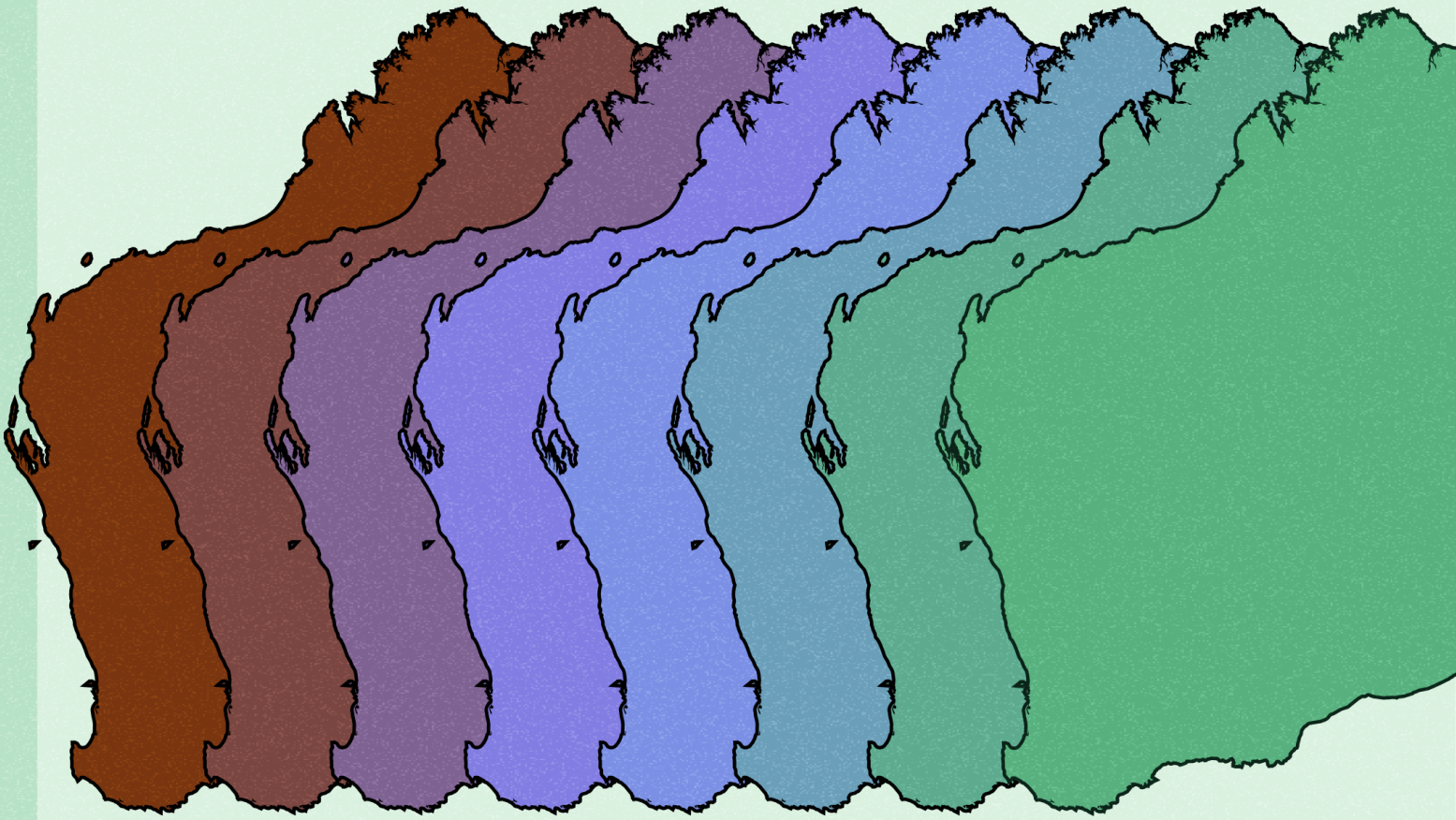
REPORT

Western Australia Green Iron Roadmap

Turning ambition into action



About The Superpower Institute

Founded in 2023 by economist Ross Garnaut and public policy expert Rod Sims, The Superpower Institute is a not-for-profit organisation dedicated to helping Australia seize the extraordinary economic opportunities of the post-carbon world.

The Institute's focus is on developing the policy settings, market incentives and practical knowledge necessary for Australia to become a major exporter of renewable energy and green industrial products. By leveraging the nation's comparative advantage, the Institute aims to elevate Australia's economic and climate ambition and secure its place as a leader in a decarbonised global economy.

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Further reading

Explore the modelling behind this Roadmap, alongside related research from TSI:

Western Australia Green Iron Roadmap (this report)
superpowerinstitute.com.au/work/western-australia-green-iron-roadmap

Digging Deeper: Modelling green iron in WA
superpowerinstitute.com.au/work/digging-deeper

Digging Deeper model methodology and inputs
superpowerinstitute.com.au/model-methodology-digging-deeper

A Green Iron Plan for Australia
superpowerinstitute.com.au/work/green-iron-plan

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Acknowledgement of Country

This report was authored and edited on the Traditional Lands of the Whadjuk People of the Noongar Nation and the Wurundjeri People of the Kulin Nation. We pay our respects to their Elders past and present, and acknowledge the enduring strength of their cultures, knowledge and custodianship.

As Australia advances toward a new era of clean energy trade, we recognise the vital importance of First Nations voices, rights and leadership. A just transition must ensure that First Nations communities share equitably in the benefits of new industries, and that their deep connections to Country inform how we shape a more sustainable and inclusive future.

AI Statement

This report is the work of its authors. Artificial intelligence (AI) tools were used to support selected research and production tasks. AI-assisted content was subject to human review and verification. The Superpower Institute retains full responsibility for the research, analysis, findings and recommendations presented in this report.

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Foreword

When The Superpower Institute (TSI) published *A Green Iron Plan for Australia* in May 2025, we set out the economic case for green iron and the national policies needed to address the market failures holding it back. That work showed that, with sound policy, green iron made in Australia can compete with iron made using fossil fuels. This was a crucial finding for realising Australia's green iron potential,

Plenty of reports now say green iron is a good idea for Australia. Few ask where, when and why it is likely to succeed. This *Roadmap* asks those questions for Western Australia, which mines most of the nation's iron ore and is likely to host much of Australia's green iron industry.

First, it takes national modelling down to the local level. Green iron is not a single opportunity that can happen anywhere in the State. Its cost depends on a few highly local factors: ore grade, technology choice, available infrastructure and skills, energy system design and access to the grid. Small changes in these factors produce large changes in cost. This is why the *Roadmap* finds the Mid West offers the lower-risk place to build the initial projects. Long-lead work in the Pilbara should proceed in parallel, so that region can move when technology and markets are ready.

Second, it focuses on what the State itself controls. Most reports, including our own national plan, direct their recommendations to the Commonwealth. Commonwealth support remains essential. But the *Roadmap* argues that coordination, rather than technology or cost alone, is likely to be the main constraint on getting projects built. Western Australia built its iron ore and LNG industries through deliberate State coordination of infrastructure, approvals and risk. Much of that capability has, unfortunately, since been lost. The State should begin rebuilding it now.

Third, it is disciplined about public money. Government should enable private investment, not replace it. Public funds belong where markets fail, such as common-user infrastructure with clear public benefits. They should not underwrite the commercial risk of individual projects or the specific infrastructure they need or subsidise gas. This approach is what will give governments and taxpayers confidence that support is focussed, and so well spent.

Fourth, it is realistic about who will invest. Industry is not one actor. The major iron ore producers, overseas steelmakers and Mid West developers are following different strategies. Those strategies will decide whether iron-making happens in Western Australia or offshore. Certainly, therefore, policy should not be designed around the incumbent miners alone.

The *Roadmap* also gives government a practical tool. Its project Scorecard can help government decide where to focus its limited coordination and infrastructure effort and test those judgements as proposals emerge.

Finally, it is candid about what we do not yet know. This includes when hydrogen supply will become available, which is relevant now to opportunities in the Mid West, and when technologies suited to Pilbara ores will be ready and how quickly volume markets will emerge for them. The *Roadmap* is a framework to guide the way forward in WA, and to be tested and updated as required.

Western Australians know how to build export industries. The task now is to help the first green iron projects reach final investment decision quickly, and to build the conditions for the industry that can follow.

I thank the excellent team, led by Jessica Shaw and drawing on the deep expertise within TSI, who prepared this *Roadmap* and the many people in government and industry who gave their time and insight.

I commend this *Roadmap* to the Western Australian Government, the Commonwealth and industry. Now is the time to get projects moving. It would be a tragedy if Australia missed this huge opportunity simply due to a lack of focus and effort.

Rod Sims
Chair, The Superpower Institute

Executive Summary

Purpose and context

The decarbonisation of steel production is emerging as a critical component of global net zero pathways. While scrap-based steelmaking will expand, it cannot meet projected demand for primary steel, particularly in fast-growing economies. This creates a structural need for low-emissions primary iron inputs, commonly referred to as *green iron,* produced using renewable energy and/or low-emissions hydrogen rather than coal.

Western Australia is well placed to participate in this transition. It has world-class iron ore resources, strong renewable energy potential, existing industrial and export infrastructure, extensive experience delivering large-scale resource and energy projects and a well-established reputation as a stable, reliable supplier to international markets (Chapter 1). At the same time, green iron production presents challenges that differ materially from traditional iron ore mining and export, including new technology risks, large electricity requirements, common-user infrastructure needs, workforce constraints and complex coordination challenges.

This *Roadmap* sets out how Western Australia should position itself to capture green iron opportunities while managing these risks. This *Roadmap* sets out the logic by which choices about regions, technology pathways and projects could be made. It provides an evidence-based framing to guide government decision-making and partnership as the industry emerges, grows and matures.

Roadmap recommendations

Build early momentum while preparing for scale

01. **Act now on one or two commercial-scale lighthouse projects, likely in the Mid West.**

Early development is most likely where energy, water, port access, workforce and approvals can be aligned at lower risk and cost, and the Mid West currently holds notable advantages. Government effort should support projects using proven direct reduction technology, local ore, existing infrastructure and access to the Wholesale Electricity Market. It should scope enabling infrastructure and utilise market-revealing processes to test costs and demand, with early-stage demand most likely to emerge from high-value, low-volume niche markets.

Chapters 2, 6 and 10

02.	**Accelerate long-lead enabling work in the Pilbara in parallel.** The Pilbara holds the greatest potential for volume production, but that potential depends on two developments outside the state's control. Technologies suited to Pilbara ores must mature, and high-volume green iron markets must emerge as China transitions its steel industry and ageing blast furnace assets. Some of this work is underway, but coordinating project-ready land, heritage approvals, transmission and finance models with greater pace will allow the region to move quickly when both conditions are met. Chapters 2, 3 and 6
Strengthen the State's capacity to deliver	
03.	**Rebuild the State's coordination capability.** Coordination, rather than technology or cost alone, is likely to be the binding constraint on delivery. Much of the institutional 'muscle memory' that delivered past resource and energy developments has atrophied. Rebuilding it requires a clear mandate, authority to convene and escalate, resourcing matched to the task and sustained senior leadership. The state will also need to work closely with the Commonwealth (see recommendation 6). Chapter 8
Direct public support where it adds most value	
04.	**Enable private investment rather than replace it.** Public investment should focus on common-user infrastructure with strong public-good characteristics and should not underwrite project-specific commercial risk. Large-scale and location-specific commitments should remain conditional on what market processes reveal, preserving optionality and avoiding premature lock-in. Chapter 5
05.	**Prioritise green hydrogen and other near-zero pathways.** Public support, coordination and policy facilitation should be directed to electricity and/or hydrogen-based iron-making, not gas-based iron-making. Where a project chooses to start on gas, that is a commercial decision and should be commercially funded. Government should not subsidise gas use or fund gas infrastructure for iron-making, and any support for gas-start projects should be limited to their capability for green production. Chapter 5

Work in partnership with the Commonwealth

06.	**Establish an effective Commonwealth–State partnership early.** Many key levers sit with the Commonwealth, including the Green Iron Investment Fund and hydrogen support mechanisms. In the near term, the state and Commonwealth should establish coordination mechanisms, develop joint infrastructure investment proposals, and align on access to the Hydrogen Production Tax Incentive, standards and certification, and workforce strategy. Chapter 9

Success is not automatic: it will depend on acting early, coordinating deliberately and adapting as information improves.

Foundations

Global demand for green iron is expected to emerge initially in niche markets where buyers face either strong decarbonisation pressures or are willing to pay a green premium for low-emissions inputs. Over time, as technology matures and costs fall, these markets are expected to expand. Western Australia's potential role is therefore shaped by both near-term market constraints and longer-term volume opportunities as major customer economies, particularly China, transition their steel industries.

Green iron can be produced through several pathways, combining different ore types, beneficiation processes, hydrogen or electrochemical-based direct reduction technologies and energy system configurations (Chapter 2). Gas-based direct reduction is commercially proven and hydrogen-based direct reduction is close to commercial scale, although neither yet works with Pilbara ores. Other technologies are commercially and technically immature. This diversity reinforces the need to examine a range of pathways.

Western Australia's regions also differ materially in their characteristics. The Mid West, Pilbara and South West vary in ore types, infrastructure endowment, energy systems, workforce availability, approvals complexity and proximity to export facilities (Chapter 3). These differences matter for cost, risk and timing.

Modelling undertaken for this *Roadmap* explores relative cost drivers and trade-offs across locations and production pathways (Chapter 4). The modelling is intended to inform rather than determine recommendations. It shows that green iron is not a single opportunity that can happen anywhere in Western Australia. Cost depends on a small number of highly local factors, including energy resource quality, system design and grid connection, along with ore grade and technology choice. Minor changes in these factors produce substantial changes in cost, so enabling conditions, including infrastructure, need to be planned location by location, with proponents.

Strategic framework: the role of government

This *Roadmap* identifies a clear rationale for state and Commonwealth government involvement, grounded in market failures and coordination challenges (Chapter 5). Known market failures include:

- The lack of carbon pricing signals to address the carbon emissions externality
- Innovation spillovers leading to underinvestment by early movers
- Infrastructure spillovers leading to underinvestment in supporting critical infrastructure

Further challenges requiring government coordination include:

- Fragmented planning and delivery across energy, water, ports, hydrogen and land access approvals.
- Workforce and capability constraints that require early investment ahead of demand.

The appropriate role of government is not to replace private investment, but to enable it by addressing market failures, as well as playing a vital role in providing coordination, policy certainty and capability-building. This *Roadmap* sets out a suite of state government policy levers including infrastructure coordination and investment, planning and approvals reform, workforce development and a limited role for market-shaping tools. We emphasise that the effectiveness and relative importance of these levers changes over time as the industry matures.

Importantly, the *Roadmap* recognises that government intervention should evolve as markets, technologies and project pipelines develop and that early decisions should preserve flexibility rather than lock in outcomes prematurely.

Industry development, regional factors and project assessment

The *Roadmap* establishes two distinct but related tools: a strategic framework for government involvement and a project assessment scorecard to guide decisions about individual projects. Applying these tools and our insights from modelling green iron production costs in Western Australia leads to indicative expectations about the focus of government effort on green iron as the industry develops. This development trajectory reflects differences in system readiness, cost, risk and coordination requirements – it does not constitute endorsement of specific projects or regions, nor does it pre-empt future decisions about where government support may be directed.

Early development is more likely to occur where energy, water, port access, workforce capability and approvals pathways can be aligned at lower risk and lower cost. Current indications are that the Mid West region has notable existing advantages in these areas.

As capability is built, infrastructure expands, technologies and markets mature, a wider range of locations and technology pathways should become viable at scale.

Our analysis indicates a likely three-phase development trajectory defined by the maturity of the industry:

- a foundation phase of first-of-a-kind *lighthouse* projects and capability building;

- a scale-up phase as markets deepen, technology matures and infrastructure expands; and
- a maturity phase as volume markets drives large scale export production.

These phases describe an evolving configuration of government focus across all three regions. Foundational lighthouse project activity is likely to concentrate in the Mid West and demonstration project activity in the South West while the work to build the enabling conditions in the Pilbara will unlock longer term investment to meet volume market demand. An indicative trajectory for industry development is set out in Chapter 6.

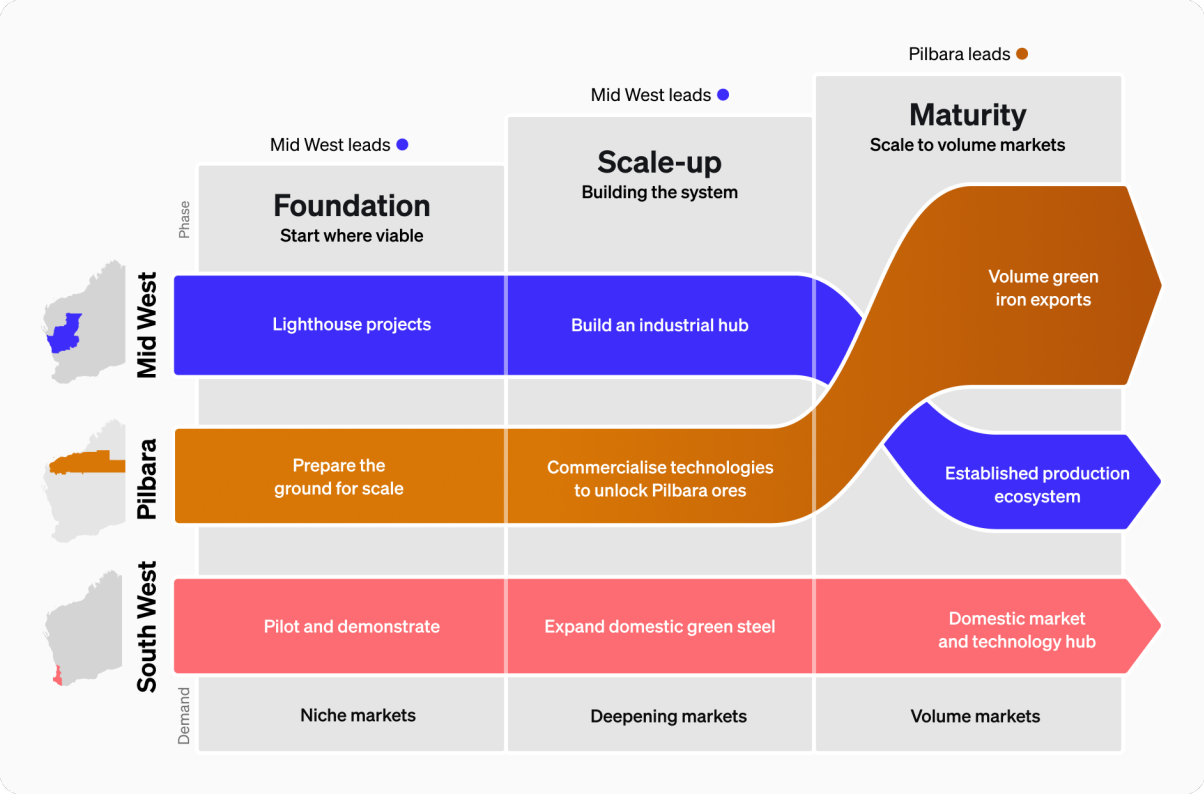


Figure ES1: WA's green iron industry will develop differently across its regions

Source: The Superpower Institute analysis.

The *Roadmap* therefore treats sequencing of government intervention as conditional and information-revealing. Government expectations should be tested and refined as projects emerge. To support this, the *Roadmap* also sets out a project assessment "Scorecard" designed to inform government decision making (Chapter 7). The project Scorecard aligns assessment criteria with the strategic objectives of risk reduction, system efficiency and long-term value creation, while allowing flexibility as markets and technologies evolve. Detailed criteria and governance arrangements are provided to ensure transparency without constraining adaptive decision-making.

Delivery systems and coordination

Green iron development depends on the successful integration of multiple delivery systems (Chapter 8). Energy supply, water infrastructure, ports and logistics, workforce and skills, planning and approvals, and coordination capability are all potential bottlenecks.

Western Australia has taken important steps to strengthen its delivery capabilities, including reforms to planning and approvals, the creation of Strategic Industrial and State Development Areas, and institutional changes to support coordination. However, challenges remain, particularly resourcing of coordination functions commensurate with the scale and complexity of the task and workforce readiness, community engagement and Traditional Owner partnerships.

The *Roadmap* emphasises that coordination is central to success. Effective coordination requires clear mandates, adequate resourcing and sustained senior leadership, drawing on Western Australia's experience delivering complex industrial systems.

Commonwealth partnership

Many of the challenges associated with green iron development, including early-stage technology risk, infrastructure scale and market creation, are shared between state and Commonwealth governments. The *Roadmap* therefore identifies areas where Commonwealth–State partnership can add value, particularly in relation to production and investment support, infrastructure co-investment, and research, development, skills and trade engagement (Chapter 9).

