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Briefing Note

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DRI smelters: promise, progress and barriers

Technology advances could unlock Pilbara ores for low-emissions ironmaking

- *New ironmaking technologies enabling the use of lower-grade ores are expected to commence operation before 2030, which is encouraging for the next phase of iron and steel decarbonisation.*
- *With only one commercial-scale project under construction, significant work is still required to prove these solutions at scale.*
- *Australian projects – alongside pilot and demonstration initiatives led by technology providers – are focused on derisking solutions to future-proof Pilbara ores.*
- *Developing these technology solutions for Pilbara iron ores is a priority, but it should not delay Australia's transition to green iron by using available high-grade iron ore and mature direct reduction technologies.*

Introduction

The pressure on steelmakers to decarbonise and reduce emissions is intensifying. This imperative cannot be achieved through existing production methods. Fossil fuel-based technologies for primary (ore-based) steelmaking – coal-based blast furnace (BF)–basic oxygen furnace (BOF) routes and gas- or coal-based direct reduction (DR) combined with electric arc furnace (EAF) – are highly carbon-intensive. Even incremental mitigation measures, such as carbon capture, are unlikely to deliver the emissions reductions required to meet net-zero targets.

Secondary steelmaking via scrap-based EAF routes offers significantly lower emissions; however, its scaleability is constrained by the global availability of scrap.

Therefore, alternative technological solutions for primary steel are required, with green hydrogen-based DRI–EAF emerging as one of the most promising pathways.

While DR technologies can effectively remove oxygen from a wide range of iron ores, they cannot eliminate impurities. This is because the process, unlike BF, is non-melting. If the raw materials feed contains high levels of gangue and impurities, the high-gangue DRI produced has limited suitability for EAF steelmaking. The EAFs commonly used alongside DRI facilities are not well suited to handling high-impurity iron metallics.

EAFs were initially developed to melt scrap, and while they are highly efficient, their oxidising atmosphere limits their ability to reduce iron ore to metallic iron and remove impurities. Feeding EAFs with high-gangue reduced iron increases flux requirements and slag volume, leading to lower iron recovery, and reduced overall process efficiency. It also raises electricity demand due to the additional energy required for slag formation and longer processing times.

This explains why DR-grade material (iron content above 66%, with combined silica and alumina below 3.5%) is required for the DRI–EAF pathway. Iron ore producers are seeking to expand the supply of DR-grade material to keep pace with the global expansion of DRI capacity. However, given the relative scarcity of high-grade iron ore amenable to beneficiation, scaling up DR significantly will require increased utilisation of more abundant, low- to mid-grade ores, such as Western Australia (WA)'s Pilbara ores.

Australia, as the world's largest iron ore producer with output of about 900 million tonnes a year (MTPA) and accounting for approximately 52% of global seaborne supply, will require new technological solutions. The country's dominant hematite/goethite ores, concentrated in the Pilbara, are generally not suitable for DR, and developing pathways to enable their use in low-emissions steelmaking represents a significant challenge for the industry.

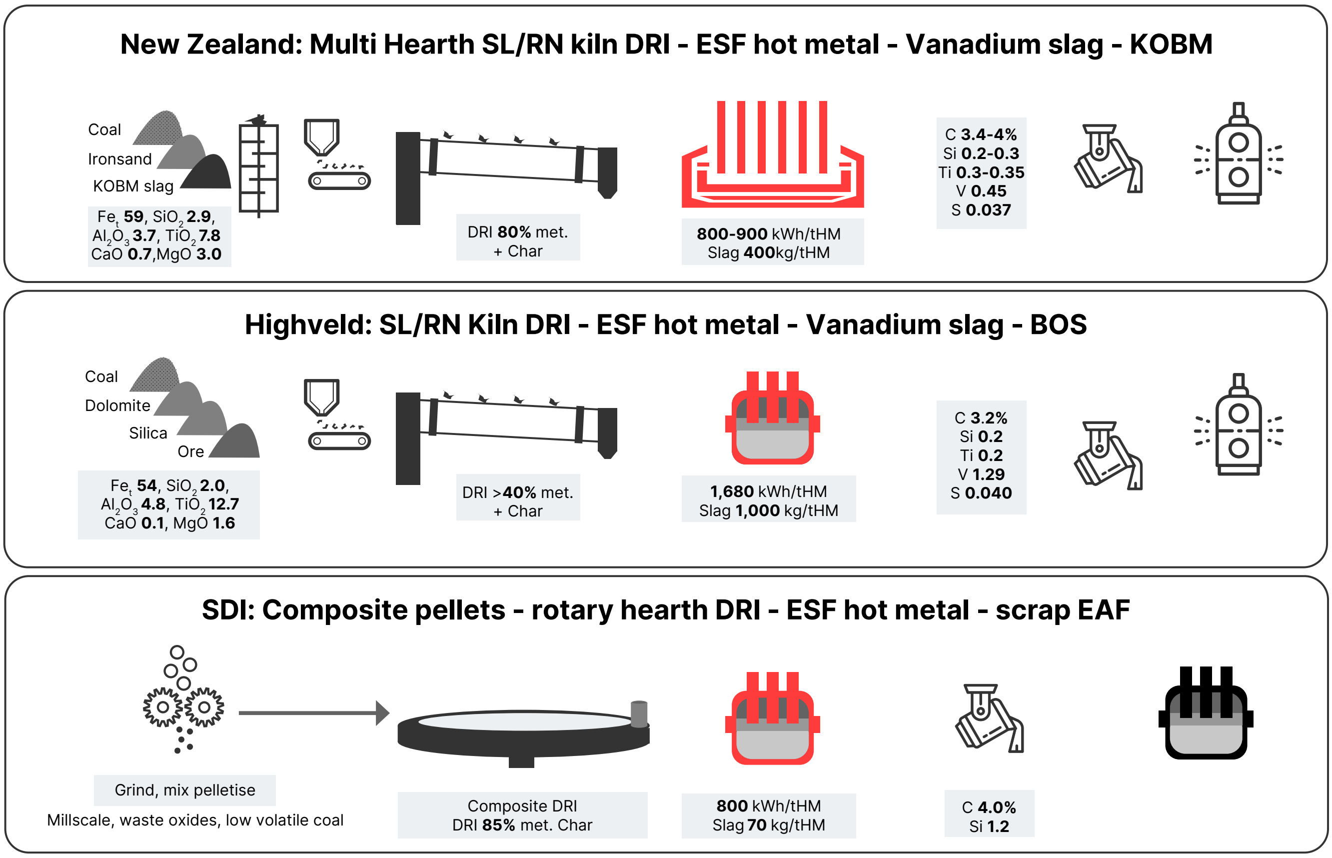
To address this, an additional step between ironmaking (via DR) and steelmaking (in EAF or BOF) is required to better manage impurities. Electric smelting furnaces (ESF) are emerging as a promising solution to this challenge. Unlike the EAF, the ESF can handle high-gangue feedstocks and produce iron comparable to the pig iron from blast furnaces.

