of hydrogen infrastructure in Australia?

Both strong private sector and government investments such as public private partnerships have a strong role to play in the build out of hydrogen infrastructure in Australia. However there appear to be other fundamental issues and roadblocks such as the stimulation of market demand and long term certainty for investor returns.

Certainly collaboration partnerships between Australian steel makers with Australian ore miners, which are already underway, are critical in combining forces, intellect and relevant R&D programs to initiate technology advancements using either haematite or magnetite. Similarly collaboration partnerships between Australian steel makers with major OS steel producers where there is a strong fit to support the growth of this Australian based industry could also elicit breakthroughs in technology improvements, increased private investment and importantly stimulate much needed and significant government investment in this space. Production credits or similar schemes are already being used internationally to de-risk private investment in the nascent hydrogen industry.

The critical factor to lower cost green hydrogen is getting renewable energy costs as low as possible. Innovative renewable technology in solar cells in particular is likely to be critical.

Section 4: Government policies towards green iron production (federal and state levels)

- What is your assessment of the federal and state-level government policies currently in place to support green iron initiatives, and what additional policy measures are necessary to promote investment and innovation in this space?

There needs to be greater coordination, collaboration and unity across both Federal and State governments working closely with our industry if we are to successfully stimulate a next generation green iron industry in Australia. A collegiate approach across levels of *government is needed to effect appropriate change, including policy coordination and contribution incentive schemes.*

Whilst we have seen an early commencement of government policy signals including Future Made in Australia, the Federal Governments RET policy targets for renewables, DISRs investigations into Green Metals Policy which is timely and which has established an industry review panel ASIs CEO is participating on, together with some State and Federal policy incentives for the development of a Hydrogen industry in Australia, to date there has been minimal significant new policy developments capable of initiating structural change, and large enough incentives to pave the way forward and provide strong signals and confidence to the market.

Appropriate new policy measures required to promote investment and innovation in this space include:

- *A Federal Government –* ***Industrial Decarbonisation Natural Gas Reserve policy****, which establishes appropriate level of domestic gas development and reserves for the near to medium term, with suitable review periods such as 10 years. This policy must ensure the Australian steel industry has priority access to industry natural gas reserves for both the 'Green Iron' industry development and Australia's primary steel makers decarbonisation transition from BF-BOF to Gas-DRI and eventually H-DRI. Abundant natural gas supply at highly competitive prices is a critical resource for the Australian steel industry as it transitions towards low carbon steel making. Importing gas to Australia for our industry's next generation technology and decarbonisation development needs will be untenable, uneconomic and not viable to secure our industries future.*
- *Due to the enormous potential of low carbon iron making in Australia which could become a major exporting sector employing many thousands of jobs, and to help secure the future for a low carbon Australian steel industry which is critical to our country's sovereign manufacturing and construction capability, the Federal and State Governments should initiate a range of very significant capital support schemes. This would include:*
    - ***'Green' – Low Carbon Steel Manufacturing grant funding programs****; capital investment required for new facilities, transport and storage and energy pipeline infrastructure, plant and equipment is expected to be in the hundreds of billions of dollars;*
    - ***Private and Government Co-Investment schemes*** *and appropriate support policies providing* ***tax incentives*** *and* ***carbon credits*** *would be appropriate;*
    - *Policy which enhances and* ***modernises Australia's electricity grid*** *in areas close to Australian steel and low carbon manufacturing sites, and*

*which also enables high amounts of **firmed renewable energy supply** will be important next generation low carbon iron and steel industry catalyst;*

- *Importantly both Federal and State governments must develop and rollout new additional policies which ramp up **Australia's skills network** to help ensure adequate people skills capabilities to support the modern era of Australian new technology manufacturing along with the critical rollout of new energy projects, pipelines and construction of new facilities;*
- *Federal and State policies and regulations which support the optimal local supply of critical resources for steel manufacturing as we progress through the decarbonisation journey, such as the supply of **ferrous scrap steel** is critical for the immediate and longer term future. Next generation DRI will also require fixed volumes of scrap steel inputs;*
- *Policy to prevent carbon leakage and ensure that domestic iron and steel producers transitioning to low or zero emissions production routes do not have their viability undermined.*

- What are the most impactful incentives or regulations you believe could help support Australia's transition to green iron production?

*We maintain all of the above programs will be highly impactful, however the most critical include the **Industrial Decarbonisation Natural Gas Reserve policy**, those programs which incorporate and stimulate the very significant **capital investment and funding support***, and firmed, high amounts of renewable energy supply to the low emissions steel production sites.