Near term priority actions for government

The *Roadmap* identifies near-term priority actions, key decision points and indicators of success and emphasises the need for adaptation as information improves. Given uncertainty in markets, technology and project pipelines, the ability to learn and adjust is as important as the initial strategic direction (Chapter 10). A summary of the near-term priorities for government are:

Coordinate delivery	
01.	Establish and resource a coordination function with a clear mandate, authority to convene and escalate, and sustained senior leadership.
02.	Maintain structured, ongoing engagement with proponents and infrastructure providers.
Test costs and demand	
03.	Use market-revealing processes, such as tenders and expressions of interest, and apply the Scorecard to proposals.
Prepare enabling infrastructure	
04.	Scope and coordinate enabling infrastructure for early Mid West projects and identify a location for a Mid West industrial hub.
05.	Align transmission planning with industrial timelines and improve information on capacity, connection and access for proponents.

06.	Accelerate long-lead enabling work in the Pilbara: project-ready land, heritage approvals, transmission and finance models.
07.	Coordinate hydrogen supply planning with early green iron projects, including links to Commonwealth hydrogen programs.
Partner with the Commonwealth	
08.	Establish Commonwealth–State coordination mechanisms, develop joint infrastructure proposals, and align state support with Commonwealth instruments, including the Green Iron Investment Fund and HPTI.
Prepare communities and the workforce	
09.	Begin regional community and Traditional Owner engagement ahead of individual project approvals.
10.	Co-develop a workforce strategy with the Commonwealth and invest in training ahead of demand.

In the near term, government effort is most effectively directed toward actions that will support a small number of green iron projects being developed in the state. The demonstration effect, market development and the broader knowledge generation from this are likely to deliver significant benefits, including industrial decarbonisation.

Overall message

Western Australia has a credible opportunity to lead the global transition to green iron, but success is not automatic. It will depend on effective planning, coordination, targeted public intervention and constructive partnership with industry, markets and the Commonwealth. This *Roadmap* provides a structure to guide those choices, manage risk and support informed decision-making as the industry evolves.

Further work and next steps

This *Roadmap* provides a structured, evidence-based framing for the development of a green iron industry in Western Australia, but it does not pre-empt decisions about specific projects, policy instruments or funding allocations. Further clarity on the precise role of government, including which projects to support, which policy tools to deploy and where targeted public infrastructure investment is justified, will require additional work and detailed engagement with industry proponents, infrastructure providers and the Western Australian and Commonwealth Governments, to test the assumptions and indicative industry development trajectory set out in this *Roadmap* against emerging project proposals and evolving market conditions.

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Introduction

From vision to delivery

This *Roadmap* builds on a substantial existing body of work on the ‘superpower’ trade opportunity and sets out a practical plan for realising it, starting with green iron and laying the foundations to extend beyond into other green commodities. Its focus is on Western Australia, recognising the state as the home to all the ingredients for superpower trade success.

In 2019, Ross Garnaut's book, *Superpower: Australia's Low-Carbon Opportunity,* made a case that few others were making: that Australia's renewable energy resources could underpin a new era of industrial prosperity, contributing significantly to global decarbonisation efforts in the process. At the heart of that vision was a prediction that seemed bold at the time but has since become consensus: as the world decarbonises, demand for zero carbon energy will grow substantially and this will drive large scale trade in green commodities.

The most significant example of green commodity trade will occur in the steel supply chain, with a need to replace carbon-intensive blast furnaces used in steelmaking. This will open the door for production of ‘green iron,’ an intermediate product made from processing iron ore using renewable energy. Iron-making is the most carbon intensive stage of steelmaking and green iron can be easily traded internationally.

Since *Superpower*'s publication, The Superpower Institute (TSI) has developed the initial vision into a detailed analytical framework.

TSI's *The New Energy Trade* (2024) positioned the global shift to net zero as a fundamental reshaping of trade flows, industrial strategies and investment decisions across energy-intensive industries. It made the case for Australia’s prominent place in global green trade in a world where many countries will lack sufficient zero carbon energy sources to meet their needs in a decarbonised world.

In 2025, TSI published *A Green Iron Plan for Australia* (*GIPA*), demonstrating that green iron production was not only technically feasible but economically competitive with the right policy settings in place. *GIPA* modelled production pathways, estimated costs, analysed global markets and identified the policy settings needed to unlock private investment. It provided a policy prescription that would allow Australia to produce green iron at costs comparable to or lower than international competitors:

- Green iron production credits, adding to the existing hydrogen production tax incentives, to make up for the lack of international carbon prices
- Support for innovation, so that early movers are incentivised and rewarded for the early knowledge they will generate that subsequent producers will benefit from
- Support for infrastructure critical to green iron production, such as transport and energy storage

- International engagement and diplomacy with our trade partners, to promote green iron trade and the development of complementary policy settings to advance it.

Building on previous work

There is growing global recognition of the importance of green iron in steel decarbonisation and Australia's role. The OECD published a dedicated report on green iron in 2023, calling it essential to steel decarbonisation. The International Energy Agency's iron and steel technology roadmaps now centre green iron as the primary pathway for reducing emissions from primary steel production. The World Steel Association, World Economic Forum and major multilateral development banks have all reached the same conclusion: green iron is not a niche product; it is the future of primary steelmaking. What began as a bold prediction in *Superpower* has become global consensus. The question is no longer whether green iron will be necessary, but which regions will supply it, on what terms and with what strategic positioning.

TSI has undertaken WA-specific modelling which draws on local energy costs, ore characteristics, infrastructure availability and regional differences. The outcomes of this modelling can be found in *Digging Deeper*, the companion publication to this Report. *Digging Deeper* compares green iron production across the Pilbara and the Mid West, identifying where near-term projects are best positioned and where larger-scale production depends on longer-term technology maturation or infrastructure development. The work demonstrates the regional variation in costs of production in WA and emphasises the need for strategic choices about location-specific planning, technology pathways and public investment coordination. These choices will determine whether WA captures early-mover advantages or arrives too late.

Why Western Australia and why now?

This *Roadmap* answers these questions for Western Australia. It builds on previous TSI analysis to provide a clear framing of how WA can lead in green iron production. It moves from analysis to strategy, from modelling to implementation, from opportunity to action.

The state that built the world's most efficient iron ore supply chain can now build the world's most competitive green iron industry if it moves with purpose, clarity and strategic discipline.

Some WA stakeholders will view the pursuit of a green iron industry as a radical departure from what has delivered prosperity to the state in the last half century or so, built in large part on the great success of the iron ore and LNG industries. The *Roadmap* demonstrates why pursuit of green industries in the state makes economic sense, utilising the natural advantages the state has, leveraging the industrial capacity and knowledge it has accumulated and acting as a hedge against the real prospect that existing industries will decline as the world moves towards net zero emissions.

While the focus of the *Roadmap* is green iron, much of the content presented will have relevance in the development of other green commodities. TSI will expand its work to consider these other commodities beyond 2026.

What Makes This Roadmap Different

It establishes a strategic framework: the rationale for government involvement, the levers available and how their use should change over time and the principles for targeting effort. This framework provides the logic for everything that follows.

It provides regional context to industry development: this *Roadmap* explains the role each region is likely to play in industry development and why. Current evidence indicates that the Mid West is positioned for early-mover, new-entrant projects, the Pilbara for long-run scale and the South West can contribute capability building and domestic market development.

It provides a project assessment scorecard for prioritisation: the Scorecard provides transparent criteria for assessing projects and allocating scarce government resources. Some projects are more likely to serve WA's interests than others. The Scorecard makes those trade-offs visible and defensible.

It addresses coordination systematically: green iron requires coordination across energy systems, water infrastructure, port capacity, approvals processes, Traditional Owner partnerships and policy settings at state and Commonwealth levels. This *Roadmap* treats coordination as a system challenge, not a collection of separate issues.

It goes beyond analysis and into strategy for delivery: the *Roadmap* is not just further analysis; it is strategic advice. TSI recommends that WA prioritise initial efforts and resources on supporting lighthouse projects using established technologies to produce near-zero iron for existing markets and that government play an active infrastructure coordination role. Government support for emerging technologies and new market opportunities will be enhanced by the success of early lighthouse projects.

How this Roadmap should be used

For the WA Government:

- Infrastructure investment priorities (how to make decisions about which ports, which transmission, which water infrastructure, when etc)
- Project prioritisation (how to prioritise which projects receive coordinated government support)
- Policy focus (how to make decisions about where to deploy finite coordination capacity and public resources)
- Governance architecture (how to organise delivery)

For the Commonwealth:

- Clear advocacy tied to WA's priorities (subsidy design, transmission co-funding, offtake facilitation)
- Specific contributions that could unlock each phase of industry development

For international partners:

- WA's positioning as an early, reliable supplier in specific market segments
- Understanding the timing and scale of industry development by region

Box 1: How to Read this Roadmap

- This *Roadmap* sets out decision logic, not decisions
- It explains why phased intervention matters, not which projects win
- Regional discussion reflects risk and readiness, not permanent preference
- Policy options are conditional and adaptive, not fixed commitments

The value of the *Roadmap* is in how choices are made, not what is chosen today.

Structure of this Roadmap

The Roadmap moves from context and evidence to strategy, application and action, in five parts. Each part opens with a page saying what it covers.

Part I

Motivation and context

Sets out why green iron matters for Western Australia now.

In this part

01	Green Iron is a Priority for Western Australia	16

01.

Green Iron is a Priority for Western Australia

Chapter 1 overview

> Global steel demand will remain high and scrap cannot meet it, so primary steelmaking must decarbonise, creating structural demand for green iron
>
> Western Australia's renewable energy, iron ore base, export relationships and project delivery history give it a credible basis to compete
>
> Inaction carries real costs: iron ore royalties fund around a quarter of state revenue, competitors are moving quickly and carbon pricing is reshaping markets

Together, these explain why green iron matters for Western Australia now: it is both a major industrial opportunity and insurance against the erosion of the state's largest industry.

In this chapter we establish the strategic case for green iron with a specific focus on WA's opportunity and risks.

1.1 Global steel decarbonisation and the role of green iron

Western Australia sits at the centre of one of the most significant industrial shifts in modern history. As steelmakers around the world move to cut emissions, demand will rise for low-carbon iron products that can be used in electric arc furnaces, produced from emerging hydrogen-based and electrochemical technologies. This shift will reshape global supply chains, investment flows and industrial strategies. It presents Western Australia with an opportunity that is broader and more transformative than any resources development since the rise of iron ore and LNG.

1.1.1 Western Australia's history as a global iron ore supplier

WA is one of the world's largest and most reliable suppliers of seaborne iron ore. The state supplies 60 per cent of the world's seaborne iron ore trade. Its ore has supported decades of steelmaking and industrial growth in Japan, China and Korea, anchored Australia's most

important trading relationships and underpinned the state's fiscal position. In 2024, WA's iron ore exports were valued at $123 billion.

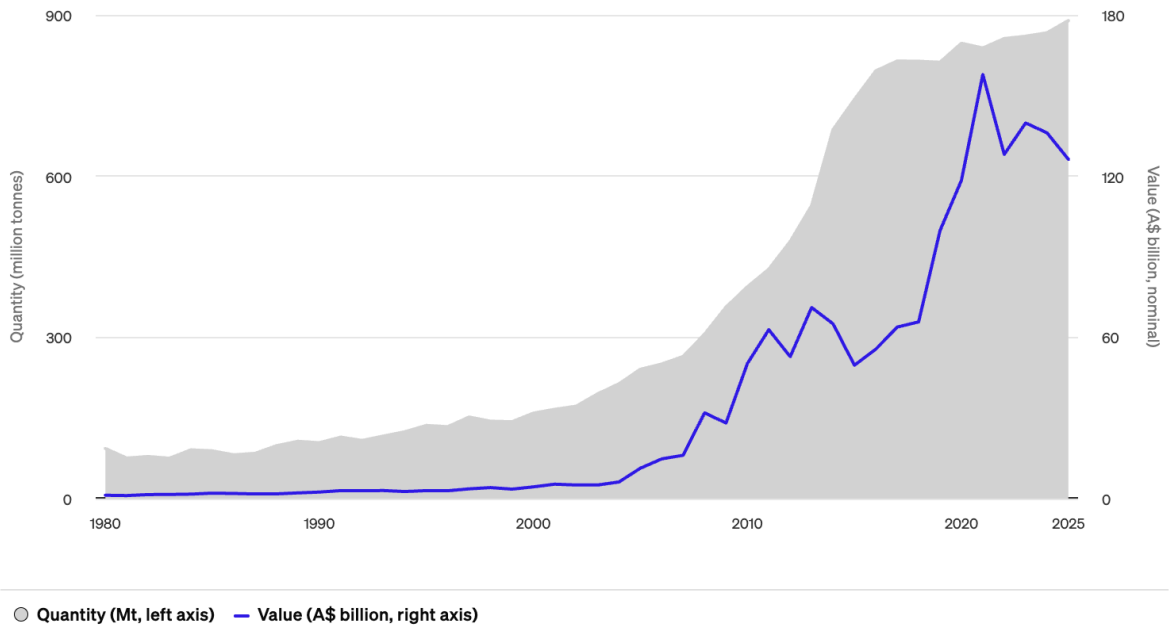


Figure 1: Western Australian iron ore export volumes and revenue 1980-2025.

Notes: Value in nominal Australian dollars, not adjusted for inflation. The two y-axes are scaled independently, so where the line sits against the area does not by itself mean anything. 2014 to 2025: quantity 686.2 Mt to 889.5 Mt; value $65.06 billion to $126.23 billion.

Source: Department of Mines, Petroleum and Exploration (WA), Major Commodities Data File 2025.

These trading relationships were forged in the decades following World War II. The discovery of vast iron ore deposits in the Pilbara during the 1960s, combined with Japan's industrialisation ambitions, created conditions that transformed both economies. The partnership established Western Australia as a reliable supplier of high-quality ore and Japan as an advanced manufacturer of steel. This relationship shaped the contours of the international iron ore trade for decades and was later replicated with Korea's steel industry from the mid-1980s.

At the turn of the 21st century, China's rapid industrialisation created unprecedented demand. Over two decades, the Pilbara's major producers quadrupled their output from under 200 million tonnes at the start of the century to over 800 million tonnes by the 2020s. By 2020, China accounted for more than 83 per cent of Western Australia's iron ore exports. This transformation reshaped the industry and reinforced WA's position as the world's lowest-cost, most reliable iron ore supplier.

In addition to export revenue, the WA iron ore sector's royalties contribute roughly a quarter of total state revenue, sustaining essential public services, public infrastructure and regional development.

1.1.2 Western Australia’s future as a green iron superpower

Global decarbonisation is now steadily reshaping the requirements of steelmaking. Major economies, including China as the world's largest steel producer, as well as Europe, Japan and

Korea, are redesigning their supply chains around low-emissions iron inputs. Over time, these economies will increasingly require green iron rather than the raw ore traditionally used in blast furnace operations.

This shift is strategic as well as economic. Green iron will play a significant role in global emissions reduction. Steel is responsible for about 8 per cent of global emissions, and many major economies cannot meet their climate commitments without decarbonising steelmaking. Western Australia can contribute to this global effort by providing the clean feedstocks needed to support the transition, strengthening its reputation as a reliable partner in a decarbonising Asia Pacific region.

The opportunity is also industrial. Producing green iron requires secure access to renewable energy, hydrogen, water, processing infrastructure and export pathways. These are the same foundations needed for a wider suite of clean-energy industries. By developing green iron capability, Western Australia can position itself for a broader industrial base that includes hydrogen and derivatives, critical minerals and metals processing, battery materials, sustainable fuels and downstream clean-technology manufacturing. This is not a single-commodity play; it is the gateway to a more diverse and more resilient industrial economy.

The economic potential is substantial. TSI's work in *The New Energy Trade* and *A Green Iron Plan for Australia* shows that green iron production can become one of Australia's largest export industries, exceeding the value of existing resource sectors. Early movers may access long-term advantages. Countries and companies are already setting procurement requirements for low-carbon materials, and investors are looking for jurisdictions that can provide long-term certainty, competitive energy and clear pathways to scale.

But the opportunity is not guaranteed. Green iron is energy-intensive, capital-heavy and globally competitive. Other regions, including the Middle East, North Africa, Brazil and parts of North America, are moving quickly, supported by integrated industrial strategies, long-term offtake commitments, public investment and coordinated infrastructure delivery. Western Australia must compete with this pace and purpose if it is to secure a meaningful role in the emerging low-carbon metals system.

The benefits for Western Australians are significant. Green iron can support long-term regional jobs, deepen local manufacturing capability and create opportunities for Traditional Owners. It can strengthen the sustainability of existing mining towns and anchor new industries that reflect modern environmental and cultural expectations. It can also reinforce the state's fiscal position by diversifying the sources of export revenue that support essential services.

In short, green iron matters for Western Australia because it touches every part of the state's future: the economy, energy system, regions, global relationships and its contribution to decarbonisation. It is a chance to build a new industrial chapter with the same ambition that defined the iron ore and LNG eras but guided by contemporary values and modern expectations.

1.2 The limits of scrap and the persistence of primary steel

The global conversation about decarbonising steel often focuses on ‘green steel’, the finished product. But for Western Australia, the opportunity lies upstream: in producing green iron, the clean metallic feedstock that steelmakers need to transition away from coal-fuelled blast furnaces.

This distinction matters.

1.2.1 Steel Will Remain Essential

Steel is responsible for more than 8 per cent of global greenhouse gas emissions. Nearly all of this comes from primary steel production, made from iron ore, which accounts for about 70 per cent of global steel output. The remaining 30 per cent is secondary steel, made by recycling scrap in electric arc furnaces, a process that generates far lower emissions.

Global steel demand is expected to remain high for decades. Around 1.85 billion tonnes of crude steel was produced in 2025[1], and the International Energy Agency’s baseline projections show global steel demand rising by more than a third by 2050.[2] Long-term projections expect demand to hold near or above current levels through 2050. China’s demand has plateaued, but India, Southeast Asia and Africa will need far more steel as they urbanise, infrastructure in mature economies needs renewing and the net zero transition itself requires large quantities of steel for wind turbines, transmission infrastructure and electric vehicles.[3]

1.2.2 Scrap Alone Cannot Meet Demand

Because the quantity and quality of scrap steel is constrained, and because demand for steel continues to grow, decarbonising primary steelmaking needs to be the global priority.

Scrap is a valuable resource and will play a growing role as infrastructure ages and collection systems improve. But it cannot meet total demand. Scrap only becomes available when buildings are demolished, vehicles are retired and infrastructure is replaced. Growing economies, building cities and industrial capacity at scale don't yet generate sufficient scrap to meet their steel needs.

This means primary steel production will remain essential for decades. The challenge is to decarbonise it.

1.2.3 From Blast Furnaces to Green Iron

About 90 per cent of the world's primary steel is currently made using the blast furnace-basic oxygen furnace (BF-BOF) process, which uses coking coal to reduce iron ore to molten iron.

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1 World Steel Association. “December 2025 Crude Steel Production and 2025 Global Crude Steel Production Totals.” World Steel Association, Media release, Brussels, 23 January 2026.

2 International Energy Agency. ‘Iron and Steel Technology Roadmap: Towards More Sustainable Steelmaking.’ IEA, October 2020.

3 Refer to Appendix A for a discussion on steel market dynamics.

This process generates over 2 tonnes of CO_2 per tonne of steel and cannot be easily decarbonised without expensive and unproven carbon capture technology.

The alternative is the direct reduction-electric arc furnace (DRI-EAF) pathway. This process reduces iron ore at lower temperatures using gas or hydrogen, producing direct reduced iron (DRI). The DRI is then melted in an electric arc furnace to make steel. When powered by renewable energy and green hydrogen, this pathway generates far lower emissions. There are also emerging technologies utilising renewables-based electrolysis to produce green iron, these are collectively referred to as Direct Electrical Reduction or DER technologies.

Green iron allows existing steelmakers to transition away from coal-based blast furnaces for iron-making and retain their downstream steelmaking assets by feeding them green DRI/HBI. Green iron also facilitates the expansion of secondary steelmaking capacity beyond available scrap supplies.