In one study, the evolution of smelter technology and its deployment in a DRI-smelt-BOF pathway was rated the dominant, ore-based route to achieve the 1.5°C target by 2050.

Electric smelting furnace

Unlike melting, which involves changing a solid material into a liquid, smelting focuses on extracting metals through high-temperature chemical reactions. This technology has been used for more than a century in ferroalloy production, and has a proven track record. ESFs have already been applied in the steel sector; however, their adoption remains very limited, with only a few examples of small-scale deployment in conjunction with DRI production (mostly coal-based DRI). Notable cases include BlueScope's New Zealand Steel (Glenbrook), Evraz's Highveld operation and the Steel Dynamics Inc. (SDI) Mesabi Nugget plant at Hoyt Lakes in Minnesota (Figure 1).

Figure 1: Smelter adaptation in the steelmaking process



Source: *Application of Electric Smelting Furnace to Ironmaking*

It is also worth noting that the primary motivation for deploying ESF technology at the Glenbrook facility in New Zealand and at the Evraz Highveld Steel & Vanadium operations in South Africa was to overcome technical challenges associated with processing titanium-rich ores. In blast furnaces, elevated titanium levels can significantly increase slag viscosity, potentially to the point of blocking the furnace. To address this issue, smelters with a wide molten bath were adopted. Importantly, this technology was not originally adapted solely for conventional steelmaking, but also to enable the utilisation of challenging raw materials in the steelmaking process.

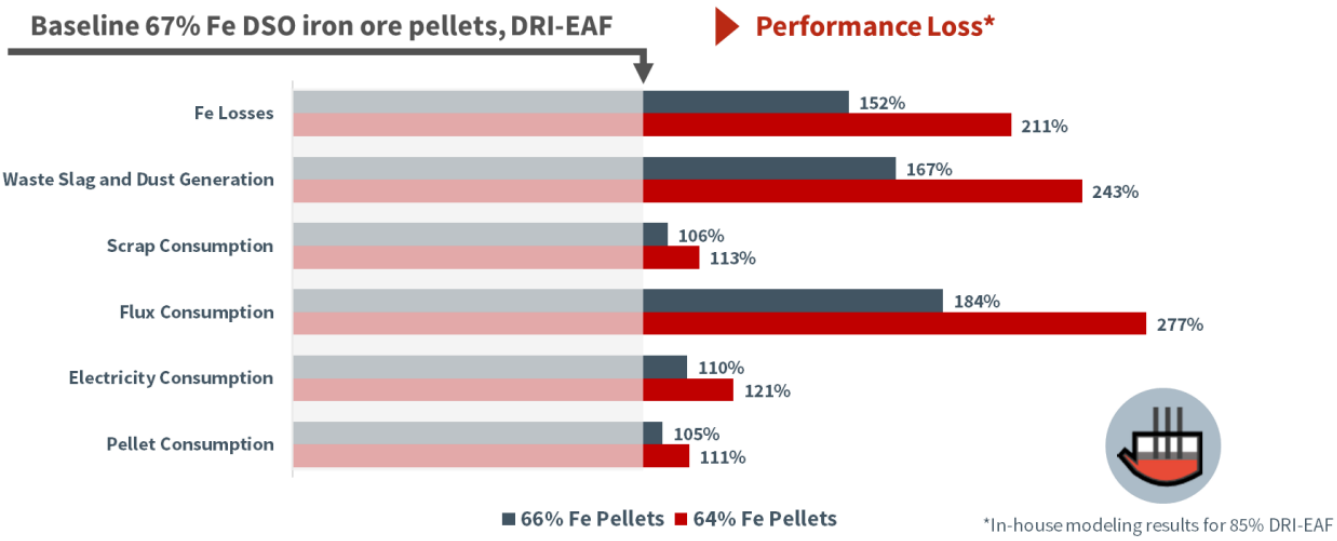
As Highveld and SDI have ceased operations, Glenbrook is the only remaining plant producing steel using smelter, which is now being shifted away from the ESF route towards EAF. The setup uses coal as a reductant, and to reduce emissions, New Zealand Steel is transitioning a portion of its production to conventional EAF.

While smelter technologies have existed for decades, further development is required to bring them into mainstream global steel production. Leading technology developers and providers are continuing to advance these solutions, aiming to bring them to a level where they can be deployed commercially at scale worldwide.

Smelter–BOF vs EAF

Studies by Hatch show that using lower-grade ores in conventional EAFs could be very inefficient with higher iron loss, pellet and gas consumption, and higher unusable slag as a byproduct. The ability to use lower-grade iron ores directly in a new DRI–ESF–BOF pathway could be more efficient than upgrading the ore through beneficiation, which typically involves iron losses during processing.

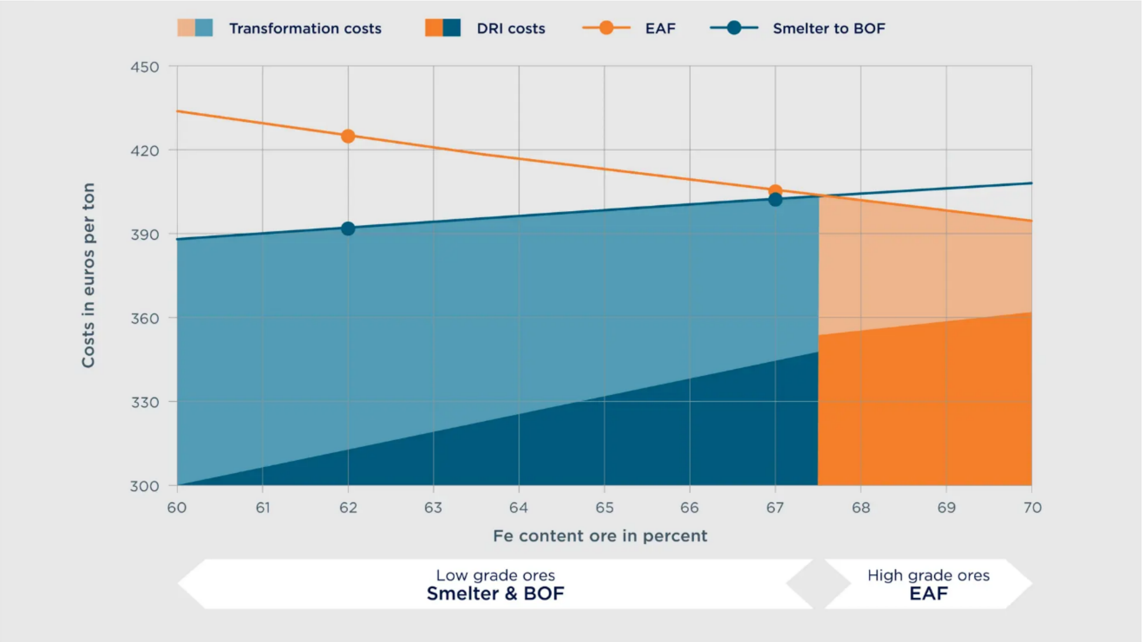
Figure 2: Processing lower-grade ores in EAF



Source: Hatch

The smelter–BOF pathway is also more economically attractive than EAF-based steelmaking, as it has the potential to recover more iron from the ore and reduce costs. Figure 3 illustrates the conditions under which smelter-BOF can outperform EAFs for lower-grade ores with Fe content below 67.5%. One study estimated that the ESF-BOF pathway can deliver a 16% lower levellised cost of steel (LCOS) compared with the EAF route, when using low-grade, hydrogen-reduced DRI as feedstock. Other academic studies support these findings for Pilbara iron ore.

Figure 3: Production costs of two pathways as a function of iron ore grade (EUR/tonne)



Source: Primetals

The deployment of smelting technologies could also preserve slag production as a raw material input to cement manufacture. EAF slag generally has a high iron oxide content of 24–37%, while BF slag contains less than 1%. Smelters are reported to generate slag similar to blast furnaces. If the DRI-smelter route replace BFs in the future, it will continue to produce slag useable in the cement industry. This will mitigate concerns that some emissions-lowering industrial symbiosis opportunities will decrease as the green transition gathers pace.

Furthermore, ensuring continued utilisation of the dominant supply of lower-grade iron ore, and the flexibility to retain existing BOF plants, many downstream integrated sites are gaining additional advantages of transitioning via smelter technologies. These steelmakers could replace blast furnaces with a DRI-smelter combination while continuing to utilise largely the same iron ore quality. It also requires substantially lower capital expenditure, making the transition more economically attractive than developing a greenfield project.

This option also could align with Australia's green iron export opportunity to key trading partners, such as China, Japan and Korea, where pig iron via DRI-smelter pathways could be supplied as supplemental feedstock alongside scrap for EAFs or as a primary feedstock for BOFs.

Another option would be to export high-gangue DRI/HBI to destination markets where integrated smelter–BOF configurations already exist, allowing the reduced iron to be further processed within existing steelmaking facilities.

The future configuration of steelmaking is likely to be shaped by energy market dynamics and the economics of where it is most efficient to reduce iron ore with hydrogen, melt it into purified iron, and undertake final steel production. In practice, these stages may ultimately be geographically separated across different regions and markets.

Technology developers

Most technology developers offer integrated solution packages that include proprietary iron ore reduction technologies along with smelters. These are largely based on the direct reduction of fine ores, eliminating the need for costly and energy-intensive agglomeration processes. Examples include HYFOR, HyREX and Circored. Others, such as SMS group and Tenova, continue to rely on shaft furnace-based reduction routes.