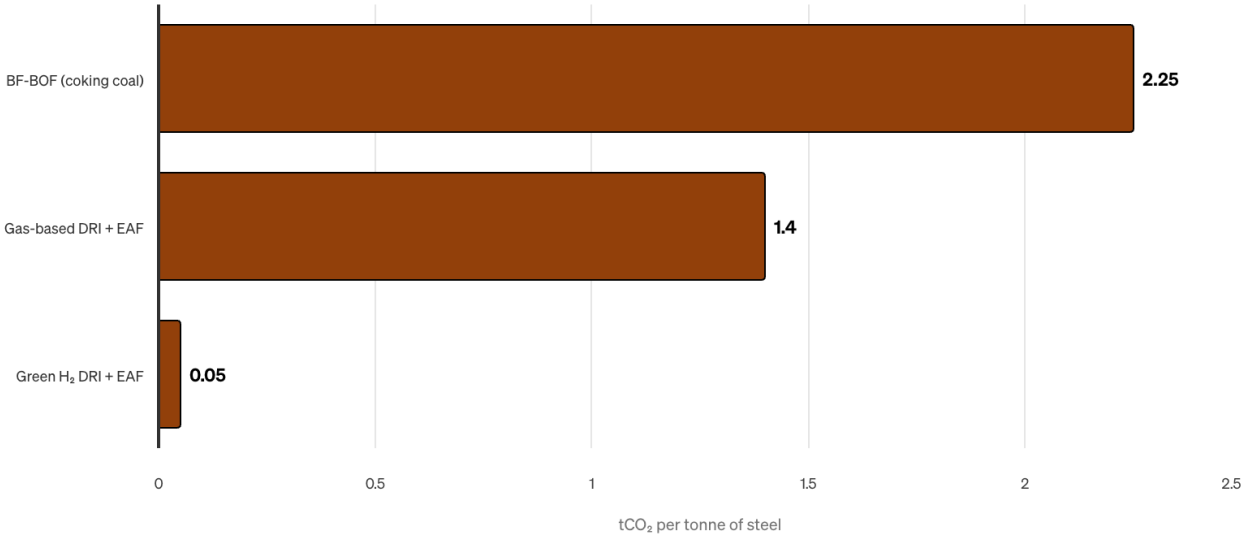


Figure 2: Gas-based iron-making cuts steel emissions by about 40 per cent; green hydrogen cuts them almost to zero

Source: World Steel Association. 'Emissions from the steel industry 2024.' World Steel Association, Climate action webpage, accessed 30 October 2026.

For Western Australia, this creates a structural demand opportunity. Customers in Japan, Korea, China, Europe and beyond need green iron to decarbonise their production. They cannot rely on scrap alone. They cannot continue with blast furnaces indefinitely. They need clean primary iron inputs, and they need them at scale.

Box 2: Why Green Iron Matters More Than Green Steel for WA

- Scrap cannot meet global steel demand
- Primary steelmaking must be decarbonised
- Emissions are concentrated in iron-making
- Green iron is tradable, scalable and energy-intensive

Implication: WA's highest-impact role is supplying clean iron to global steelmakers.

1.3 Western Australia's comparative advantages

WA does not need to invent a new industrial model. It needs to apply the strengths that built the iron ore and LNG industries to this next wave of opportunity.

1.3.1 World-Class Renewable Energy

Western Australia's solar and wind resources are among the best in the world. The Pilbara has exceptional solar irradiance. The Mid West benefits from both strong solar and reliable wind. The South West has established wind farms and grid connectivity through the South West Interconnected System (SWIS).

These advantages have the potential to translate directly into lower-cost green hydrogen and electricity: two of the critical inputs for green iron production. TSI's modelling shows that locations in Australia with high-quality renewables and access to wholesale electricity markets could produce green iron at globally competitive costs.[4]

1.3.2 A Major Iron Ore Base Across Multiple Regions

WA supplies 60 per cent of the world's seaborne iron ore. The Pilbara holds vast hematite reserves. The Mid West has substantial magnetite deposits, well-suited to pelletisation and green iron production.

Different ore types suit different production pathways. Magnetite's magnetic properties make it ideal for beneficiation into high-grade pellets. Hematite can be processed into pellets but is better suited to fines-based technologies (for example, fluid bed technologies). All ore types are suitable for emerging electrolysis technologies. This diversity gives WA flexibility to serve different market segments and respond to evolving customer specifications.

1.3.3 Established Export Relationships

WA's iron ore industry has spent decades building deep, trust-based relationships with customers in Japan, Korea, China and beyond. These relationships rest on reliability, quality and long-term partnership.

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[4] The Superpower Institute. 'A Green Iron Plan for Australia.' TSI Report, May 2025.

Japanese and Korean steelmakers are already engaging with Australian suppliers on green iron offtake agreements, joint ventures and technology partnerships. European steelmakers, facing carbon border adjustment pressures, are actively seeking certified low-carbon inputs. For premium steel products such as automotive, specialty and defence-grade steels, early markets are emerging and green premiums can offset higher production costs.

The trading relationships that underpin WA's iron ore exports provide a foundation for green iron market development.

1.3.4 Strong Project Delivery History

Western Australia has taken frontier industries from concept to global scale. The Pilbara iron ore industry was built in the 1960s on Japanese (and then Korean and Chinese) demand and innovative State Agreements. The LNG industry rose in the 1980s and 90s through coordinated infrastructure and long-term offtake contracts.

WA knows how to coordinate government, industry and communities around a shared goal. It knows how to build large-scale infrastructure in remote environments, structure commercial arrangements that attract global capital and manage complex approvals processes.

This is WA's ‘muscle memory’: the institutional capability to turn ambition into delivery. It's in WA’s economic DNA. The clean energy transition is a chance to reclaim and strengthen it, applying the lessons of past successes while addressing their shortcomings.

Box 3: Western Australia’s sources of Green Iron Comparative Advantage

- **Renewable energy:** world-class solar and wind resources underpin low-cost power and hydrogen
- **Ore base:** Pilbara hematite and Mid West magnetite suit multiple green iron pathways
- **Markets:** deep, long-standing trade relationships with Asian steelmakers
- **Delivery capability:** proven ability to build frontier industrial systems at scale

Together, these give WA a credible foundation to move from raw ore export to clean iron production.

1.4 The risks of inaction

Opportunity and risk are two sides of the same coin. If WA moves decisively, it can secure decades of industrial growth and export revenue. But if it hesitates, it will watch competitors capture the green iron market while WA's traditional exports lose value.

1.4.1 Fiscal Sustainability Is at Stake

Iron ore royalties contribute roughly a quarter of WA's state revenue. TSI's analysis, drawing on MRIWA's *Green Steel Opportunity* report[5], includes a decline scenario in which WA's iron ore industry contracts as global steelmakers shift to alternative suppliers or onshore more processing. In that scenario, the state could lose up to $3.2 billion annually in royalties by 2050, one-third of current royalty revenue.

Green iron is not just an export opportunity. It is insurance against the erosion of WA's largest industry and the fiscal foundation it provides.

1.4.2 Other Jurisdictions Are Moving Fast

The Middle East and North Africa are investing heavily in green iron and hydrogen, backed by sovereign wealth and low-cost renewables. Brazil is pursuing green pellet production and partnerships with European steel companies. North America has mobilised investment through the US Inflation Reduction Act[6] and Canadian critical minerals strategies.

These regions are not waiting. They see the same opportunity and they're acting with coordinated policy, public investment and long-term strategic planning.

1.4.3 Carbon Pricing Is Reshaping Markets

The European Union's Carbon Border Adjustment Mechanism has imposed costs on high-carbon steel and iron imports from 2026. Japan and Korea are tightening emissions standards. China is expanding its emissions trading scheme to cover steel, cement and aluminium alongside power generation, albeit that the signal remains modest given intensity-based rather than absolute emissions caps and carbon prices well below European levels now.

WA's iron ore exports will face growing competition and potential penalties as customers seek lower-carbon alternatives. Green iron offers a hedge: it allows WA to maintain market share by adapting to what customers increasingly demand. While customers could in principle produce green iron domestically, WA's combination of world-class renewable energy resources, established ore supply and export infrastructure positions it to do so at lower cost than most steel-producing economies, making imported WA green iron a more competitive option than domestic production for many of WA’s key customers.

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[5] Minerals Research Institute of Western Australia. ‘Western Australia’s Green Steel Opportunity.’ MRIWA Project M10471, 2023.

[6] Noting that the industrial policy landscape in the US is undergoing significant structural adjustment under the new administration.

Box 4: Three Risks of Inaction

1. **Fiscal Sustainability at stake**
    - Iron ore royalties = 25 per cent of state revenue
    - Potential loss of $3.2 billion annually by 2050
2. **Green Iron is insurance against erosion of the state's largest industry. Competitors are moving fast**
    - Middle East, Brazil, North America are not waiting
    - Coordinated policy, public investment, strategic planning
    - They see the same opportunity and are acting
3. **Carbon pricing is reshaping markets**
    - EU CBAM from 2026; Asia tightening standards
    - WA's iron ore exports face growing competition
    - Green iron offers hedge to maintain market share

Opportunity and risk are two sides of the same coin. Acting decisively secures decades of growth; hesitating risks watching competitors capture the market.

Part II

Foundations and evidence

Provides the factual and analytical foundations that ground the Roadmap's conclusions.

In this part

02	Understanding Green Iron and Its Markets	26
03	Western Australia's Regional Characteristics	39
04	What the WA Modelling Tells Us	56

02.

Understanding Green Iron and Its Markets

Chapter 2 overview

> Ore quality constrains technology choice
>
> Technology readiness constrains near-term deployment
>
> Early markets favour quality and certification over volume

Together, these constraints explain why green iron development is phased and why regions contribute at different points while progressing in parallel.

Chapter 1 set out why green iron matters for Western Australia. This chapter explains the technical and market foundations that shape how a WA industry could develop: the ore types available, the production pathways that can convert them to green iron, how green iron is defined and certified, and how the market for it is emerging. These foundations underpin the regional analysis in Chapter 3 and the modelling in Chapter 4.

2.1 Ore types and characteristics

Iron ore refers to a naturally occurring concentration of iron-bearing mineralisation. Commercial iron ore mining primarily targets concentrations of a single iron-rich mineral such as magnetite (Fe_3O_4) or hematite (Fe_2O_3) which contain approximately 72 and 70 per cent iron by mass respectively.

Typically, magnetite mines exploit in-situ ore grades between 20-30 per cent iron (this is equivalent to 27-41 per cent of the rock being made up of tiny magnetite crystals). To concentrate the magnetite into a saleable product, the waste minerals in the ore need to be removed. This is achieved through beneficiation - a process of crushing and grinding the rock to a specific particle size that frees the uniquely magnetic magnetite crystals so they can be recovered through a magnetic separation circuit. The bulk of the material beneficiated becomes waste and must be managed on the mine site as tailings.

The result is a magnetite concentrate product which generally contains between 85 and 96 per cent magnetite depending on deposit-specific technical, metallurgical and commercial factors.

The remainder of the concentrate is made up of gangue material mostly composed of silica and alumina.

Pilbara iron ore deposits are dominated by hematite-enriched banded iron formations. Generally, the iron ore is mined at naturally occurring grades above 55 per cent iron (equivalent to more than 76 per cent of the rock being mineral hematite). Because of the high in-situ grade of the ores, beneficiation can be avoided and the ore is sorted into direct shipping products via crushing and screening. Most Pilbara iron ore is sold as a fine rock powder product grading between 58 and 62 per cent iron.

Table 1: Magnetite and hematite, ore to product

	Magnetite (Fe_3O_4)	**Hematite (Fe_2O_3)**
In-situ grade	20–30% Fe	55–62% Fe
What beneficiation does	Upgrades readily — magnetic separation to a high-grade concentrate	Limited upgrading; largely direct-shipping already
Product grade reached	>66% Fe, DR-grade	BF-grade; DR-grade not reliably reached
Gangue	Removed in beneficiation	Carried through to the furnace
DR-grade suitable?	Yes	No — needs an ESF, or an unproven fines reactor
Where it is in WA	Mid West (~8 Bt); Pilbara (~4 Bt)	Pilbara (~56 Bt)

Source: The Superpower Institute analysis.

Australia has large reserves of both magnetite and hematite ores, though nearly all WA iron ore exports today are hematite.

Making iron from either ore requires first, the removal of oxygen from the iron oxide via a process called "reduction", and second, the separation of the iron from the non-iron "gangue" minerals. Making steel from iron involves refining it to adjust carbon content and adding other elements for specific steel properties.

The next section will explain why ore types and characteristics matter for green iron production.

2.2 Green iron production pathways

Green iron production replaces carbon with clean energy. Multiple technology pathways exist, each with different technology readiness levels, ore requirements and infrastructure needs. Understanding these pathways, and particularly which ores suit which technologies, is critical to understanding the differentiated development pathways between Western Australia's iron ore regions. *GIPA* provides detailed analysis of these production technologies, their technology readiness levels and their suitability for different ore types. This section summarises those findings with particular attention to WA's circumstances.

2.2.1 Pathway 1: Green Hydrogen and Vertical Shaft Furnaces

Most commercial-scale green iron projects globally use (or plan to use) vertical shaft furnace technology adapted for hydrogen. This technology is mature and proven using natural gas as a feedstock, but yet to be deployed at commercial scale for hydrogen, with hydrogen availability at scale being a primary constraint. Companies like Midrex and HYL/Energiron manufacture furnaces that can operate on pure hydrogen, natural gas or blends of both.

How It Works: Iron ore pellets (high-grade, low-gangue) are fed into the top of a vertical shaft furnace. Green hydrogen rises from the base of the furnace as a reducing gas. Hydrogen reacts with iron oxide, removing oxygen and producing iron metal and water vapour (not CO_2). Solid DRI emerges from the bottom of the furnace. If transport is required, DRI can be compressed into HBI.

The green hydrogen itself is produced through electrolysis, using renewable electricity to split water into hydrogen and oxygen.

Operating Examples: Hydrogen-based DRI is considered technically proven but is not yet operating at commercial scale. Several industrial scale demonstration plants are in service, notably in Sweden (HYBRIT) and Germany (SALCOS), with commercial plant installations well advanced in Sweden (Stegra) and Germany (SALCOS). Several Middle Eastern projects are pursuing similar approaches.

Ore Requirements: Vertical shaft technology needs lump ore or high-quality pellets. Iron ore must be in coarse physical form because fine particles would block gas flow through the furnace. This typically means pellets with 65-70 per cent iron content and less than 3.5 per cent gangue.

Both high-grade magnetite and high-grade hematite can meet this standard. However, beneficiating different ore types to this standard varies significantly in difficulty and cost, a challenge examined in section 4.4 of *Digging Deeper*.

Energy and Infrastructure Needs

Producing green iron via this pathway requires substantial infrastructure:

- Renewable electricity for hydrogen production via electrolysis and ore processing
- Large-scale electrolysers and hydrogen storage
- Water (typically requiring desalination in WA)
- Ore processing infrastructure (particularly for magnetite beneficiation and pelletisation)
- Port and logistics for HBI export

A Grid connection, where available, lowers costs mainly by firming supply. TSI's modelling shows a benefit of more than $80 per tonne for inflexible technology Appendix D and *Digging Deeper* provides details.

2.2.2 Pathway 2: Emerging Technologies for Iron Ore Fines

While vertical shaft hydrogen-DRI is the most mature pathway, several other technologies are in development that may be better suited to iron ore fines without requiring high-quality pellets.

These technologies could potentially unlock ore bodies that are difficult or expensive to pelletise to DR-grade specifications.

Fluidised Bed Reactors: These directly reduce iron ore fines by suspending them in rising reductant gas, eliminating the need for lumpy ore or pellets. Technologies include Circored, HyREX, HYFOR and Finored. Some have operated commercially with fossil fuels; adaptation to green hydrogen is under development.

HyREX, developed by POSCO, is particularly relevant to WA. It integrates fluidised bed technology with smelting and is being demonstrated at industrial scale in Korea. POSCO has proposed using this technology in WA's Pilbara region.

Flash Smelting: This rapidly reacts fine iron ore with hydrogen in heated vessels. The technology is less mature but may offer advantages for certain ore types. CALIX's hydrogen-based ZESTY flash smelting technology has been trialled at pilot scale in Victoria, and an industrial scale demonstration plant is under study for Kwinana, supported by ARENA funding.

Iron Electrolysis: This uses electric current to separate iron from oxygen in dissolved ore, bypassing chemical reductants entirely. Technologies are being developed by Element Zero, Fortescue, Electra, Boston Metal and others. Boston Metal is building a pilot plant in Brazil. However, electrolysis remains at laboratory or early pilot scale.

Smelting Reduction: These integrate direct reduction with smelting, producing molten iron. The HIsmelt technology has been commercially proven with coal and the HIsarna process at pilot stage; green versions using biochar or hydrogen are in development.

Technology Maturity Timeline: These emerging technologies generally sit at pilot or demonstration scale. They require several more years of development, demonstration and de-risking before they can attract commercial-scale investment. This technology maturation timeline is a critical constraint on deployment, particularly for ore bodies that do not suit vertical shaft technology.

2.2.3 Pathway 3: Gas-Based Direct Reduction

Natural gas can be used as the reductant in direct reduction processes, producing DRI with lower emissions than blast furnaces but higher emissions than green hydrogen pathways.

How It Works: The process is similar to hydrogen-based direct reduction but uses natural gas (primarily methane) for combustion heat and as the reducing agent instead of hydrogen. Iron ore pellets descend through a vertical shaft furnace while CO and H2 gases rise from below. The gases react with iron oxide, removing oxygen and producing iron metal, with CO_2 and water vapour as waste products.

Natural gas-DRI produces approximately 1.47 tonnes of CO_2 per tonne of steel (when used with EAF steelmaking), compared to 2.34 tonnes for blast furnace steelmaking and near-zero for green hydrogen-DRI.[7]

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[7] Total CO_2 emissions per tonne of crude steel in 2024. Source: World Steel Association. ‘Emissions from the steel industry 2024.’ World Steel Association, Climate action webpage, accessed 30 October 2026.

Operating Examples: This technology is commercially mature and widely deployed. Gas-based DRI accounts for most of the world's current direct reduction capacity, operating in regions with low-cost natural gas access, particularly the Middle East and North America.

Flexible Technology: Modern direct reduction furnaces from manufacturers like Midrex and HYL/Energiron can operate on natural gas, hydrogen or blends of both. This flexibility allows facilities to potentially transition from gas to hydrogen over time as hydrogen supply becomes available.

"Blue Hydrogen" Variants: Some proposals involve using natural gas with carbon capture and storage (CCS) to produce "blue hydrogen". This adds cost and complexity, and carbon capture rates typically achieve 85-90 per cent capture rather than complete elimination of emissions. The effectiveness and long-term viability of CCS at the scale required for large-scale hydrogen production remains subject to ongoing debate.

Resource and Market Context

For Western Australia specifically, gas-based pathways face several considerations:

- WA's domestic gas supply is constrained and subject to reservation policy
- International competitors (particularly in the Middle East) have lower gas costs
- WA's comparative advantage lies in renewable energy resources rather than gas
- Emerging international market requirements increasingly favour near-zero emissions pathways

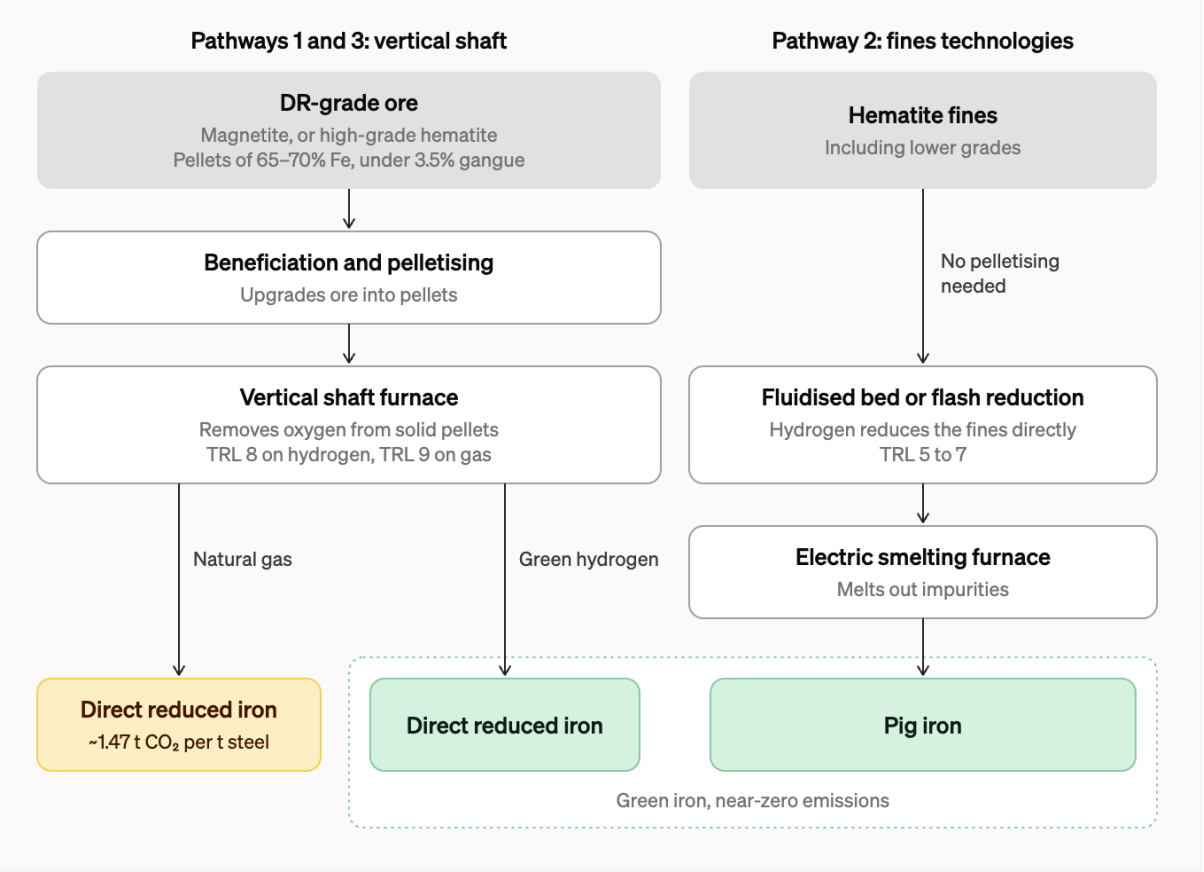


Figure 3: Proven furnaces need high-grade pellets; lower-grade fines rely on emerging technology

Notes: TRL is technology readiness level; 9 is commercially proven. Iron electrolysis (TRL 4 to 6) is not shown. All three irons are made into steel in an electric arc furnace.
Source: The Superpower Institute analysis.