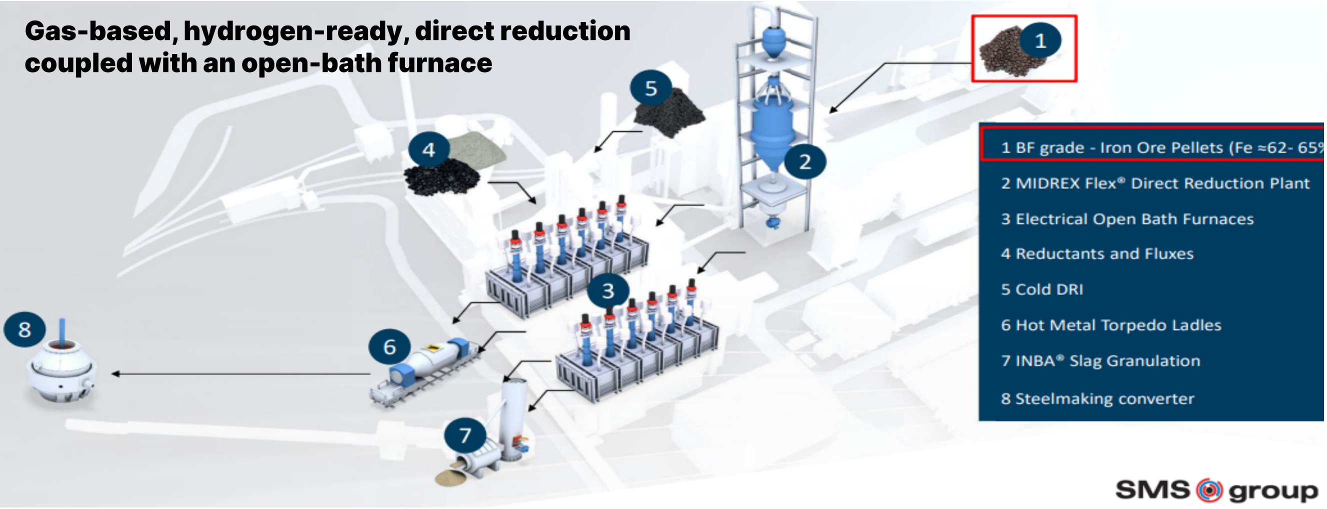
Further standalone hydrogen-based iron ore reduction technologies and developers – such as the ZESTY and HIFRI processes – are discussed below, along with smelter developers, as they could serve as valuable complements to future smelter developments.

Metix OBF (SMS group)

Metix is responsible for deploying its proprietary open-bath furnace (OBF) technology (also known as Controlled Open-Arc (SOAC) process) as part of ThyssenKrupp's transformation from BF–BOF to the DRI–smelter–BOF pathway at its Duisburg steel plant in Germany. The project, which is planned to start by the end of 2026, combines 2.5MTPA Midrex DR technology with two 100MW smelters to produce pig iron and replace the existing blast furnace.

Metix designs these smelters based on the conventional submerged-arc furnace (SAF), a well-established technology widely used in industrial plants, supported by extensive operational experience and technical references in the production of ferroalloy and other metals.

Figure 4: The ThyssenKrupp Steel transition



Source: SMS Group

Metix has tested its technology for DRI processing in two campaigns from June 2023 at the MINTEK facility in South Africa. While the ThyssenKrupp facility is a commercial-scale project, MINTEK's second test at demonstration-scale reached a Technology Readiness Level (TRL) of 7-8.

Table 1: Test results from two campaigns using DRI in Metix's smelter technology

Description	Pilot	Demonstration
Campaign duration (days)	10 (26 June–7 July 2023)	34 (2 April–5 May 2024)
Operating power (kW)	100 to 210	900 to 1,400
Material processed (tonne)	10	370
Feed materials	DRI crushed lump ore	DRI pellet
Fe total of DRI%	88.5	87
Final product Fe%	94	94.2

Source: Advancing Electric Smelting for Sustainable Iron Production. Note: Please refer to the report for a detailed analysis, including comprehensive operational results and plant specifications.

The DRI used in the trials was produced from low-grade feedstock, comparable to typical blast furnace inputs. Despite this, the final products achieved a very high grade, demonstrating the process's capability to effectively remove gangue and impurities from high-impurity DRI.

HyREX–ESF (POSCO)

Building on the FINEX technology developed by Primetals and POSCO, the two companies are advancing the HyREX process. This technology is based on a fluidised bed reactor (FBR) that can utilise a wider range of iron ores without the need for agglomeration, accommodating feed sizes of up to 8mm. POSCO has also developed its own ESF technology at Pohang Steelworks, which can be integrated with HyREX to produce low-emissions iron.

At the pilot scale, POSCO built a DC arc round furnace with a capacity of 1 tonne per hour. Construction was completed in April 2024, and the unit operates on a batch basis. The furnace design is based on the smelter used at SNNC's ferronickel plant at Gwangyang, South Korea, and has been modified for H_2–DRI smelting.

Following successful pilot-scale test results, POSCO plans to build a 0.3MTPA demonstration plant. The construction phase is expected to be finished by 2027 with operational campaigns planned to continue through to 2030. For the demonstration plant, a 37t/h rectangular furnace equipped with six Soderberg electrodes will be used. The company secured government approvals in March 2026.