The strategic considerations around gas and green hydrogen production pathways for WA are examined in section 5.5. Chapter 4 summarises the modelled costs and emissions of using gas as a reductant.

2.2.4 Comparing the Pathways

Each pathway has distinct characteristics that affect deployment timing, regional suitability and long-term competitiveness:

Table 2: Green iron production pathways compared

	Pathway 1: Hydrogen vertical shaft	Pathway 3: Gas vertical shaft	Pathway 2: Fines technologies
Readiness	TRL 8: proven, not yet at commercial scale	TRL 9: commercially mature, most of today's DRI capacity	TRL 5 to 7: pilot to demonstration
Ore	Pellets or lump, 65–70% Fe, under 3.5% gangue; magnetite or high-grade hematite	As for Pathway 1	Fines, including lower grades; no pelletising
Emissions	Near zero, with renewable electricity	~1.47 t CO_2 per t steel, about 40% below blast furnace	Near zero, with green hydrogen or electricity
Infrastructure	Very high: renewables, electrolysers, water, hydrogen storage, pelletising	Moderate: gas supply	Very high: renewables, electrolysers, water, hydrogen storage
Examples	HYBRIT, SALCOS demonstrations; Stegra, SALCOS commercial plants under way	Middle East and North America	POSCO HyREX (Korea, proposed for the Pilbara); Calix ZESTY (Victorian pilot, Kwinana study)

Source: The Superpower Institute analysis, drawing on *A Green Iron Plan for Australia*.

Regional Implications for WA

These pathway differences have profound implications for which WA regions can deploy which technologies and when:

- Regions with ores (or limited volumes of lump) suitable for beneficiation to DR-grade can pursue proven vertical shaft technology now
- Regions with ores that are difficult or expensive to beneficiate must either wait for emerging technology maturation or pursue ore upgrading solutions such as ESF
- The choice between green hydrogen and gas-based pathways involves strategic trade-offs beyond pure technology considerations

Chapter 5 examines these strategic considerations in detail. Chapter 6 shows how they translate into a phased industry development trajectory for Western Australia, applied across all three regions.

Box 5: Magnetite vs Hematite: Why Ore Shapes Timing

Magnetite:

- Requires beneficiation and pelletisation
- Can achieve DR-grade feedstock today
- Well suited to proven hydrogen-DRI pathways
- Supports earlier deployment where infrastructure aligns

Hematite

- Difficult to upgrade to DR-grade pellets
- Dominant Pilbara ore type
- Relies on emerging smelting technology to remove excess gangue
- Relies on emerging fines-based H2 reduction technologies
- Likely to be deployed at scale later as technologies mature

Implication: ore characteristics determine which technologies are viable today and the pace at which each region can move.

Box 6: What the Technology Analysis Shows

- Proven pathways depend on high-grade feedstock
- Emerging technologies expand options but increase risk
- Energy system design is a major cost driver
- Technology maturity affects timing, not just location

Implication: early projects must align ore quality, technology readiness and energy systems.

2.3 Definitions, standards and certification

There is not currently a globally agreed definition or certification standard for 'green iron'. Different companies, jurisdictions and certification schemes apply varying emissions boundaries, assumptions about hydrogen production, treatment of natural gas and lifecycle accounting of upstream emissions. In the Western Australian context, where the industry is emerging and will require a government role, it is important to be clear on a definition. TSI's position is that the preferred definition, and therefore the boundaries around the role for government, should be guided by the economics of Australia's long-term comparative advantage.

2.3.1 Eighteen Standards and Counting

A global consensus on what constitutes "green" steel remains elusive. There are currently 18 different steel industry standards, protocols and initiatives, each with varying definitions of 'greenness' depending on their focus (supply, demand or finance) within the steel value chain.

Some prominent definitions include:

The **World Economic Forum's First Movers Coalition** defines green steel as 'near-zero emissions steel', tied to the International Energy Agency's (IEA) definition of 0.05 to 0.4 tCO_2e per tonne of steel, depending on the production route and ratio of scrap to virgin iron. ResponsibleSteel similarly aligns with IEA targets.

The **Global Steel Climate Council's Steel Climate Standard** applies IEA's declining carbon intensity projections to specific steel products rather than production routes. Their 'lower-carbon steel' benchmarks for 2030 are 1.31 tCO_2e per tonne for flat steel and 1.11 tCO_2e for long steel products. By 2050, both converge at 0.12 tCO_2e per tonne.

The **Green Hydrogen Organisation** (GH2) launched the Green Iron Principles at COP30 in Belém, establishing that green iron is iron produced with renewable energy and green hydrogen, and explicitly excluding the use of fossil fuels in every part of the production process.

The **RMI Sustainable Steel Buyers Platform's** request for proposal specifies a near-zero emissions threshold in line with IEA, First Movers Coalition and ResponsibleSteel definitions: less than 0.4 tCO_2e per tonne of crude steel or less than 0.35 tCO_2e per tonne of iron.

Regional variations reflect different decarbonisation pathways and policy contexts. Europe's definitions emphasise alignment with CBAM thresholds. Asian markets focus on practical transitions from existing BF-BOF capacity. Middle East producers emphasise hydrogen purity and renewable energy sourcing.

2.3.2 Why Definitions Matter for WA

These definitional debates have material implications for Western Australia:

Role for Government: There is an appropriate role for government in addressing significant market failures. It is also important for the government's scarce resources to be directed to their highest-value use, that is, where support can be deployed towards Australia realising its potential in areas of long-term comparative advantage. It is therefore important that the boundaries of a role for government are defined with reference to Western Australia's circumstances.

Market Access and Pricing: Different customers and markets may require different emissions certifications and create different incentives for low-emissions iron. European steelmakers under CBAM face different commercial considerations from Japanese steelmakers pursuing voluntary decarbonisation. Lower lifecycle emissions may support access to a wider range of markets, reduce exposure to carbon-related costs and attract a green premium. However, these potential commercial advantages must be weighed against the costs of production and do not necessarily translate into superior overall project economics.

Policy Eligibility: Australia's Hydrogen Production Tax Incentive (HPTI) requires hydrogen production below 0.6 kg CO_2e per kg of hydrogen. Projects targeting HPTI eligibility must meet this threshold, influencing technology choices and energy supply. TSI's modelling shows that the HPTI has a material influence on the cost of green iron production in Australia.

Competitive Positioning: Competitors in other regions may claim 'green iron' status under more lenient definitions. WA proponents must navigate this landscape carefully: too strict a standard may price them out of markets; too lenient may undermine green credentials.

Investment Confidence: Certifications, guarantees of origin and carbon accounting frameworks affect project bankability. Investors need confidence that products will meet customer specifications and maintain market access as standards evolve.

Beyond Carbon: Buyers and investors are increasingly assessing environmental performance beyond emissions, including impacts on biodiversity, land use and ecosystem integrity. Market access may come to depend on these broader standards as well as on emissions intensity.

Box 7: Why Standards Matter for WA

- Market access: different buyers recognise different definitions of “green”
- Policy eligibility: standards determine access to production incentives
- Competitiveness: stricter definitions can unlock green premiums
- Bankability: clear certification underpins investor confidence

Bottom line: standards are not technical detail: they shape who can sell, where and at what price.

2.3.3 TSI's Working Definition

For the purposes of this *Roadmap* and TSI's modelling analysis, we adopt the definition of green iron as **'near-zero' emissions iron produced via an electricity or green hydrogen-DRI process that is suitable for EAF steelmaking**.

This definition:

- Aligns with IEA near-zero benchmarks
- Ensures eligibility for the HPTI (0.6 kg CO_2e/kg hydrogen threshold)
- Positions WA products for green premium markets with stringent requirements
- Provides a clear north star aligned with long-term comparative advantage and competitiveness

Using green hydrogen rather than fossil gas ensures both low lifecycle emissions and policy eligibility. The 'greener' the iron, approaching true zero emissions, the greater the carbon benefit to steelmakers and the higher the green premium they can justify paying.

The base cases run in TSI's modelling (discussed in Chapter 4 and detailed in *Digging Deeper*) assume that a project proponent will wish to access the benefits of the HPTI. Therefore, the model limits the use of firming electricity from the grid to ensure the annual average emissions intensity remains below 0.6 $kgCO_2e/kg$ of hydrogen. This is a conservative treatment: the *Digging Deeper* model counts the physical emissions of grid electricity, which limits imports to a small share of demand. In practice, proponents may be able to source grid electricity under renewable power purchase agreements or matched by renewable energy certificates. This could allow greater use of the grid for firming and lower costs. How the HPTI and international standards treat such arrangements in the WEM requires further consideration (see section 2.3.5).

2.3.4 An Emerging Consensus

Despite the complexity of competing standards, an emerging consensus is taking shape across the international literature, including in *GIPA*. At its core, this consensus recognises that truly near zero iron must be hydrogen-based or produced via electrolysis using renewable electricity, and capable of reaching near-zero emissions at scale.

Other pathways may play important roles during transition, but they do not meet the long-run definition of green iron that early-mover markets (particularly in Europe, Japan and Korea) are beginning to require.

2.3.5 The Certification Challenge

Beyond definitions, the global trading system for green iron is likely to require:

- Guarantees of origin for renewable energy and hydrogen
- Lifecycle carbon accounting covering ore extraction, processing, transport and iron production
- Third-party verification to prevent greenwashing
- Trade facilitation so certification costs do not become prohibitive barriers

How grid electricity is counted is likely to be one of the most consequential of these questions for WA. Australian rules may allow grid electricity matched by renewable certificates or power purchase agreements to be counted as renewable, while the European Union will require hourly matching from 2030. The approach adopted will affect how far a project can rely on the grid for firming, and therefore its cost. Given its ultimate responsibility for energy market structures, the state has a direct interest in how these rules develop.

The Commonwealth is responsible for leading Australia’s international standards alignment and certification frameworks. TSI recommends that the WA government engages early with customers on their specific requirements and partners with the Commonwealth to inform robust carbon accounting systems that will be essential for WA green iron market access.

2.4 The emerging market for green iron

Demand for green iron is emerging from structural changes in global steel markets as major economies commit to deep emissions reduction. Steelmakers in Japan, Korea and Europe are under increasing pressure from customer expectations, regulatory requirements and investor scrutiny to reduce the embodied emissions of steel products. These pressures are translating into early demand for low-emissions iron inputs, particularly where decarbonisation of downstream processes alone is insufficient.

Early green iron markets are expected to be concentrated in high-value segments. Automotive, specialty, defence and advanced manufacturing supply chains are moving first, driven by corporate net-zero commitments, supply-chain emissions reporting and compliance requirements such as international carbon border adjustment mechanisms. In these segments, buyers are more able to pay a green premium for certified low-emissions inputs, supporting early commercial deployment.

European demand for green iron is driven by compliance with the EU emissions trading scheme. To retain sovereign steelmaking capability within the EU, steelmakers will require green iron inputs from lower-cost jurisdictions, such as Western Australia.

Japanese and Korean manufacturing industries must comply with the EU carbon border adjustment mechanism to maintain access to EU markets for their finished steel products such as cars, pipes and machinery. Steelmakers in Japan and Korea are therefore under pressure from these domestic manufacturers for low carbon steel and are actively exploring low-emissions production pathways including the import of green iron

Over time, demand is expected to extend beyond high-value and compliance markets as decarbonisation requirements deepen and production of low-emissions steel expands. Growth in southeast Asian markets for green iron is expected as a pathway to decarbonise young blast furnace assets and as electric arc furnace capacity increases. As markets mature, competitiveness will increasingly be shaped by cost, scale, product quality and supply reliability, alongside emissions performance.

China remains a longer-term, volume market. Challenges around timing related to the age of some Chinese blast furnace assets, the move to secondary steel production and the 2060 target for net-zero mean no significant near-term investment in decarbonisation of existing assets. Furthermore, China has the world’s lowest cost of production which creates the largest premium gap for green iron.

Green iron markets are developing in two distinct ways. For early movers and new entrants, green iron is an emerging market that must be built, initially in compliance-driven and premium segments in Europe, Japan and Korea. At volume, however, it is a transitioning market: large-scale demand depends on the transition of the Chinese steel industry, the world's largest, as iron-making is separated from steelmaking and imports of iron ore and coal give way to imports of iron. That transition is likely to involve Chinese capital, with steelmakers seeking equity positions in iron-making to manage supply risk and control the cost of iron. China's slower pace explains why volume demand is a longer-term prospect, but it is the market on which very large-scale green iron exports ultimately depend.

Western Australia's existing iron ore export relationships, scale and reputation as a reliable supplier position it to participate in the early development of green iron markets and to compete as the volume markets transition. A detailed analysis of global market trends is provided in Appendix A.

Box 8: An Emerging Market for Green Iron

- Early demand will come from high-value markets under decarbonisation pressure
- Europe, Japan and Korea are likely first movers
- Initial volumes will be modest but strategically important
- Over time, demand depends on the transition of China's steel industry, likely involving customer equity in iron-making.

WA's advantage: long-standing trade relationships position it well to serve early markets and scale with them.

03.

Western Australia's Regional Characteristics

Chapter 3 overview

> The Mid West combines magnetite that can be upgraded to direct reduction grade, proven technology and SWIS access, making it the lowest-risk entry point for first-of-a-kind projects, although major investment is needed to scale beyond one or two
>
> The Pilbara holds the state's largest iron ore resources and established export infrastructure, but faces a trilemma of challenging ore, high infrastructure costs and off-grid energy
>
> Pilbara volume production depends on technologies that can process hematite fines, which are still at pilot or demonstration scale
>
> Pilbara producers and their customers are pursuing different strategies, and early Pilbara investment may depend more on miners moving downstream and steelmakers investing upstream than on the largest incumbents
>
> The South West underpins capability, technology demonstration and the domestic market rather than export-scale production

Together, these differences explain each region's comparative advantages and anticipated challenges as a green iron industry develops in Western Australia.

Chapter 2 showed that ore quality and technology readiness limit which green iron pathways are viable. This chapter applies those constraints to Western Australia's regions. It compares the Mid West and Pilbara iron ore regions across ore characteristics, infrastructure and energy, and industrial base and describes the complementary role of the South West. These differences explain why each region's contribution is likely to vary in timing and scale, even as all three progress in parallel.

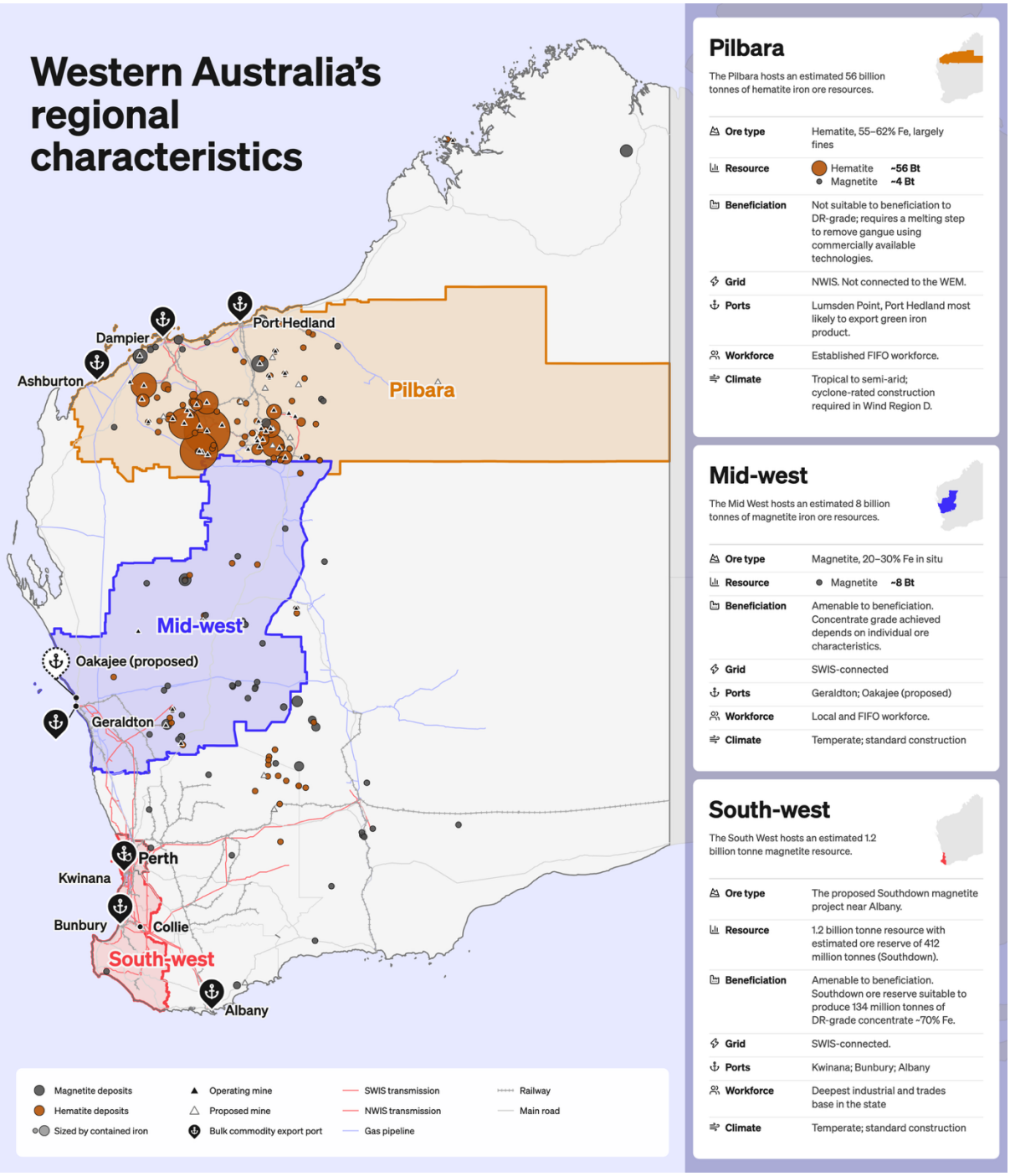


Figure 4: Western Australia's regional characteristics

Notes: Deposits sized by contained iron.

Sources: Data WA (DPIRD-020) (WP-032); Geoscience Australia, OZMIN; Global Energy Monitor, Global Iron Ore Mines Tracker; Geoscience Australia, transmission lines and gas pipelines.

3.1 The Mid West

The Mid West region hosts over 8 billion tonnes of identified magnetite resources.[8] Typically magnetite deposits in the region report BF-grade resources, however many could be amenable to further beneficiation to DR-grade under suitable market conditions. A pipeline of magnetite projects is progressing through approvals towards final investment decisions. The region hosts one operating mine that currently produces 8 million tonnes per annum BF-grade concentrate for export through the Geraldton Port.

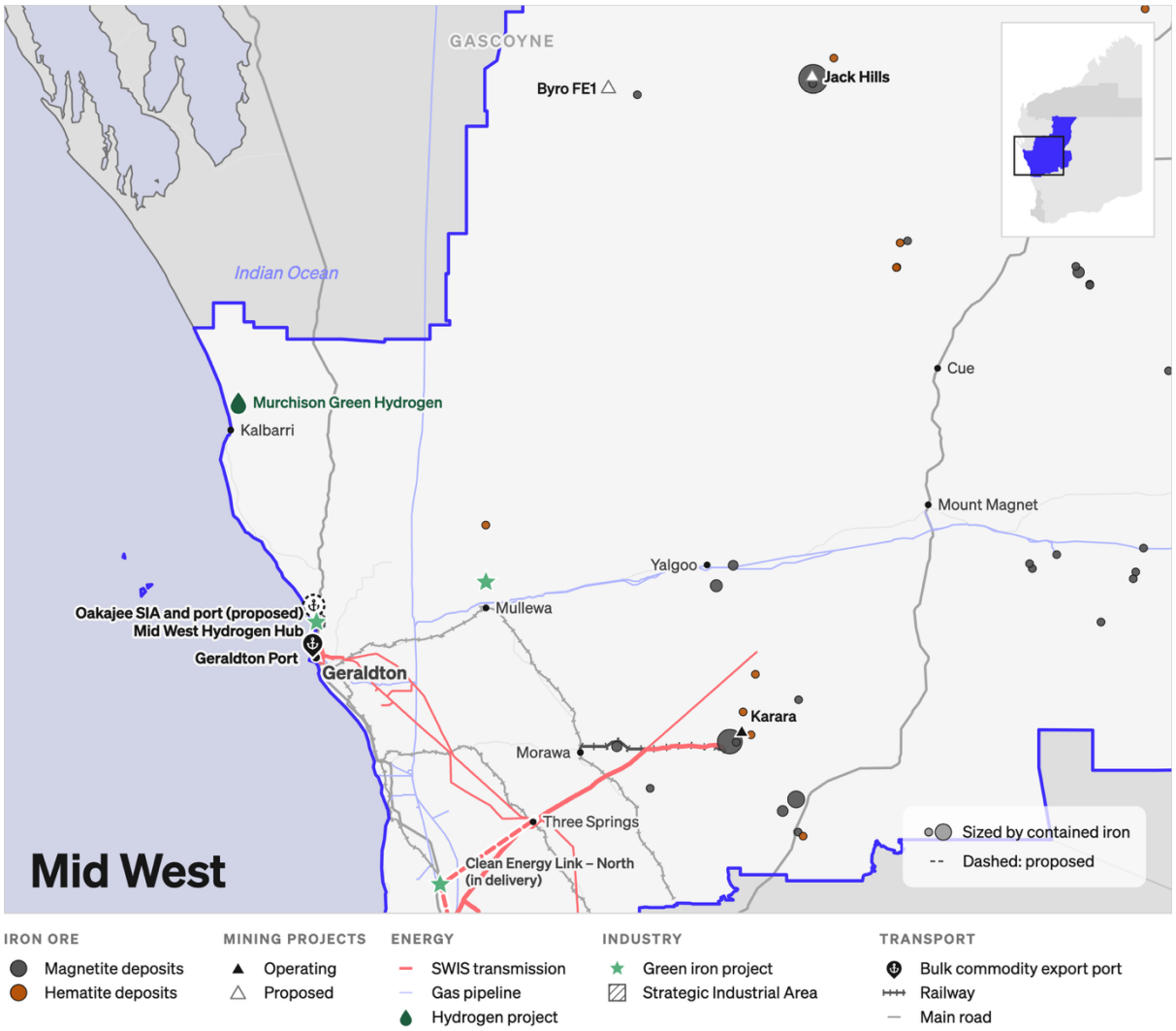


Figure 5: Proposed green iron projects, iron ore resources and related infrastructure in the Mid West

Notes: Deposits sized by contained iron. Dashed lines show proposed infrastructure. Green iron projects shown without names.

[8] The estimate is based on publicly reported mineral resource estimates for advanced projects. Sources: Department of Mines, Petroleum and Exploration (DMPE). Mines and Mineral Deposits (MINEDEX). Geological Survey of Western Australia, extract October 2026; company reports.

Sources: Data WA (DPIRD-020) (WP-032); Mines and Mineral Deposits (MINEDEX). Contains information © Government of Western Australia (Department of Mines, Petroleum and Exploration), used under CC BY 4.0.

3.1.1 Ore Characteristics

- Magnetite's magnetic properties enable efficient separation of iron from gangue, making it amenable to beneficiation
- Depending on individual resource deposit characteristics, magnetite ores can be beneficiated to produce concentrates suitable for a DRI-EAF pathway based on the current standard of >66 per cent Fe and <3.5 per cent combined SiO_2 and Al_2O_3
- The grinding and magnetic separation processes are mature but further research and development would improve the economics of achieving DR-grade concentrate for the green iron market
- Multiple deposits have economically demonstrated resources and are at advanced feasibility stage

3.1.2 Infrastructure and Energy

The Mid West benefits from critical infrastructure access that could materially reduce costs for early projects

Grid Connection

The Mid West has access to the SWIS, providing the potential for:

- Connection to the Wholesale Electricity Market (WEM), providing firming supply
- Shared transmission infrastructure rather than fully dedicated off-grid build
- Firming capacity from the grid, reducing backup generation requirements
- Lower overall capital requirements for energy systems

TSI's modelling shows that SWIS access can provide a material cost advantage compared to off-grid configurations, reducing the cost of iron by more than $80 per tonne for inflexible technology (see Chapter 4 for further modelling results). These advantages depend, however, on the availability of grid capacity. Connection costs, transmission augmentation and the supply of renewable energy at the volumes green iron requires remain material constraints (see Chapter 8).

Infrastructure

The Mid West has an existing infrastructure base that could support 1-2 "first of a kind" (FOAK) projects, before it requires substantial infrastructure investment (subject to project specific requirements);

- Geraldton port has a limited volume of capacity to support early movers, but will require significant upgrades for additional green iron volumes and product handling
- Road and rail networks exist with limited capacity to transport some ore concentrate and green HBI, but will need enhancement for scale-up

- Water infrastructure must be developed at scale (large desalination and pipelines required)
- Proximity to regional centres (Geraldton) provides some workforce and services base
- Less extreme climate conditions than the Pilbara, meaning assets do not need to be designed to cyclonic standards, reducing engineering, materials and construction costs. The cost to develop any type of major infrastructure asset in the Mid West is significantly lower than for the Pilbara.

There is an important caveat: To scale a green iron industry beyond 1 or 2 FOAK projects, major investment is still required. Geraldton port capacity is constrained. Shared water and hydrogen infrastructure must be built. Transmission upgrades will be necessary. The Mid West is not "shovel ready" - it requires government coordinated infrastructure and industrial land development to enable a green iron industry to develop.

3.1.3 Industrial Base

The Mid West magnetite resource is controlled by a heterogenous mix of tier 1 majors, mid-tier producers, Asian steelmaker consortia and ASX-listed juniors. This means the commercial drivers and capabilities of industry participants in the region vary widely. However, some general assumptions can be made about the development of Mid West magnetite and green iron projects:

- **Beneficiation economics:** Upgrading magnetite to DR-grade adds processing cost and can increase the emissions footprint of the mine. Whether it is commercially viable depends on the premium green iron producers are prepared to pay. Where that premium is insufficient, the cost may shift to green iron developers through integrated ownership or long-term supply arrangements. TSI's modelling suggests that beneficiating Mid West magnetite to DR-grade is likely to cost less than using an ESF, assuming the ore premium covers beneficiation (Chapter 4).
- **New relationships:** Green iron suppliers may require direct engagement with steel producers or end-users (automotive, construction, manufacturing) for small, certified volumes. New small cap entrants are more motivated to exploit these first niche opportunities compared to mid and Tier 1 magnetite producers who have existing relationships based on volume business models.
- **Integrated value chains and risk:** New entrants are more likely to form partnerships along the value chain as equity participation between magnetite and green iron producers. This shares the project-on-project risk.
- **Capital allocation:** For new entrants, green iron is the business. Mid and Tier 1 iron ore producers are more likely to allocate capital for fit-for-purpose transport and port export capacity.

3.1.4 Green iron as a driver of Mid West magnetite development

The scale of FOAK green iron projects will determine which magnetite projects are targeted for supply. Small, high-grade resources are unable to meet long-term volume markets, but they are ideally placed to meet the demand of lighthouse 2-2.5 million tonnes per annum green iron facilities. Small resources owned by junior companies are most likely to meet this FOAK

demand. Publicly announced partnerships between magnetite and green iron project developers are detailed in Appendix C.

TSI's modelling indicates that the Mid West has material cost advantages for early projects. Combined with ore suited to proven technology and existing infrastructure, this makes it the lowest-risk entry point for FOAK green iron production in Western Australia. Major critical factors already exist - brownfields transport and export infrastructure, grid access, local magnetite supply chains, proximal workforce and excellent renewable energy. To scale an industry in the region beyond a few mid-scale facilities, the infrastructure requirements are substantial but can leverage the existing infrastructure base and planning in place for the Oakajee Strategic Industrial Area and associated export facilities. Building the enabling infrastructure in the Mid West is likely to be materially lower-cost than building the equivalent capacity in the Pilbara.

3.1.5 Why This Matters

Mid West magnetite, if used with proven vertical shaft technology, combined with grid access and comparatively lower infrastructure costs than the Pilbara can materially de-risk a FOAK project. Projects could potentially reach final investment decision before 2030. However, proven technology addresses only one category of risk. Early projects will still depend on access to affordable hydrogen and electricity and may require concessional finance or other forms of support. This positions the Mid West as WA's early-mover region for new entrants.

Box 9: Why the Mid West has Near-term Advantages

- Ore–technology alignment: magnetite resources suitable for proven DRI pathways de-risks investment and project finance.
- Energy access: connection to the SWIS provides firming supply and significantly lowers capital intensity
- Infrastructure base: existing port, transport and logistics services align with early project scale
- Cost profile: lower capital cost multipliers than Pilbara
- Local workforce: green iron production could avoid the high operation costs of a FIFO workforce

Result: a lower-risk entry point for new entrants developing small to mid-scale lighthouse projects while technologies, markets and delivery capability mature.

3.2 The Pilbara

The Pilbara region is estimated to host 56 billion tonnes of hematite resource.[9] For the past decade the average total sales volume from the region has exceeded 800 million tonnes per annum. The major producers export two hematite products; fines and lump. Pilbara fines typically grade 58-62 per cent iron and require sintering before they are fed to a blast furnace. Lump products grade 62.5 per cent iron and can be directly fed into a blast furnace. Because Pilbara hematite cannot be easily beneficiated to DR-grade, it faces a more complex pathway to green iron production.

[9] This is the inferred total economic and uneconomic resource base. Geoscience Australia. 'Australia's Identified Mineral Resources 2024'. Geoscience Australia, 2025.

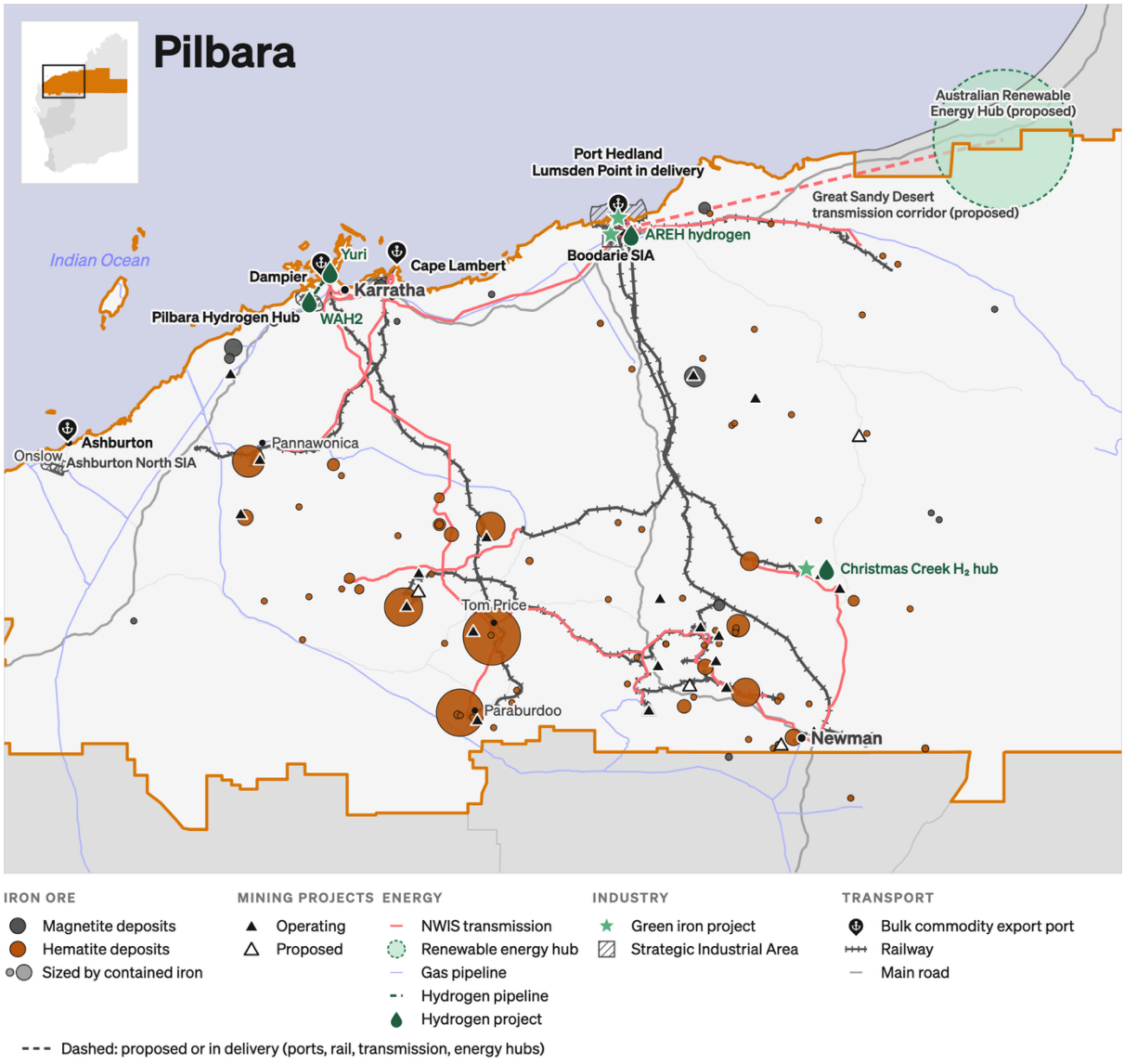


Figure 6: Proposed green iron projects, iron ore resources and related infrastructure in the Pilbara

Notes: Deposits sized by contained iron. Dashed lines show proposed infrastructure; the renewable energy hub and transmission corridor are indicative. Green iron projects shown without names.

Sources: Data WA (DPIRD-020) (WP-032); Mines and Mineral Deposits (MINEDEX). Contains information © Government of Western Australia (Department of Mines, Petroleum and Exploration), used under CC BY 4.0.

3.2.1 Ore Characteristics

- Hematite lacks magnetite's magnetic properties, making beneficiation very challenging
- Emerging electric smelting technology offers an alternative way to upgrade hematite to an EAF compatible iron product but is energy intensive and adds capital costs
- The grade of the Pilbara hematite resource base is declining in comparison to resources coming online in Africa and Brazil
- Pilbara hematite ores are difficult to pelletise for feeding into direct reduction shaft technologies

3.2.2 Infrastructure and Energy

The Pilbara is not connected to the WEM but hosts the independent and largely privately-owned North West Interconnected System (NWIS). Other privately owned stand-alone electricity networks also exist. The NWIS primarily services heavy industry, major mining operations and local coastal towns through self-supply or bilateral Power Purchase Agreements, rather than through a centralised energy trading environment. With such a shallow energy market, green iron projects will likely need to build entirely self-contained renewable energy-based systems: solar, wind, batteries, electrolysers, hydrogen storage and backup generation. Any new large-scale commercial supply of renewable electricity or hydrogen for green iron projects in the NWIS is also constrained while uncertainty remains about major planned transmission infrastructure development timelines.

These market and asset configuration challenges carry a substantial capital penalty compared to SWIS-connected projects. SWIS-connected projects can firm their renewable energy generation through the Wholesale Electricity Market and avoid oversized generation and storage capital.

TSI's modelling shows that a grid connection materially reduces the cost of green iron production which is dominated by the cost of energy capital. The benefit comes mainly from firming, rather than selling surplus electricity. Grid connection provides:

- Lower capital requirements (shared rather than dedicated infrastructure)
- Firming capacity without full backup duplication
- Operational flexibility

This positions Pilbara-based projects at a significant disadvantage relative to Mid West projects with access to the SWIS, as they must oversize renewable energy generation and storage assets to build behind-the-meter firming capacity. Chapter 4 summarises the modelling results that demonstrate this and Appendix D provides further details.

Infrastructure Capital Intensity: Developing large-scale industrial infrastructure in the Pilbara is exceptionally expensive:

- Remoteness and competition with the established iron ore and energy industries increases construction and logistics costs
- Some locations have cyclone engineering standards which add to capital requirements
- Water infrastructure requires long-distance pipelines from coastal desalination
- Workforce accommodation and services for construction and operations
- Port facilities may need modification or expansion

The combination of off-grid energy systems and remote infrastructure development creates a very high capital threshold for Pilbara green iron projects. Based on consultation with energy system developers operating across WA, TSI's modelling applied locational cost factors of 1.55 and 1.15 for the Pilbara and Mid West respectively. These factors reflect costs generally available to a new entrant. Some established operators report they can build renewable energy

assets at materially lower cost. If those costs prove achievable more widely, that will strengthen the case for accelerating enabling work in the region (see Chapter 4).

3.2.3 The Pilbara Trilemma

Green iron production in the Pilbara faces a trilemma of technical and economic conditions which substantially increase the cost of production relative to the Mid West: challenging ore characteristics, high infrastructure costs and energy system constraints. Even as technology challenges are resolved, Pilbara projects are likely to face higher costs than Mid West projects in the near to medium term, until scale and lower-cost energy offset infrastructure and energy system penalties. This shapes the scale of any early activity and influences when the Pilbara will reach full volume and scale. The Mid West offers the lower-cost, lowest-risk entry point for small to mid-scale early activity. Long-term investment in the Pilbara will likely rely on economies of scale and established relationships with iron ore majors. Modelling undertaken for TSI's *The New Energy Trade* [10]indicates that the Pilbara's long run energy costs should be among the lowest in the world and given the volumes of low-cost ore available in the Pilbara, the region is a critical component of any future Australian green iron value chain and central to scaling the industry to 2050.

3.2.4 Industrial Base

The Pilbara's industrial base is dominated by the four iron ore majors - Rio Tinto, BHP, Fortescue and Hancock Prospecting. By volume they are the lowest-cost iron ore producers globally, allowing them to dominate seaborne trade. To achieve this, business models are typically based on owning and operating the entire ore production value chain, from high-volume extraction of direct shipping ore, requiring minimal processing, to highly-efficient rail to port logistics. The ore is sold through intermediaries to steelmakers, for value-add processing.

Current Export Model: The Pilbara's existing business model is built on high-volume, low-cost export of mid-grade hematite, shipped to blast furnaces specifically optimised to process their ore. The producers typically do not produce iron or steel in their own right. Moving to value-add processing represents a fundamental business model shift along the value chain, which would likely dilute returns and potentially place iron ore producers in competition with their current steelmaking customers.

The Pilbara incumbents therefore currently have fundamentally different business models to new green iron entrants. The Pilbara's major iron ore producers operate highly profitable businesses optimised for volume extraction and logistics efficiency, not value-added processing. Green iron represents a fundamentally different business and the two should not be conflated.

- **Risk-adjusted returns:** Green iron adds energy, reduction and beneficiation costs, and its margins will depend on energy costs, technology, carbon pricing and green premiums. For incumbents, the more relevant test is whether green iron offers a better risk-adjusted return than their existing ore business.

[10] The long-run lower cost of renewable energy in the Pilbara is based on the logic presented in The Superpower Institute. 'The New Energy Trade.' TSI Report, November 2024.

- **Different customer relationships:** Incumbents sell ore to mills; green iron requires more direct engagement and commercial interface with steel producers, technology providers and/or end-users (automotive, construction, manufacturing).
- **Integrated value chains:** New entrants are more likely to form partnerships along the value chain, similar to Japanese and Korean utilities' equity participation in North West Shelf LNG.
- **Technology risk:** Incumbents are investing in unproven processes through pilots and partnerships but are cautious about committing capital at commercial scale; new entrants may accept higher technology risk to secure market position.
- **Capital allocation:** For incumbents, green iron competes with brownfield ore expansions yielding higher returns; for new entrants, green iron IS the business.