BHP has also signed a memorandum of understanding to collaborate on the development of HyREX. The agreement focuses on testing BHP's Pilbara iron ore within the FBR and ESF pathway. As part of this collaboration, BHP aims to evaluate the performance of its iron ores in the new HyREX demonstration plant.

Circored-DRI smelting furnace (Metso)

Metso's DRI smelting furnace represents another ironmaking technological pathway. The company has been developing the pilot plant since 2025, and has successfully completed two campaigns. Building on its experience in ferroalloy furnace development, Metso designed a pilot plant with a three-in-line configuration that can process up to 1t/h.

The company is using these trials to address key technical questions, including refractory performance and the carburisation of molten iron, ensuring it matches the quality of blast furnace hot metal.

Metso has also developed a fluidised-bed process for fine iron direct reduction (Circored), designed to use 100% hydrogen. This technology was deployed in a plant in Trinidad and Tobago with a capacity of 0.5MTPA in 1999; however, it never achieved its nominal capacity, and was idled shortly after start-up.

More recently, Metso commissioned a new Circored pre-reduction pilot plant in Frankfurt, Germany, in 2025 to further demonstrate the technology for future applications. The company has also completed the divestment of its ferrous business, including Circored, which is now part of the SMS group.

Metso is also developing the core process design and technology for Fortescue's Christmas Creek Green Metal Project in the Pilbara.

DRP–OSBF (iBLUE) (Tenova)

Tenova has an established track record in designing and developing furnaces for both steelmaking and ferroalloy smelting operations. The company has introduced a new smelting technology that appears highly promising for ironmaking compared with the conventional smelting arc furnace (SAF). Its open slag bath furnace (OSBF) is a DRI smelter capable of using BF-grade raw materials to produce pig iron of comparable quality to a blast furnace. In addition, it generates a slag product suitable for cement production, with properties similar to conventional BF slag. OSBF is also integrated with Energiron DR technology (iBlue), offering a potentially efficient and flexible route for ironmaking.

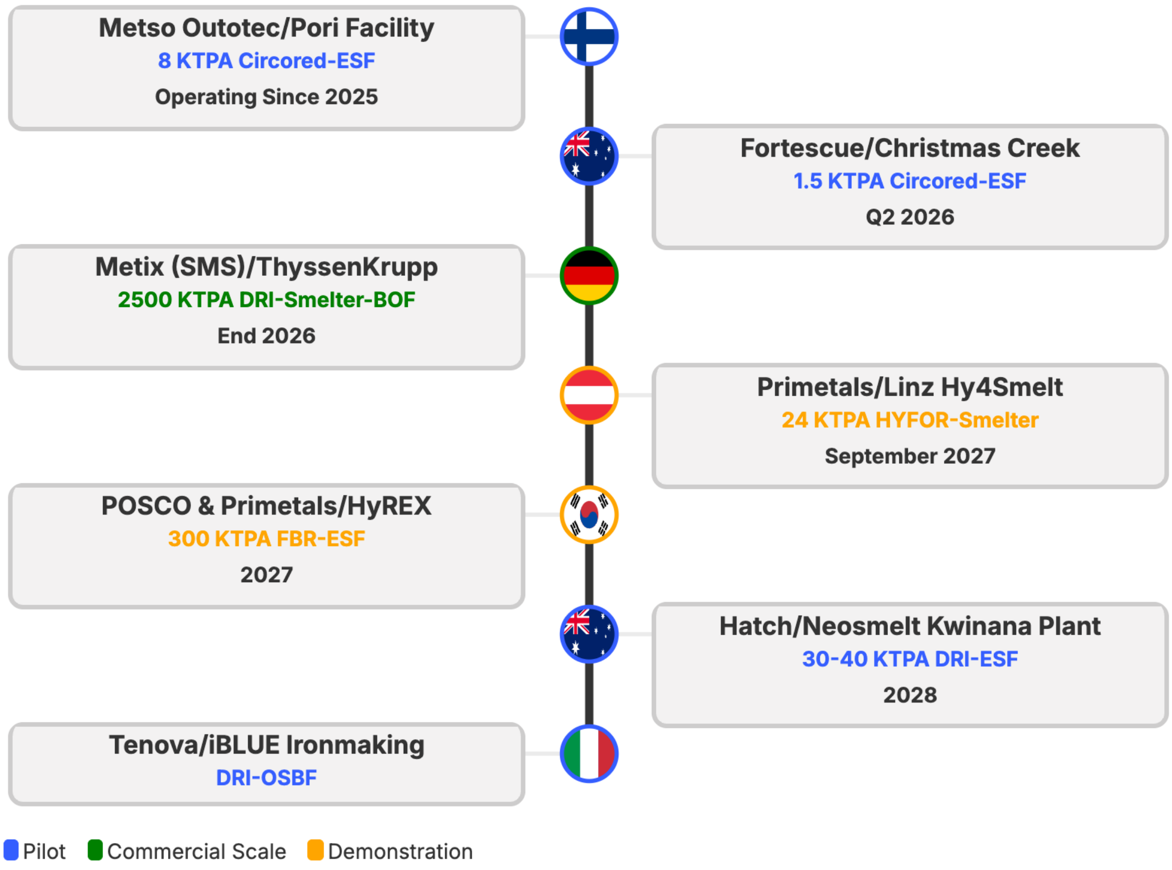
Tenova has also tested this technology in combination with its DR plant (based on a HYL reactor) and a smelter developed by its furnace division, Tenova Pyromet. The results demonstrate a high potential pathway for producing pig iron from BF-grade DRI. Results show that the company processed BF-grade pellet into DRI with 74.44% Fe and processed that into pig iron with 95.73% Fe.