The North West Shelf analogy: Just as Japanese and Korean buyers took equity stakes in NWS LNG to secure supply and share risk, green iron projects are prime candidates to attract participants from along the value chain (technology providers, steel producers, trading houses, goods manufacturers) willing to accept different risk-return profiles, than incumbent ore exporters.

These business model characteristics do not mean that Pilbara incumbents are standing still. Pilbara producers and their customers are responding to the transition in distinct ways. Three strategic models are emerging. They differ most in where iron-making takes place and who owns it.

Preserve and adapt: BHP and Rio Tinto have publicly stated their intentions to continue supplying iron ore to their offshore customers while partnering with them to lower steelmaking emissions, through technology development and process improvements that keep Pilbara ore competitive as steel decarbonises. They are partnering with BlueScope and Woodside to develop the pilot NeoSmelt facility at Kwinana. The pilot aims to de-risk the technology for customers considering deployment at full scale. In April 2026, this project was amongst the first to be accorded "Priority Project" status under the *State Development Act 2025*, reflecting its importance to the WA Government. Rio Tinto has also partnered with Calix on the ZESTY green iron demonstration plant[11], which will test Pilbara ore in a hydrogen-based process using electric heating. Under this model, customers decide where commercial iron-making occurs, and that may be offshore.

Diversify downstream: Fortescue has adopted a different approach and has expressed its intent to extend its existing business into green metal production in Australia. Its Christmas Creek facility produced first hot metal in August 2026 using an electric smelting furnace. Technologies for the upstream direct reduction using green hydrogen step are still being refined.[12] Fortescue is also studying an Australia–China green metal supply chain, which aims to supply more than 100 million tonnes per annum of green iron to China. Under this model the miner owns iron-making in WA, although commercial scale remains a goal rather than a demonstrated result.

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[11] Government of Western Australia. "First State Development Area and Priority Projects Announced." Department of Premier and Cabinet announcement, 16 April 2026.

[12] Fortescue. "What Is Green Iron?" Fortescue webpage accessed 20 October 2026.

Integrate upstream: Steelmakers may invest in WA to secure iron supply, combining technology, offtake and equity in a single project. This is the model the North West Shelf analogy describes. Asian steelmaker ownership of Mid West magnetite (section 3.1.3) shows it already has a foothold in WA. POSCO's proposal to deploy its proprietary HyREX fluidised bed technology at the Boodarie Strategic Industrial Area illustrates this model in the Pilbara, combining technology capability, offtake demand and equity participation in a single project. Its proposed gas-based start places it outside this *Roadmap's* definition of green iron in the near term. However, POSCO's interest signals the strategic importance major Asian steelmakers place on securing iron supply from Western Australia.

These models carry different implications for the state. BHP and Rio Tinto account for over 75 per cent of the Pilbara iron ore market, and their model does not, on its own, locate iron-making in WA. However, the technologies they are de-risking are among those most likely to unlock Pilbara ores. Their research and pilot investment therefore has value for the state even if they do not build green iron plants themselves. The other two models place iron-making in WA, but each faces the trilemma described in section 3.2.3. Early commercial investment in Pilbara green iron may therefore depend more on miners diversifying downstream and steelmakers integrating upstream. For government, this means engaging with each model on its own terms rather than designing policy around the investment decisions of a single type of producer.

3.2.5 A Note on Pilbara Magnetite

The Pilbara also hosts substantial magnetite resources with 4 billion tonnes of identified resources.[13] There are two magnetite mines operating in the Pilbara; CITIC Pacific operates the Sino Iron project and Fortescue's Iron Bridge project. Both projects are located in the northern Pilbara outside of the Hamersley iron province which hosts the majority of the Pilbara's large hematite deposits.[14] While the Pilbara is prospective for magnetite, these deposits are not the focus of resource development investment in the region due to the much higher capital and operational costs. Unlocking the larger volumes of lower cost hematite remains the mid- to long-term priority for scaling a green iron industry in the Pilbara which the world relies on for more than half of all global seaborne iron ore trade.

3.3 Comparing the Iron Ore Regions

Western Australia's iron ore endowment is diversified across regions with different comparative advantages for green iron. The Mid West's magnetite can be beneficiated to the high-grade concentrate that proven direct reduction technology requires, and the region has access to the SWIS and existing common-user port, road and rail infrastructure. The Pilbara holds the state's largest iron ore resources and established export infrastructure, but its predominantly lower-

[13] The estimate is based on publicly reported mineral resource estimates for advanced projects. Geological Survey of Western Australia, "Mines and Mineral Deposits (MINEDEX)"; company reports. Appendix B provides details of advanced magnetite projects by region.

[14] The Hamersley province is less attractive for magnetite because of the increased deleterious mineral content of deposits in this geological setting and the risk of asbestos. Duuring, P, Teitler Y, Hagemann SG and Angerer T. 'Exploration Targeting for BIF-Hosted Fe Deposits in the Pilbara Craton, Western Australia.' MRIWA Project M426, Geological Survey of Western Australia Report 163. Perth, 2016.

grade hematite fines are not well suited to current direct reduction technology, and the region is not connected to the WEM. Neither region offers a complete solution on its own: one combines proven technology with suitable ore at a smaller scale, while the other offers globally significant scale that depends on technologies still being developed. This section compares how this ore–technology mismatch shapes the timing of each region's contribution, the alternative approaches being explored to bridge it, and what it means for the phases of industry development.

3.3.1 The Technology Maturation Pathway

This ore-technology mismatch explains why emerging technologies matter for the Pilbara. If fluidised bed reactors, flash smelting, electric smelting or electrolysis can process iron ore fines or lower grade ores at commercial scale, without expensive beneficiation to DR-grade pellets, they could unlock Pilbara ores for green iron production. Several of these technologies are being piloted with backing from Pilbara producers (section 3.2.4).

The Timeline Question: Emerging technologies suited to processing fines are currently at pilot or demonstration scale. They need several more years of development, demonstration and de-risking before they can attract commercial-scale investment. This technology maturation timeline, likely 2030s rather than 2020s, is another constraint on Pilbara green iron development.

Technology Risk vs Ore Certainty: The trade-off can be summarised as:

- **Mid West:** Proven technology and suitable ore can equate to near-term viability, albeit the economic scale remains undetermined.
- **Pilbara:** Massive ore reserves, if combined with emerging technology could lead to long-term, globally significant market share, but this depends on technology maturation.

3.3.2 Alternative Pathways Under Consideration

Several alternative approaches are being explored to address the ore-technology mismatch:

Ore Transport: Some proponents have examined the economics of transporting Pilbara ore to the Mid West for processing. Coastal shipping or inland rail could potentially enable access to Mid West infrastructure and SWIS electricity while leveraging Pilbara ore volumes. Commercial viability depends on transport costs, processing economics and infrastructure coordination.

Novel Upgrading Processes: Research into new ore beneficiation techniques continues. If Pilbara hematite could be upgraded to DR-grade specifications more efficiently, it would unlock vertical shaft technology for Pilbara ores. However, no technology has yet achieved commercial viability.

Blending Strategies: Some projects are investigating blending strategies, combining higher-grade imported ores or Mid West magnetite with Pilbara ores to achieve acceptable feedstock quality. The economics depend on scale and consistent long-term supply to optimise blending ratios.

3.3.3 Why This Matters for WA's Industry Development Trajectory

The ore-technology matching challenge is a key determinant of how WA's green iron industry is likely to emerge and mature. The phases below describe this dynamic and the regional context which also influences it. Importantly, both of WA's iron ore regions will progress in parallel, each at the pace and scale its own conditions allow:

Foundation phase: Proof of concept where established technology and suitable ore align, most likely in the Mid West. Build commercial models, establish supply chains, develop workforce capability and prove WA's credibility as a green iron supplier. Accelerate activation of the Pilbara now, building on work already under way on project-ready land, heritage, transmission and finance, so the region is ready as technologies mature and projects advance. Small to mid-scale commercial projects may emerge in the Pilbara during this phase, most likely led by miners diversifying downstream or steelmakers investing upstream.

Scale-up phase: Deploy technologies and processing routes suited to Pilbara ores at commercial scale. Expand shared infrastructure as markets deepen, coordinate activation of the Mid West with a focus on a fit-for-purpose industrial hub. Innovation spillover from earlier projects reduces technology and delivery risk across all regions.

Maturity phase: Approaching 2050, large-scale Pilbara iron ore production is increasingly diverted from direct shipping to green iron production for volume markets, drawing on the region's established infrastructure. This depends on miners and steelmakers, separately or in partnership, choosing to locate iron-making in WA. Those decisions will be shaped by the cost of producing green iron in WA relative to offshore processing, the policies of importing countries and whether enabling infrastructure is in place.

These phases and timelines are indicative, based on current knowledge about ore availability, renewable energy and hydrogen economics, green iron production technologies and regional infrastructure planning. Changes in any or all of these factors may emerge and alter the phased development we set out here.

Chapter 5 examines the strategic framework that informs government interventions in more detail. Chapter 6 translates it into an indicative industry development trajectory for Western Australia.

Box 10: Why Pilbara Volume Scale Is a Maturity Phase Opportunity

- **Ore–technology interaction:** dominant hematite ores rely on emerging or energy-intensive upgrading pathways, compounding locational cost factor impacts
- **Locational cost factor penalties:** remote construction, logistics, workforce and cyclone standards materially increase capital and operating costs compared with the Mid West
- **Energy system isolation:** absence of SWIS connection requires fully self-contained generation, storage and firming, increasing capital intensity and reducing flexibility
- **Incumbent strategies :** the largest producers are focused on keeping their ore competitive as customers decarbonise, rather than producing green iron themselves
- **Market maturity:** volume production in the Pilbara depends on blast furnace operators separating iron-making from steelmaking and moving to imported green iron

Implication: the Pilbara's challenge is not scale or resource availability, but near-term cost, technology readiness and market maturity. That sets when full volume production is viable, not the pace of enabling work, which is already underway and should accelerate. . Learning, cost reduction and technology maturation bring full Pilbara-scale deployment forward while enabling work proceeds in parallel.

3.4 The South West

This chapter has focused primarily on the Pilbara and Mid West iron ore regions. The South West's role in WA's green iron industry is different: rather than producing green iron at commercial scale, it underpins the technology, workforce and market development the broader industry depends on. In the context of this *Roadmap*, "South West" refers broadly to the SWIS-connected southwestern land division including the Kwinana Industrial Area, Collie and the Great Southern region.

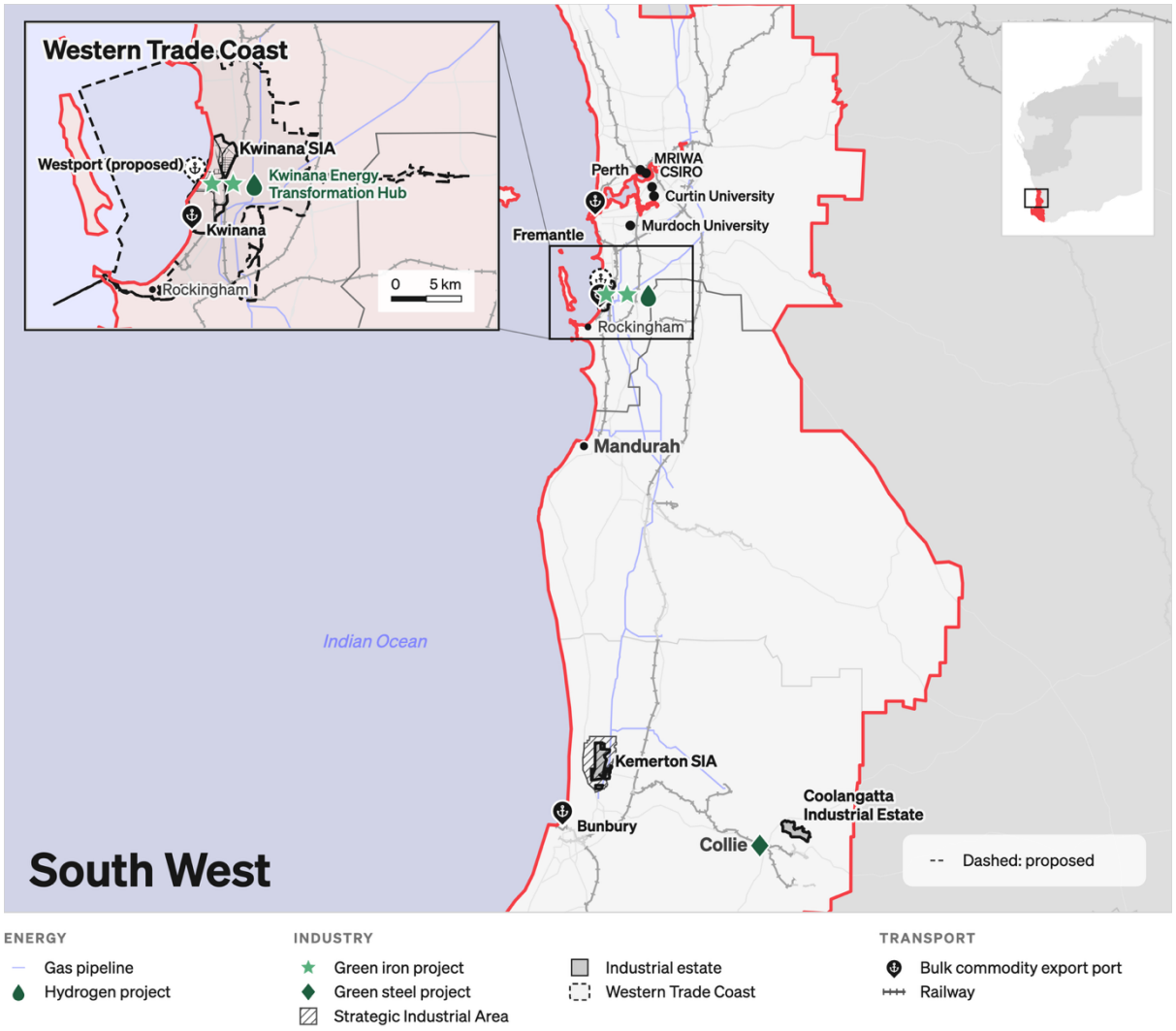


Figure 7: Green iron projects and related infrastructure in the South West region

Notes: Dashed lines show proposed infrastructure. Westport and MRIWA locations are approximate. Green iron projects shown without names

Source: The Superpower Institute, *WA Green Iron Roadmap* (Appendices B and C); DEMIRS (MINEDEX); Geoscience Australia (infrastructure); DevelopmentWA; WA Department of Planning, Lands and Heritage; Western Trade Coast (DPC); Westport; DPIRD.

What the South West Offers:

- **SWIS grid access and established industrial precincts:** the Kwinana and Kemerton Strategic Industrial Areas and the Coolangatta Industrial Estate in Collie.
- **Scrap availability and domestic market potential:** sufficient scrap steel supply for secondary steelmaking via a proposed electric arc furnace facility at Collie, and proximity to the state's steel demand.
- **Technology demonstration and proximity to research institutions:** the NeoSmelt pilot facility and the Calix ZESTY demonstration plant are proposed for construction at the Kwinana Strategic Industrial Area. Both are backed by Pilbara iron ore producers (section 3.2.4), making the South West a testing ground for technologies that may later unlock Pilbara ores. Several key research institutions and organisations investigating the green iron

value chain are active in Perth including the Minerals Research Institute of Western Australia (MRIWA), CSIRO Mineral Resources and the Heavy Industry Low-Carbon Transition Cooperative Research Centre (HILT CRC).

- **Workforce and capability development:** proximity to the Perth labour market and training institutions.

The South West's role in industry development: Rather than ore-to-iron production, the South West is well positioned for green steel production and market development, to host technology pilots and demonstrations that may later be deployed in other regions and build domestic capabilities and social licence to support the broader industry.

Box 11: The South West's Complementary Role

- **System capability:** grid access, industrial precincts and institutional capacity
- **Workforce and skills:** proximity to labour markets, training and R&D
- **Market development:** suitable for pilots and demonstration facilities, domestic demand and early learning
- **Integration role:** supports energy, hydrogen and approvals systems needed elsewhere

Role in green iron industry development: the South West underpins capability and system readiness rather than export-scale production.

04.

What the WA Modelling Tells Us

Chapter 4 overview

> The Mid West is the lowest-cost location modelled for early projects
>
> A grid connection lowers costs mainly by firming supply, not by selling electricity
>
> Local ore that can be upgraded to DR-grade has a large effect on cost
>
> Higher Pilbara costs point to long-lead enabling work starting now, alongside early Mid West projects

The modelling informs where to start and what to build, not which projects to back

Chapter 3 described how Western Australia's iron ore regions differ in ore characteristics, energy systems, infrastructure and industrial base. This chapter examines what those differences mean for the cost of producing green iron. It summarises techno-economic modelling undertaken by TSI, which updates the earlier *GIPA* modelling to reflect conditions in the Mid West and Pilbara. It is one input to the *Roadmap's* strategic judgements, rather than a forecast of project economics, and section 4.4 sets out what it cannot tell us.

4.1 Modelled scenarios and assumptions

The modelling prepared for *GIPA* in 2024-25 looked at five green iron locations around Australia including three in WA: Pilbara, Mid West and Kwinana. The purpose of that modelling was to establish the cost of production in locations across and understand the drivers of cost to identify locations with comparative advantages over others. Modelling inputs were prepared on this basis, making adjustments to inputs between regions based on differences in characteristics.

TSI has since updated the *GIPA* model to better reflect conditions in the Mid West and Pilbara. Capital costs now draw on GenCost 2025-26. Locational cost factors were revised after consultation with energy developers and agencies. The plant's interaction with the WEM is now modelled more realistically, using historic market data. Project-specific road and port costs are

also included. Industry and government agencies provided input to the scenarios and cost assumptions.

Expanded scenarios align with current WA government initiatives and infrastructure plans. Green iron production is modelled at hypothetical projects located at Boodarie in the Pilbara (off-grid, local hematite) and at Oakajee in the Mid West (grid-connected, magnetite or imported Pilbara hematite). Differentiation between magnetite grades reflects beneficiation limits and existing WA exports, while shipping hematite to Oakajee offers a lower-cost alternative to Pilbara processing.

All scenarios model a 2.5 million tonne per year plant. Processing Pilbara magnetite in the Pilbara was not modelled. Neither was scrap-based EAF steelmaking, because of data limitations. The modelling does test natural gas as a reductant at Oakajee, blended with green hydrogen in varying proportions. This allows its cost and emissions to be compared with hydrogen-based production (see section 4.3 and section 5.5).

Table 3: Characteristics of different green iron production locations based on refined assumptions and additional scenarios

Location	Connected to wholesale electricity market	Locational Capital cost factor	Type of iron ore	Inflexible technology processing	Flexible technology processing
Boodarie (Pilbara)	No	1.55	Pilbara lower-grade hematite	Pelletisation + Vertical shaft furnace DRI + Electric Smelting Furnace	Flash smelting DRI + Electric Smelting Furnace
Oakajee (Mid West)	Yes	1.15	Pilbara lower-grade hematite	Pelletisation + Vertical Shaft Furnace DRI + Electric Smelting Furnace	Flash smelting DRI + Electric Smelting Furnace
Oakajee (Mid West)	Yes	1.15	Central WA BF-grade magnetite beneficiated to DRI-EAF-grade magnetite	Pelletisation + Vertical Shaft Furnace DRI	Flash smelting DRI
Oakajee (Mid West)	Yes	1.15	Central WA BF-grade magnetite	Pelletisation + Vertical Shaft Furnace DRI + Electric Smelting Furnace	Flash smelting DRI + Electric Smelting Furnace

The model applies the Hydrogen Production Tax Incentive (HPTI) emissions limit using the physical emissions intensity of grid electricity. This limits grid imports to around 2 to 3 per cent of a plant's annual demand. It is a conservative treatment. Large WA electricity users, including

desalination plants, already buy renewable electricity through power purchase agreements, and surrendered certificates may also count. Arrangements like these could allow a plant to use more grid electricity for firming. Some export markets apply stricter tests, however, before according “green” status to iron.

Box 12: How to Read the Modelling Results

- The modelling compares relative cost drivers, not project economics
- Results reflect assumptions and configurations, not site-specific designs
- Outputs are directional, not price forecasts
- Differences between scenarios matter more than absolute values

Purpose: to inform strategic judgement about risk, priorities and system design, not to select projects or set prices.

4.2 Levelised cost of iron results

TSI modelled four scenarios, each for inflexible and flexible iron-making technology. The results are summarised in Table 4 as the LCOI for each scenario compared by technology type. Figure 8 provides a breakdown of the cost of iron for each scenario.