Energiron's DRI technology, developed mutually by Tenova and Danieli, is being used in new low-emissions pilot plants, including NeoSmelt and HYBRIT. However, no specific collaborative project has been publicly announced using this Tenova's OSBF smelter, and the company appears to be more focused on internal development of this technology.

Tenova has taken a conservative approach to developing the integrated DRP–OSBF route, emphasising that more real-world projects will be needed in coming years if it is to contribute meaningfully to steel industry decarbonisation. The replication of pilot plants further highlights that additional work is required to ensure reliable performance and to validate process parameters, process chemistry and real-world outcomes.

Roberto Pancaldi, Tenova's group CEO, also emphasised that the entire industry is closely watching the ThyssenKrupp project, anticipating it will become the first real-world application to come to fruition.

Figure 5: DRI smelter projects under development



Sources: Company reports, IEEFA. Note: Some projects combine new DR technologies, such as HyREX, HYFOR, or Circored, while others rely on conventional shaft furnace technologies. Standalone innovative DR technologies, such as ZESTY and HIFRI were not included in this graphic.

Hy4Smelt (Primetals)

Primetals Technologies has developed its own smelting solution, which, in combination with its advanced Hydrogen-based Fine-Ore Reduction (HYFOR) technology, will be demonstrated through the Hy4Smelt project in Linz, Austria. The facility features a round furnace with three electrodes and a maximum active power of about 3MW. It has a capacity of 3t/h of hot metal, and is scheduled for commissioning by September 2027. Rio Tinto, together with Mitsubishi and voestalpine, is also involved in developing this industrial-scale demonstration plant, following the exit of Fortescue.

Primetals Technologies successfully developed a HYFOR pilot plant before deciding to proceed with a demonstration plant.

While the company has extensive experience in FBR technology through developments such as FINEX, its smelting technology is relatively new, and requires further time to mature at scale.

In addition to this project, Primetals is also collaborating with POSCO on the development of the HyREX technology. Results from pilot tests support the next phase to scale up Primetals' initiatives.

NeoSmelt (Hatch)

NeoSmelt, a consortium comprising BHP, BlueScope, Mitsui Iron Ore Development, Rio Tinto and Woodside Energy, has selected Hatch as its technology provider.

The project aims to demonstrate that Pilbara iron ore can be processed via ESF as a part a new pathway using Hatch's Continuous Reduced Iron Steelmaking Process (CRISP+), in which large electric smelting furnaces convert DRI into carbon-containing hot metal. The project aims to produce 30,000t to 40,000t of molten iron a year. The plan is to reach final investment decision (FID) by 2026 and commence operations by 2028. S&P Global reported, citing a spokesperson for the project, that 2029 was a more accurate commissioning timeline.

Tenova has been selected to carry out the front-end engineering design (FEED) studies for the DR pilot plant. The facility, with a capacity of 50,000t a year, will utilise Energiron technology, and is designed to operate using either gas or hydrogen.

Prior to this agreement, Hatch had already been collaborating with BHP on the development of the DRI–ESF pathway. Hatch also has extensive experience in efficiently converting waste materials into hot metal using smelting technologies. Based on its experience in smelter development, Hatch reported practical proven limits of about 85MW for circular furnaces and 110MW for rectangular furnaces.

Hatch, which can produce both rectangular and circular furnaces, considers CRISP+ technology ready for immediate implementation.

NeoSmelt has secured AU$75 million in funding from the WA government, along with AU$19.8 million from the Australian Renewable Energy Agency (ARENA).

Christmas Creek Green Iron (Fortescue)

This pilot project is based on two innovative solutions from Metso: the Circored fluidised bed DR process, and an electric DRI smelting furnace. Installation of the facilities, with a capacity of 1500t a year and a US$50 million investment, commenced in September 2025, and production is expected to begin in the June quarter of 2026. Fortescue is developing the smallest pilot plant, among others, and will use the same Metso technologies to test Australian iron ores in new pathways. Unlike NeoSmelt, which is expected to rely on gas or potentially lower-carbon emissions hydrogen in the future – due Woodside Energy's involvement in the development consortium – the Christmas Creek facility plans to operate using 100% green hydrogen.

DRI–ESF (BHP and Baowu)

China Baowu commenced production at its first Energiron DR plant at Baosteel Zhanjiang Iron & Steel in 2024. In May 2025, the company also tested BHP's Pilbara iron ore in various blends, with the resulting DRI samples subsequently processed in a 500kg ESF at Baowu's Central Research Institute to produce pig iron. These trials were reported as successful, indicating promising potential for further development of the DRI-ESF pathway in China.

ZESTY (Calix)

Calix's Zero Emissions Steel Technology (ZESTY) is an innovative iron ore reduction process that uses hydrogen as the primary reductant. The project is progressing towards a demonstration plant in Kwinana, WA, with a planned capacity of about 30,000t a year. A key advantage is its ability to process low-grade, fine iron ores from the Pilbara.

The technology is also claimed to have one of the lowest theoretical hydrogen consumption rates, as it utilises renewable electricity to generate heat, and is designed to operate flexibly with variable renewable power sources. The demonstration plant is targeting FID in 2026 and commissioning by 2028. It has secured AU$44.9 million in funding from ARENA, along with a joint development agreement with Rio Tinto valued at more than AU$35 million for this stage of the project.