Table 4: LCOI results for each scenario differentiated by technology flexibility

Scenario	Inflexible ($/t)	Flexible ($/t)
Oakajee, DR-grade magnetite	1,099	839
Oakajee, BF-grade magnetite (with ESF)	1,308	978
Oakajee, Pilbara hematite shipped in (with ESF)	1,272	964
Boodarie, Pilbara hematite (off-grid, with ESF)	2,003	1,324

Notes: All modelling results are in Australian dollars

Source: Bivios and The Superpower Institute analysis.

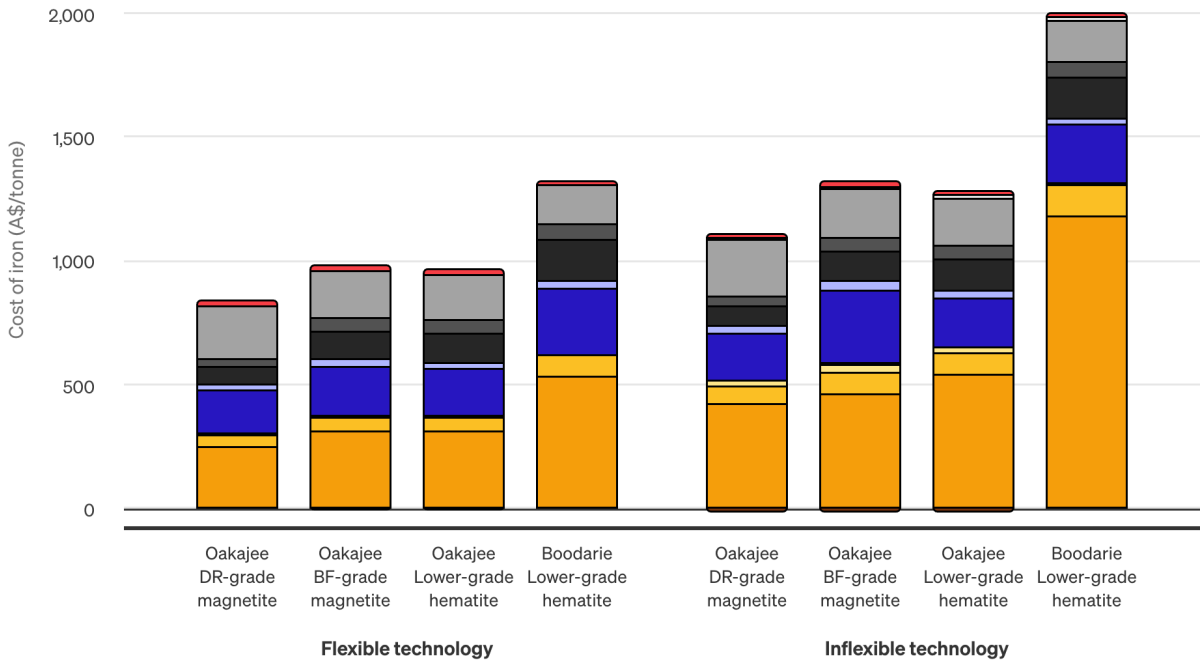


Figure 8: Breakdown of cost of iron per tonne for the updated scenarios

Notes: DR-grade magnetite refers to magnetite concentrate with a grade >66 per cent Fe and <3.5 per cent SiO2+Al2O3. BF-grade magnetite refers to a concentrate with a grade of <66 per cent Fe and >3.5 per cent SiO2+Al2O3. Lower-grade hematite refers to Pilbara fines ore with a grade of 60 per cent Fe. Inflexible technology refers to iron-making technology that operates continuously at a steady rate. Flexible technology can vary its output to match variable renewable electricity supply. "Finance" refers to annualised capital costs, including capital recovery and the modelled return on capital. "O&M" refers to operating and maintenance costs. "Electricity" includes solar, wind, batteries, transmission, electrical distribution and grid-connection infrastructure. "Grid exports" are electricity-sale revenues; "grid imports and network charges" are purchased electricity costs, grid connection and capacity charges. "Water" covers desalination, storage and distribution infrastructure. "Hydrogen" includes electrolyser, hydrogen storage and distribution infrastructure. "Iron" covers all relevant iron-making plant costs from pre- to post-processing. "Ore" is the cost of purchased iron-ore feedstock, including relevant transport and handling. "Natural gas" is the fuel consumed in processing, principally for pelletisation in the inflexible cases. "Gas lateral, port and road" combines the capital and operating costs of the local gas connection and transport infrastructure, including port-use fees and road-haulage charges.

Source: Bivios and The Superpower Institute analysis.

Detailed results are presented in *Digging Deeper* available for download from the TSI website.

4.2.1 Mid West

The primary driver of cost differences within production pathways for the Mid West is the cost of energy. The total capital cost for renewable electricity infrastructure is sensitive to demand, which is driven by ore grade and iron production technology. High-grade, or DR-grade ore

attracts a market premium reflecting its value for process efficiency in steelmaking. Despite its higher cost, utilising this ore type results in the lowest levelised cost of iron (LCOI) of the scenarios modelled, because it minimises the capital and operating costs of meeting renewable energy demand. The LCOI is about $1,099 per tonne for inflexible technology and $839 per tonne for flexible technology.

In the BF-grade magnetite scenario, the cost of green iron rises significantly because of the investment required in an ESF and the additional renewable energy it needs. This adds around $209 per tonne for inflexible technology and $139 per tonne for flexible technology, as shown in Figure 9. This suggests it is cheaper for a producer to beneficiate ore to DR-grade, avoiding an ESF, to achieve a product suitable for the EAF market. Whether a magnetite resource can be upgraded can only be confirmed project by project.

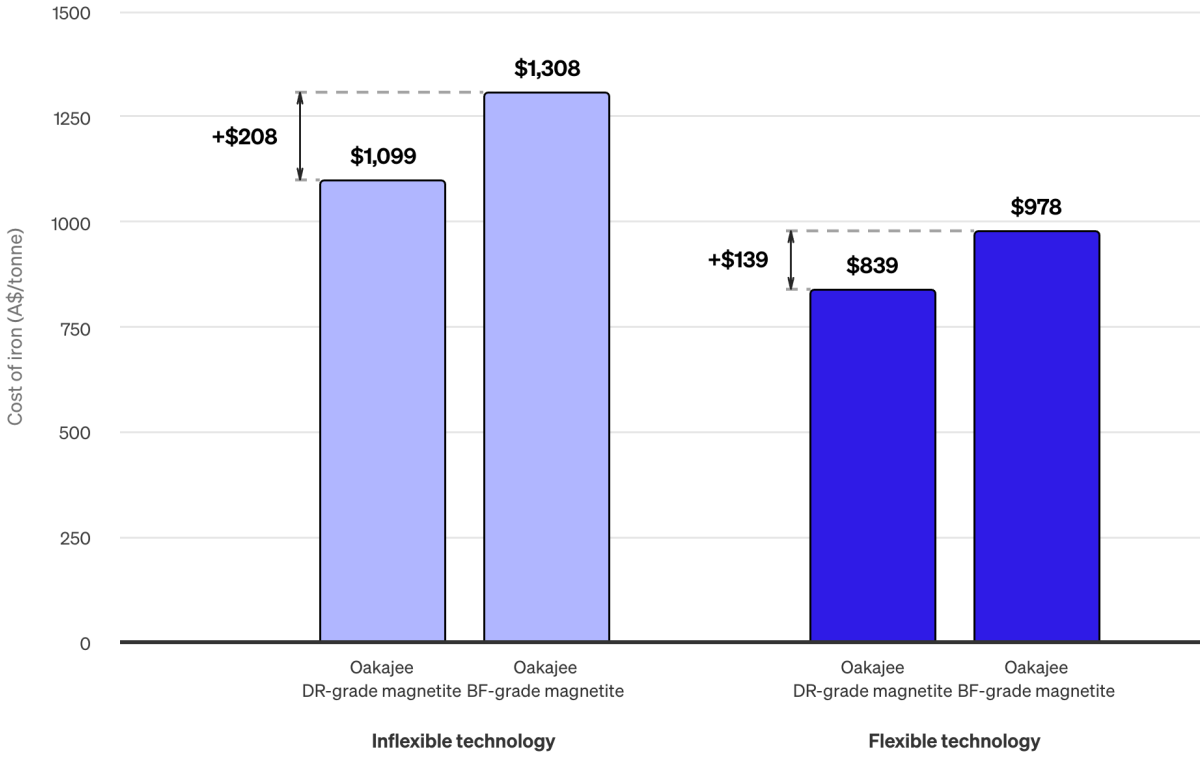


Figure 9: Beneficiation is cheaper than using an ESF to achieve DRI-EAF quality iron.

Notes: DR-grade concentrate does not require an ESF downstream while BF-grade concentrate does.

Source: Bivios and The Superpower Institute analysis.

Consistent with *GIPA*, flexible iron-making technology delivers significant savings because it avoids the capital and operating costs of pelletising. In the DR-grade case the saving is around $260 per tonne.

Benefits from operating electrolysers flexibly to take advantage of high WEM prices are small. This is partly due to the WEM price cap and partly because large exports push down the market clearing price. This revised treatment of the WEM is the main reason costs are higher than the comparable Geraldton results in *GIPA*. For inflexible technology, annual grid revenue falls from

about $331 million to $31 million, adding around $120 per tonne. Higher GenCost 2025-26 costs are largely offset by a lower locational cost factor (1.15, down from 1.24) and a re-optimised system.

There is still a clear benefit to a grid connection, but it now comes mainly from firming supply rather than trading electricity. For inflexible technology, a connection of around 300 MW offers the greatest benefit, reducing the cost of iron by more than $80 per tonne. Flexible technology needs a much smaller connection. Above around 28 MW, connection costs outweigh the benefit. Flexible technologies remain at demonstration stage, so first-of-a-kind projects are more likely to use inflexible technology.

4.2.2 Pilbara

The cost of iron produced in the Pilbara uses a locational capital cost factor of 1.55, up from 1.34 in *GIPA*. This is based on consultation with energy system developers with direct experience in the Pilbara. It reflects the high cost of doing business in the region: materials, labour and construction costs are all captured in the locational cost factor.

This regional cost factor magnifies the costs of off-grid energy in the Pilbara, irrespective of the excellent renewable or iron ore resources. At Boodarie, the cost of green iron is about $2,003 per tonne for inflexible technology and $1,324 per tonne for flexible technology. Because the case is off-grid, renewable generation and storage must be oversized to keep the plant running. An inflexible plant curtails more than 60 per cent of the electricity it generates. Flexible technology narrows the gap considerably in this setting.

Shipping Pilbara hematite to the Mid West for green iron production illustrates the large regional differences in the cost of production. For flexible technology, there is a $360 cost saving processing Pilbara ore in the Mid West. For the inflexible technology the saving more than doubles to $731.

These results use publicly available cost data. Some established Pilbara operators report that they can build renewable energy assets at materially lower cost. If such costs prove achievable more widely, the cost of Pilbara iron would fall, strengthening the case for the enabling work already under way. Cost reductions that are not specific to the Pilbara would also lower Mid West costs.

Figure 10 shows the breakdown of different costs contributing to the LCOI for processing Pilbara hematite in the Mid West relative to processing it in the Pilbara.

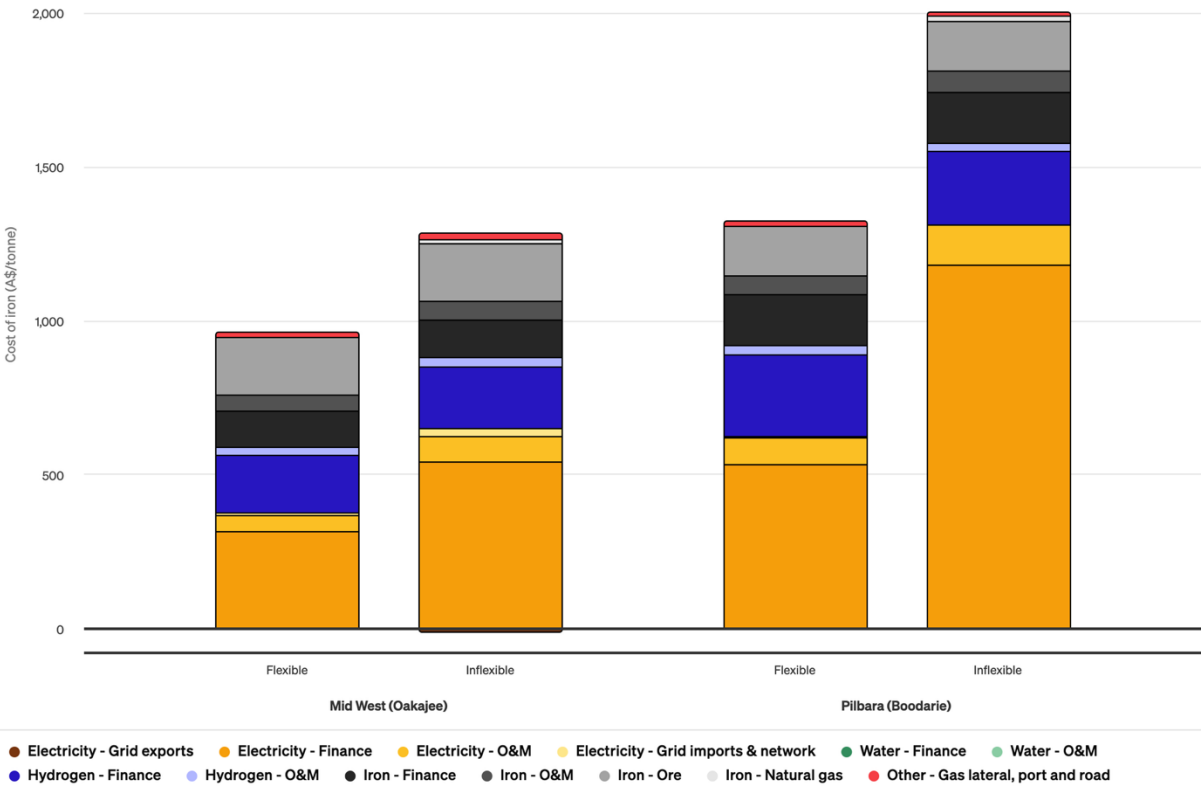


Figure 10: It is much cheaper to process Pilbara hematite ore to green iron in the Mid West than in the Pilbara

Note: "Finance" refers to the annualised cost of recovering capital investments. "O&M" refers to operating and maintenance costs. Cost categories include electricity (solar, wind, batteries, electrical distribution, and grid-connection infrastructure), water (desalination facility and storage), hydrogen (electrolysers, hydrogen storage, and distribution infrastructure), iron (pelletisation, DRI, briquetting and ESF assets), natural gas (cost of natural gas consumed in processes), gas lateral (local pipeline connection to the plant), port (O&M to reflect port-use charges such as vessel, berth, and wharfage fees), and road (road infrastructure connecting plant to port and haulage charges).

Source: Bivios and The Superpower Institute analysis.

4.3 Key cost drivers and sensitivities

The results point to a small number of factors that shape project economics.

Energy system configuration. This is the largest cost driver. Grid-connected projects can firm supply and need less generation and storage capacity. Off-grid projects must oversize both.

Renewable resource quality. The capital cost of renewable energy is sensitive to solar and wind capacity factors and to how well the two complement each other. Better resources allow the system to be optimised with less generation and storage capacity. The Mid West has strong solar and wind resources with some complementarity: wind tends to be stronger at night, when solar is unavailable. The Pilbara's renewable resources are also high quality, but they complement each other less. Where a grid connection is available, its firming benefit outweighs the gains from better renewable resources alone. In the Pilbara, high installation costs and the

lack of a grid mean that the quality of the region's resources cannot currently overcome the high cost of renewable energy capital.

Ore grade and processing. The need for an ESF adds both capital costs and the extra renewable energy needed to run it.

Location-specific costs. Locational cost factors increase the cost of energy infrastructure. The effect is greatest in the Pilbara.

Transport infrastructure. Road and port costs are small relative to total costs. Road upgrades account for around 1 per cent of total capital costs in the Oakajee scenarios. Transport infrastructure may be needed to enable a project, but projects are unlikely to succeed or fail on these costs.

Treatment of grid electricity. Results are sensitive to how grid electricity is counted under the HPTI (section 4.1). A less conservative treatment would be likely to lower costs, particularly for inflexible technology.

Natural gas. Using natural gas as the reductant in place of green hydrogen lowers the modelled cost of iron at Oakajee, but it substantially increases emissions intensity. Section 5.5 discusses the policy implications.

In the near term, the Mid West combines the ore, renewable resources and grid access that matter most to project economics. Pilbara costs are higher under current conditions for new entrants. This is why long-lead enabling work there needs to begin alongside early Mid West projects.

Box 13: Key Modelling Insights

- Energy system configuration is the major cost driver
- A grid connection's value lies mainly in firming, and the right size depends on each project's technology
- Off-grid systems face higher capital costs and must curtail much of the electricity they generate
- Ore quality and processing requirements materially affect energy demand and capital costs
- Transport infrastructure enables projects but does not drive their economics

These insights are intended to inform planning and risk assessment, not to rank projects or predict prices.

4.4 What the modelling cannot tell us

TSI's techno-economic modelling provides indicative cost profiles of Western Australian produced green iron. The cost drivers are clear: energy systems, ore processing and technology account for the major differentials between regions and pathways.

But modelling, no matter how rigorous, has inherent limitations. Our model estimates the cost of production in different locations using publicly available data but cannot tell us what locations are strategically optimal in the context of Western Australia's industrial ambitions or draw on confidential commercial information.

4.4.1 Beyond the Spreadsheet

The modelling provides LCOI estimates under specific assumptions about capital costs, energy prices, hydrogen production and market conditions. These estimates are valuable for comparing scenarios and identifying cost drivers. But they don't capture several critical factors that are likely to determine whether projects succeed:

- **First-Mover Dynamics:** The modelling treats all projects as equally mature and financeable and all proponents as equally capable. In reality, FOAK projects face higher costs (infrastructure, technology risk, supply chain development) but may capture green premium pricing or strategic advantages. Later movers benefit from the knowledge created by FOAK projects but may face saturated markets or lost positioning. The modelling doesn't distinguish between going first and going later.
- **Infrastructure Coordination Benefits:** The modelling assumes infrastructure costs but doesn't quantify the value of coordination. If multiple projects share desalination, hydrogen pipelines or port facilities, unit costs fall. If each project builds independently, costs rise and development slows. The economic benefit of government coordination, or the cost of its absence, isn't captured in project-level LCOI.
- **Market Access and Certification:** The modelling doesn't account for market access barriers. A lower-cost project using gas-to-hydrogen pathways may struggle to access European markets under CBAM. A higher-cost project with impeccable green credentials may command prices in market that the modelling doesn't capture. Certification complexity, offtake negotiations and customer relationships cannot be factored into modelling processes.
- **Technology Maturation Pathways:** It is possible to compare proven vertical shaft technology against emerging technologies at current cost and risk profiles. But it is not possible to capture the value of demonstration projects that de-risk emerging technologies for future deployment. Building early capability and reducing technology risk may bring Pilbara scale-up forward in ways pure cost comparison doesn't reveal.
- **Political and Social Licence:** The modelling is silent on community acceptance, Traditional Owner partnerships, environmental approvals complexity and political will. A project with attractive economics may stall for years in approvals. Another with higher costs but strong local support may proceed smoothly. These factors fundamentally affect "bankability" but are not reflected in LCOI calculations.

4.4.2 The Strategic Questions Modelling Doesn't Answer

Given these limitations, the modelling can't definitively answer several strategic questions that this *Roadmap* must address:

Should WA concentrate early activity where costs are likely to be lowest (Mid West, proven technology, grid access) or wait until volume markets mature and Pilbara-scale projects become viable?

The modelling shows Mid West projects have lower costs than off-grid Pilbara projects. But it doesn't tell us the value of early supply chains and commercial models to derisk the projects that follow. Nor does it tell us the cost of delay while other jurisdictions establish positions.

Should WA prioritise green hydrogen pathways even if gas-based pathways show lower near-term costs?

The modelling can compare gas-DRI and hydrogen-DRI costs under specific assumptions. But it doesn't capture technology lock-in risks, stranded asset possibilities as carbon pricing tightens, opportunity costs of scarce gas resources or WA's long-term competitive positioning in markets that will increasingly require zero-carbon products.

Should the government co-invest in common-user infrastructure even if that increases public expenditure?

The modelling suggests that substantial public investment in common-user infrastructure is required to support the industry to scale. But it doesn't quantify the macroeconomic benefit of accelerating industry development, the value of de-risking FOAK projects or the cost of project-on-project competition for limited port and water resources. The return on public infrastructure investment isn't captured in private project economics.

Should WA pursue ‘lighthouse’ export projects immediately or invest first in domestic market development and demonstration?