HIFRI (Ansteel)

In August 2025, Ansteel Group announced the successful integration of its first pilot-scale green hydrogen fluidised bed DR facility, called Hydrogen-Induced Fluidised Bed Reduction of Iron (HIFRI). Construction of the facility in Bayuquan steelworks in China began in September 2022, and was completed in May 2024. This 10,000t pilot plant is powered by renewable electricity from wind sources, and uses alkaline electrolysis to produce green hydrogen. The company plans to develop a 0.5MTPA demonstration facility to further validate and scale the technology.

To reiterate, ZESTY and Ansteel are both innovative DR technologies that may need to be integrated with smelters to process lower-grade iron ores that have high impurity levels.

Technical challenges ahead

There remain several challenges to be addressed in developing smelters.

Carburising hot metal in the ESF and reducing residual iron oxide in the hydrogen-reduced DRI are key process challenges being addressed through ongoing research and pilot-scale development. It is important to note that smelters require a sufficiently reducing atmosphere to promote the recovery of iron from high-gangue DRI. In conventional practice, this is typically achieved through the addition of carbon, which generates carbon monoxide (CO), and helps maintain the necessary low oxygen potential environment within the furnace.

Heat loss from the roof and sidewalls represent a design challenge for these smelters, particularly in the case of OSBFs. Therefore, improving thermal efficiency remains a key optimisation priority.

A further challenge in the development of these furnaces is the availability of refractories that can withstand the ESF's thermal profile and distinctive chemistry. Leading refractory suppliers, including RHI Magnesita, are actively developing solutions to address this. Notably, RHI Magnesita has secured a contract to supply refractories for ThyssenKrupp's transition project.

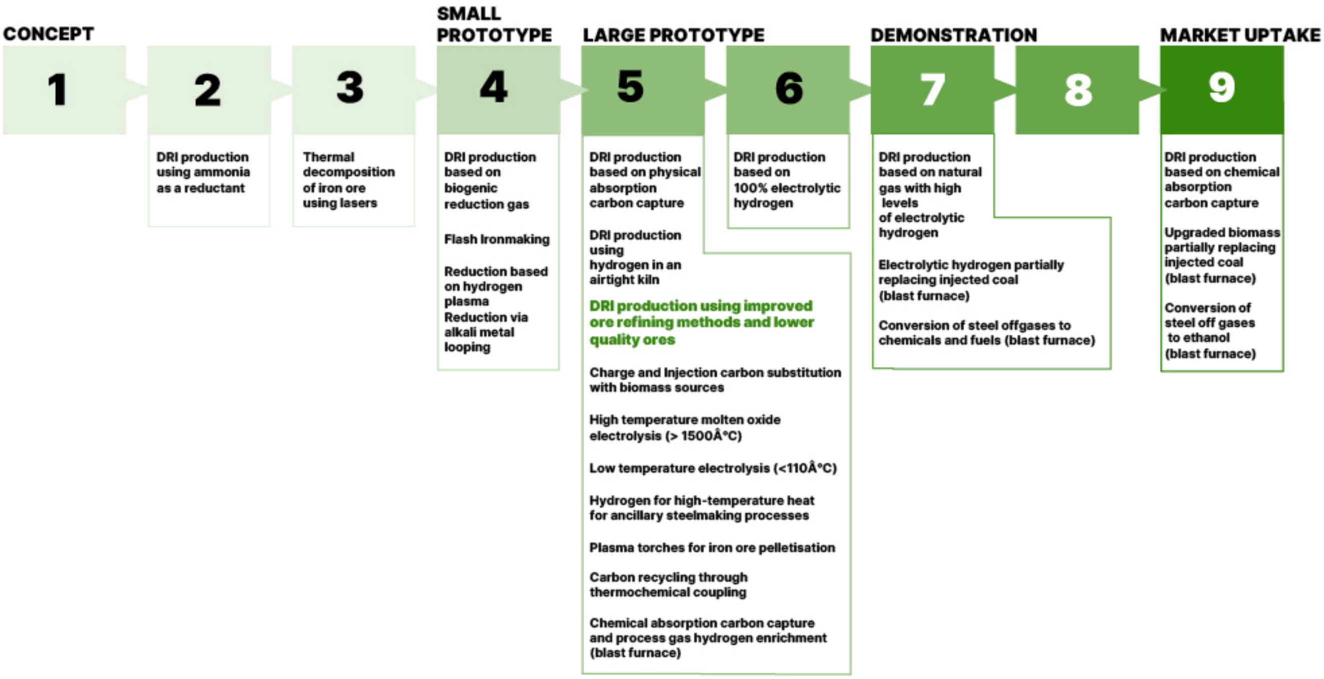
Technology maturity and commercialisation pathway

While there is no single source that provides technology readiness levels (TRL) for all these technologies, the International Energy Agency (IEA) has assessed them within a common framework. According to the IEA's ETP Clean Energy Technology Guide, the overall TRL for technologies aimed at utilising lower-grade ores in DRI production is estimated at 5, on a scale of 1 to 9 (for both DRI and smelting combined).

This represents an aggregated view across the category, although individual technologies may be more advanced. For example, Metix has reported reaching TRL 8, and is developing a first-of-a-kind commercial-scale facility at ThyssenKrupp's Duisburg plant.

Agora Industry expects the H_2–DRI–smelter–BOF pathway to be commercially ready before 2030. The OECD also reports the overall TRL for the DRI–smelter–BOF pathway as 5.

Figure 6: TRLs of emerging steel decarbonisation solutions



Sources: IEA, IEEFA

There is no simple answer to the question of how many years will be needed to reach TRL 9.

Developing new energy transition technologies at commercial scale is a multi-decade process, and the iron and steel sector is no exception. Even when a technology has been proven at commercial scale, it can still take years to achieve widespread global deployment. This reflects the many barriers – project financing, building infrastructure and supply chain and even performance uncertainty – that must be overcome before a solution becomes fully mature and broadly adopted. ARENA has introduced the Commercial Readiness Index (CRI) for the renewable energy sector, a framework that could also be applied to iron and steel. The CRI pathway begins after successful demonstration projects, supporting the transition from first-of-a-kind commercial plants to large-scale deployment.

The US Department of Energy uses an Adoption Readiness Level (ARL) framework, which is designed to complement NASA's TRL framework. The ARL framework focuses on broader factors affecting a technology's path to commercialisation, including product–market fit, demand pull, supply-chain readiness, regulatory risks and workforce availability.

Smelting pathways for Australia's iron ore mining

The development of pathways to utilise low-grade iron ore in DR is of particular strategic importance to Australia, far more so than for most other iron ore-producing nations. Smelter technology appears to be a potential solution for transforming Australia's primary export.

Developing a viable pathway for Pilbara ores should be a priority for both the federal and WA governments. The WA government has indicated its willingness to procure green steel from local producers for major public projects. As Premier Roger Cook stated, "Locally made green steel is a key part of my vision to become a renewable energy powerhouse and make more things here." To support this, the state government also plans to publish an addendum for steel to the Western Australian Industry Participation Strategy (WAIPS), which is expected to outline a clear pathway for realising WA-produced green steel.

However, the WA government appears to be lagging other parts of Australia in emissions-reduction efforts, placing significant emphasis on carbon capture and storage (CCS) technologies, which have a track record of failure and underperformance. A similar narrative is also being promoted by major iron ore producers, such as BHP, which raises questions about reliance on CCS and the pace of decarbonisation in the iron and steel sector.

Government intervention can play an important role in reducing risk for private sector investment in new technologies, particularly when the urgency of developing new technology pathways is recognised as a national strategic priority. One significant example is the green iron project in Namibia – HyIron Oshivela – which is supported by the German government. The project is progressing toward the construction of its first commercial-scale plant. Therefore, a decisive and co-ordinated set of policies is urgently required to accelerate the deployment and scaling of these technologies in Australia.

Australian iron ore producers are supporting solutions better aligned with their resource base and operating conditions than the dominant green iron and steel pathway. However, the level of involvement by iron ore miners in advancing and expanding these technologies remains limited. This may not adequately reflect the long-term risks facing Australia's largest export industry and the billions of dollars in profits generated by iron ore miners.

Table 2: Australian miners' involvement in FBR and smelter-based ironmaking development

Iron ore miner	Green iron initiatives
BHP	NeoSmelt, HyREX, Baowu
Rio Tinto	NeoSmelt, Hy4Smelt, ZESTY
Fortescue	Christmas Creek Pilot

Sources: Company reports

Furthermore, academic studies indicate that a range of iron ores from the Pilbara can be suitable for the H_2-DRI–ESF–BOF pathway. ARENA is funding more academic initiatives to derisk and accelerate the development of smelter technologies. Project timelines are broadly aligned with real-world technology development beyond laboratory scale.

Table 3: ARENA funding to develop smelter-based pathways for Australian iron ore

Project	Cost (AU$M)	Start date	Finish date	Lead organisation
Pilbara iron ores in an electric smelting furnace process	4.24	March 2024	June 2029	The University of Wollongong
Derisking large-scale Australian fine-ore hydrogen ironmaking*	13.69	March 2024	April 2028	Australian National University
Electric smelting of hematite-goethite hydrogen DRI	5.9	March 2024	February 2029	University of Newcastle

*Source: ARENA. *Note: This project is majorly focused on fluidised bed reactor along with novel smelting process.*

These technologies are still evolving, and further development is required before they can reach a mature, highly reliable stage. The repetition of academic research, including building pilot and demonstration smelter plants in Australia, further highlights that additional work is needed to validate these technologies, including process parameters, underlying chemistry and real-world performance.

Two previous attempts to pursue new ironmaking pathways in Australia – BHP's Boodarie hot briquetted iron (HBI) plant, based on FINMET technology, and Rio Tinto's HIsmelt plant in Kwinana, in 2005 and 2011, respectively – were ultimately unsuccessful.

These experiences, together with the limited number of technologies that dominate iron production (BF and DR), suggest Australia should carefully consider a broader range of available solutions while pursuing pathways to process low-grade iron ores. External factors, such as the pace of technological development in other countries and how quickly the world can transition to new smelting-based pathways, will also influence Australia's ability to realise its green iron ambitions.

Given Australia's extensive magnetite resources capable of delivering DR-grade material, a large-scale transition could begin today, by deploying mature DR technologies.

Global growth in low-emissions iron and steel projects leaves no room for delay in initiating Australia's green iron transition. DRI projects across regions such as the European Union, the US, and Middle East and North Africa are already under construction, with several approaching FID. Iron ore producers in Brazil, Canada, Africa and the Nordic countries are expanding high-grade iron ore capacity to keep pace with rising demand for DR-grade feedstocks. This reflects a clear global trend and on-the-ground reality that Australia cannot afford to overlook.

The transition will not wait for any country; without the development of commercially scaled projects in line with global trends, Australia risks falling behind.

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