The modelling compares projects producing 2.5 million tonnes per annum of green iron in different locations on unit cost grounds. But it doesn't value the capability building, workforce development, technology validation and social licence that smaller domestic projects may provide. Nor does it capture how domestic markets can provide revenue certainty for early production.

4.4.3 From Economics to Strategy

The modelling tells us WA can compete. It identifies which scenarios have lower costs and which factors drive those costs. This is essential information.

But moving from "can compete" to "will succeed" requires strategic judgments about planning, coordination, technology pathways and policy settings. These judgments must account for factors the modelling doesn't capture: first-mover advantages and disadvantages, coordination benefits, market access dynamics, capability building logic and political economy.

Chapter 5 establishes the strategic framework to support making these types of decisions. Chapter 6 translates that framework into a development trajectory. The modelling provides the economic foundation; strategy provides the roadmap for execution.

Key Insight: The WA modelling demonstrates cost profiles across multiple scenarios and between regions. The question is not "can WA afford to produce green iron?" but rather "which pathway maximises WA's advantages, minimises risks and positions the state for long-term competitiveness?" That's a strategic question, not solely an economic one.

Box 14: What the Modelling Can and Cannot Tell Us

The modelling can:

- Identify major cost drivers across regions and pathways
- Illustrate the impact of energy system configuration
- Test sensitivity to assumptions such as electricity cost and utilisation
- Inform regional roles and timing by highlighting relative cost drivers

The modelling cannot:

- Predict final investment decisions
- Capture project-specific innovation or commercial strategies
- Replace detailed feasibility studies
- Eliminate uncertainty in emerging technologies

Implication: modelling is a tool for strategic framing, not a substitute for market discovery.

4.5 Conclusion on modelling results

The modelling shows that the cost of green iron in WA depends mainly on a few location-specific factors. These are how a plant’s energy system is configured and connected, whether local ore can be upgraded to DR-grade and the local cost of building energy infrastructure. On each of these, the Mid West is better placed for early projects. The Pilbara’s costs are higher today, but the scale of its ore resources makes it central to growth over time. Lower construction or technology costs would narrow the gap. The results are indicative. They rely on public cost data, a single plant scale and a conservative treatment of grid electricity under the HPTI. They are best used to inform judgements about where to start and what to build, not read as point estimates.

Part III

Strategy

Establishes the strategic framework for government involvement.

In this part

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05.

A Strategic Framework for WA Government Involvement

Chapter 5 overview

> Market failures, including unpriced emissions, learning spillovers and coordination externalities, justify government involvement
>
> System-level constraints, such as lumpy infrastructure and capability gaps, shape how and when government should act
>
> The state's main levers are coordination, shared infrastructure, approvals, social licence and workforce development
>
> Government's role should shift from enabling to system stewardship as the industry matures
>
> Public support should go to hydrogen-based pathways, and any use of gas in iron-making should be a commercial choice and commercially funded

Chapter 2 explained the technical constraints: which ores suit which technologies and what infrastructure is required. Chapter 3 described why regional characteristics matter. Chapter 4 set out the key cost drivers for WA produced green iron: energy system configuration and grid access, renewable resource quality, ore processing and technology choice. Because these factors are highly local, small changes in them produce large changes in cost.

But competitiveness doesn't guarantee success. Other regions with comparable or weaker fundamentals are moving decisively, backed by government commitments, coordinated infrastructure and clear policy settings. Western Australia's advantages create opportunity: world-class renewables, suitable ores in the Mid West and established trade relationships.

The recommendations from *GIPA*, including production credits, innovation support and infrastructure, will help close the cost gap between WA-produced green iron and fossil-based iron, but capturing the opportunity requires the WA Government to be strategic about how it allocates resources across regions and assesses projects seeking support (Chapter 7). This will involve an assessment of the suitability of various technology pathways, addressing

infrastructure coordination issues and determining individual projects' potential to contribute to capability building.

This chapter provides a strategic framework to assess when, where and how government should allocate resources. It sets out:

- why government involvement is justified, based on market failures and system-level constraints (sections 5.1 and 5.2)
- the direct levers available to government (section 5.3)
- how the role of government should change as the industry matures (section 5.4)
- energy pathways for iron-making, including the role of gas in the transition (section 5.5)
- how to target government effort and the principles that should guide support (sections 5.6 and 5.7).

These considerations involve trade-offs, uncertainties and competing perspectives. This *Roadmap* sets out TSI's positions, grounded in our analysis, based on consultation with industry and government and assessment of WA's long-term comparative advantage.

Chapter 6 then applies the framework to Western Australia's regions and phases of industry development.

5.1 Market failures justify government involvement

Markets will not, on their own, deliver an efficient transition to green iron production in Western Australia because several well-established market failures interfere with efficient investment and coordination.

The most fundamental of these is a carbon emissions externality. Emissions from steelmaking are not fully priced globally, and existing carbon pricing mechanisms, standards and border measures are uneven, incomplete and subject to change. For trade-exposed industries, this creates uncertainty about future relative prices and weakens private incentives to invest in low-emissions production pathways at the scale and speed required to meet global decarbonisation objectives.

A second market failure arises from learning and knowledge spillovers. Early green iron projects generate information and capability that benefit the wider system, including technological learning, workforce skills, regulatory experience and supply-chain development. While these spillovers increase the social value of early investment, they cannot be fully captured by first movers. As a result, private investment decisions tend to underweight learning benefits, leading to slower or smaller-scale deployment than would be socially optimal.

There are also coordination externalities associated with shared systems and standards. The value of certain enabling investments, such as common-user infrastructure, certification frameworks or interoperable systems, depends on adoption by multiple users and alignment across time. In these circumstances, even where prices exist, decentralised decision-making may fail to achieve efficient coordination, delaying investment or locking in sub-optimal outcomes.

Taken together, these market failures provide a clear justification for government involvement in the development of a green iron industry. However, they do not fully explain the scale or nature of the challenge. Even where markets are functioning broadly as designed, additional system-level constraints shape how investment unfolds in practice.

Box 15: Why markets alone won't deliver green iron

Green iron development is constrained by several well-established market failures:

- Carbon externalities: The absence of an effective global carbon price weakens incentives to invest in low-emissions iron-making.
- Innovation spillovers: Early movers generate knowledge that benefits later entrants but cannot fully capture its value.
- Coordination externalities: the value of shared systems, such as common-user infrastructure and certification, depends on adoption by multiple users, so they are unlikely to be delivered efficiently on a project-by-project basis.

These failures justify a role for government focused on coordination, risk reduction and capability-building, rather than direct substitution for private investment.

5.2 System-level constraints compound market failures

Beyond market failures, the development of a green iron industry in Western Australia will be shaped by a set of system-level coordination and sequencing challenges that markets alone are not well equipped to resolve.

A central challenge is the presence of indivisible and lumpy infrastructure. Large-scale energy systems, hydrogen infrastructure, water supply and port facilities often need to be developed ahead of demand and at a scale that exceeds the needs of any single project. While this does not constitute a market failure in itself, it creates practical coordination problems: private proponents are unlikely to commit capital to common-user infrastructure without confidence in future utilisation, while future users are unlikely to emerge without that infrastructure in place. Section 5.3.1 sets out the principles for deciding which infrastructure should be shared and where public co-investment is justified.

Sequencing challenges are amplified where interdependencies exist across regions, technologies and systems. Decisions taken in one location or at one phase of development can materially affect the feasibility and cost of options elsewhere. Markets do not optimise such sequencing across interconnected systems, particularly where benefits accrue over long time horizons and across multiple actors.

Finally, the development of a new export-oriented industrial system requires institutional and delivery capability that markets do not supply. Coordinating planning, approvals, infrastructure development, workforce formation and engagement with international partners requires

sustained public capability. This matters particularly because large-scale green iron exports will develop alongside the transition of customer steel industries, above all China's, as iron-making is separated from steelmaking and imports of iron ore and coal are replaced by imports of iron. Customer steelmakers are likely to seek equity in Western Australian iron-making to manage supply risk and cost, much as Japanese and Korean buyers took equity in North West Shelf LNG. Government will need the capability to engage with customer governments and steelmakers on that transition, and to work with the Commonwealth on the trade and foreign investment settings it involves. The absence of such capability can delay projects, increase risk and reduce the effectiveness of otherwise sound policy settings (see section 8.6).

These system-level challenges heighten the importance of the form and timing of government involvement. Recognising the distinction between market failures and coordination and sequencing challenges is critical to designing interventions that are targeted, proportionate and effective. It will also inform which levels of government engage in which aspects of development of green iron industries. The Commonwealth will be well suited to particular roles such as large scale funding of the green premium and innovation support, while the states will have a more appropriate role in solving coordination and sequencing challenges. Importantly, the role of governments will be made more effective if there is coordination and alignment between the levels of government, as discussed in more detail in Chapter 9.

Box 16: System-level challenges

The development of green iron faces system-level challenges that markets are not designed to resolve:

- Lumpy and indivisible infrastructure that must be built ahead of demand
- Interdependencies across regions, technologies and time that require sequencing
- Institutional and delivery capability gaps that affect planning, approvals, coordination and engagement with customer economies.

These challenges shape how and when government should intervene. They require targeted coordination, capability and sequencing, not blanket subsidy or project selection.

5.3 Government has direct levers in place for industry development

This section recognises and catalogues the areas over which the Western Australian government can have major influence in the development of a green iron industry. The state also owns many of the businesses and agencies that deliver the infrastructure green iron depends on, including Western Power, Horizon Power, Water Corporation and the Pilbara and Mid West port authorities. Through these entities and its ultimate responsibility for energy

market structures, the state has direct influence over the cost and availability of energy, water, port and land access for green iron projects.

5.3.1 Coordination and shared infrastructure should attract, not substitute, private capital

Green iron requires simultaneous development of mining, ore processing, logistics, energy systems, water supply, hydrogen production, port facilities and environmental approvals. No single proponent can efficiently develop all of these systems alone. The central questions are what should be shared, how it should be governed and where public co-investment is justified.

In practice, infrastructure coordination involves aligning land access, planning, approvals, and infrastructure development across agencies and proponents to ensure systems are delivered in the right sequence, at the right time and at the right scale. Government must choose coordination structures, resource them adequately and empower them to deliver (see section 8.6). WA's primary role is enabling private investment through coordination, policy certainty and strategic infrastructure. There is a role for public financing, but it is not open ended. Public infrastructure investment should be guided by clear principles: it should address assets with public-good characteristics, reduce system-wide risk rather than project-specific risk, be scalable to future demand, and preserve optionality as technologies and markets evolve. Its timing and scale should align with credible private demand, avoiding premature overbuild while enabling early projects to proceed.

Common-user infrastructure makes most sense in the following areas:

Transmission: SWIS upgrades matched to industrial load growth, renewable energy zone connections and grid firming and storage coordination. Private investment in common-user transmission should be facilitated where public funding is constrained (that is, not insisting that Western Power own all common-user infrastructure associated with green iron), with public investment where the commercial case is insufficient for private proponents alone (see section 8.2).

Water: coastal desalination plants sized for multiple users, shared pipeline routes where projects cluster geographically and common treatment and recycling systems, reducing per-project capital and operating costs (section 8.3).

Ports: multi-user berths designed for green iron products and renewable energy infrastructure imports, common storage and blending facilities and shared ship loading equipment and marine services. Government co-investment or facilitation reduces the first-mover burden (section 8.3).

Roads and Rail: road infrastructure for the freight task of developing renewable energy assets, and rail and road to move ore and product from pit to processing to port (section 8.3).

Hydrogen (potentially): shared electrolyser facilities and hydrogen hubs, common pipeline networks and storage sized for collective demand, where commercial models are viable. Any public investment in hydrogen infrastructure would need to be conditional on demonstrated demand aggregation, credible offtake and cost-sharing arrangements among users (section 8.2).

Other systems are inherently project-specific: mine-specific extraction and primary processing, project-scale ore processing and pelletisation, on-site renewable generation and project-specific hydrogen use, although clustering, grid connection and shared hydrogen production may still offer benefits. The coordination role is to determine which systems benefit from sharing and to facilitate appropriate commercial and governance arrangements. Public investment should not be used to underwrite project-specific commercial risk or compensate for uncompetitive project economics.

Box 17: Shared vs project-specific infrastructure

Public coordination or co-investment is most appropriate where infrastructure:

- serves multiple current or future users
- reduces system-wide cost and first-mover risk
- preserves optionality as technologies and markets evolve
- has public-good or natural monopoly characteristics

Infrastructure is more appropriately project-specific where assets:

- are integral to a single proponent's commercial model
- do not benefit materially from shared use
- primarily affect project-level, rather than system-level, risk

The State's role is to distinguish between these categories and enable appropriate governance and financing arrangements, not to underwrite uncompetitive projects.

Priority actions could include targeting the development of designated SIAs for green iron, applying assessment frameworks to prioritise and coordinate regional activity, refining land allocation methodologies within SIAs to prevent land-banking, establishing transmission network planning aligned with industrial timelines, creating collaborative governance frameworks for common-user infrastructure financing and access.

5.3.2 Approvals and land-use mechanisms exist to streamline investment timelines

The Western Australian Government has implemented a range of reforms and institutional mechanisms to support the planning and approvals process for large, complex developments, including:

- **State Development Act 2025 amendments:** Reforms establishing State Development Areas (SDAs) with coordinated approvals, stronger ministerial coordination powers and explicit support for common-user infrastructure. SDAs enable strategic environmental assessment at a precinct scale, early project designation and more coordinated land assembly.
- **Office of the Coordinator General:** Established within the Department of Premier and Cabinet to provide senior-level coordination and accountability for major project delivery.

- **Department of Energy and Economic Diversification (DEED):** Institutional restructure creating a department with a clear focus on energy transformation and economic diversification, aligned with emerging industries such as green iron.
- **Strategic assessment provisions:** EPA strategic assessments for Strategic Industrial Areas, enabling streamlining of subsequent project-level approvals.
- **Green Energy Approvals Initiative:** Establishment of a dedicated team focused on approvals streamlining and cross-agency coordination.

Approvals complexity and timelines can delay or prevent projects regardless of economic viability or proponent capability. Transparent, streamlined approvals processes are critical to de-risking private investment.

Land use and spatial planning play a critical role in enabling green iron development at scale. Decisions about zoning, co-location of industrial activity, buffer management and cumulative environmental impacts can materially affect project feasibility and community acceptance. Strategic Industrial Areas and State Development Areas provide mechanisms to manage these issues at a precinct scale rather than on a project-by-project basis. Refining land allocation methodologies within SIAs to prevent land-banking would strengthen these mechanisms further.

When applied effectively, these reforms enable approvals to be coordinated at a precinct level, support early project designation and facilitate the planning and delivery of common-user infrastructure; section 8.5 sets out what this requires in practice.

5.3.3 Social licence and Traditional Owner partnership need to move beyond compliance

Community support and Traditional Owner participation are material considerations in planning and approvals for green iron development at scale. Projects that lack community support are more likely to face delays, legal challenge and reputational risk, regardless of their technical or economic merits. Native Title and heritage processes provide essential legal protections, but on their own are not designed to support industry-scale development involving multiple projects, common-user infrastructure and long development horizons. Current approaches tend to treat engagement as a late-stage approvals or compliance requirement rather than as an early and ongoing part of planning, which risks creating delays and conflict rather than supporting durable outcomes.

For communities, government has a role in establishing clearer frameworks and expectations for community engagement at a precinct and regional level. This includes supporting early engagement during planning stages, promoting consistent and transparent communication about industry development and impacts, and encouraging approaches that recognise local benefits alongside broader economic objectives. While proponents remain responsible for project-level engagement, effective community participation requires coordination, resourcing and leadership beyond individual projects.

For Traditional Owners, government's role is to support early involvement in planning, strengthening the capacity of Traditional Owner organisations to engage with complex projects,

and facilitate pathways for economic participation where appropriate. This includes consideration of partnership models that go beyond compensation, drawing on existing examples of effective Traditional Owner partnership, while ensuring cultural heritage is protected and respected (see section 8.5).

5.3.4 Workforce development must run ahead of demand, while market-shaping stays limited

Both levers concern how government prepares for a market that does not yet exist at scale. Workforce development requires early, sustained investment; market-shaping requires constraint.

Workforce. Green iron production requires skills that do not yet exist at scale in Western Australia. Capabilities in direct reduced iron (DRI) operations, hydrogen production and handling, advanced metallurgical processing and specialised maintenance extend beyond the State's current workforce profile, which is largely shaped by iron ore mining, LNG and construction. Projects cannot wait until final investment decisions to begin training; skilled workers must be available when facilities commission. A key principle is therefore to train ahead of demand, treating early investment in skills and training as foundational to industry development.

Government has a role in supporting workforce development as an industry-building function, while employers remain responsible for recruitment, on-the-job training and workplace conditions (see section 8.4).

Market-shaping. As green iron markets emerge, governments may consider a limited role in market-shaping tools such as standard-setting, facilitation of information flows, or limited government participation as an early customer or convenor. These tools are sometimes proposed to help signal demand, support learning, or bridge early coordination challenges. Hydrogen is the clearest example: producers may be reluctant to invest without assured demand, while potential users are unwilling to commit without confidence in supply. The coordination of hydrogen systems is addressed in section 8.2, and transitional pathways, including gas, discussed in section 5.5.

As noted in *GIPA*, one mechanism proposed to address these early coordination challenges is the use of green hydrogen certification. *GIPA* identified that green hydrogen certificates would help reduce the cost of green iron production and help overcome coordination challenges during the earliest phases of green hydrogen and green iron. Green hydrogen producers would earn tradeable certificates that could be purchased and surrendered by green iron producers anywhere in Australia. .

The role of such tools should nonetheless remain constrained. Direct government intervention in markets risks distorting investment signals, locking in particular technologies or locations prematurely and transferring commercial risk from proponents to the public sector and taxpayers. These risks are heightened by rapid technological change and significant uncertainty about future demand. Any market-shaping tools should be contingent, temporary, narrowly targeted and designed to taper as markets mature and private demand becomes clearer. They

should remain subordinate to more fundamental roles in coordination, infrastructure provision and workforce development.

5.4 Government intervention should shift as the industry matures

The appropriate role of government in supporting a green iron industry should evolve over time as markets, technologies and systems mature. The foundational phase of industry development is characterised by high uncertainty, limited coordination and incomplete enabling infrastructure. As the industry matures, private investment capacity increases and the role of government shifts accordingly.

In the foundational phase, government intervention is most effective when focused on resolving significant market failures, coordination, planning frameworks, enabling infrastructure and workforce development. These interventions reduce system-wide risk and uncertainty, allowing private proponents to make investment decisions with greater confidence.

As the industry scales, the emphasis may shift towards expanding shared infrastructure, supporting standards and regulatory frameworks, and facilitating private capital mobilisation. Direct intervention should reduce as markets deepen and supply chains mature.

In a mature industry, investment decisions are led primarily by markets. Government's role narrows to regulation, competition oversight and provision of public goods.

Poorly timed intervention can increase costs, lock in sub-optimal outcomes or crowd out private investment. Maintaining optionality and sequencing interventions in line with market and technology development is therefore critical.

Box 18: How the Government's role evolves over time

The appropriate role of government changes as the green iron industry matures:

- Foundation phase: resolve market failures, coordinate systems, enable learning and reduce first-mover risk
- Scale-up phase: support shared infrastructure, standards and workforce expansion
- Mature phase: step back as markets deepen, focusing on regulation, competition and public goods

Poorly timed intervention can increase costs or lock in sub-optimal outcomes. Sequencing intervention in line with readiness is therefore critical.

5.5 Assessing the role of gas in transition

This section assesses the case for gas-based pathways in green iron production. It distinguishes between public support and private commercial choices.

While natural gas plays a significant role in Western Australia's existing industrial and energy systems, its role in green iron development is inherently limited. Gas-based iron-making is unlikely to be globally cost-competitive, durable or consistent with long-term decarbonisation objectives, and should not be treated as a foundation for a "green" iron industry.

Any limited role for gas in electricity system reliability or transition management should be clearly distinguished from direct support for gas-based iron-making, which raises fundamentally different economic and emissions risks.

5.5.1 Why some proponents are considering gas-based pathways

Several green iron project proponents are considering the use of natural gas as part of an initial or transitional pathway towards lower-emissions iron production.

The rationale typically cited by proponents includes:

- **Near-term capital availability and cost:** gas-based direct reduction technologies are commercially proven and can be financed using established investment and contracting models.
- **Existing infrastructure:** Western Australia has an established gas transmission network and industrial users with experience in gas handling and operation.
- **Technology flexibility:** some furnace configurations are designed to operate initially on natural gas and transition to hydrogen over time, reducing perceived technical risk.
- **Emissions improvement relative to coal:** gas-based direct reduction can reduce emissions compared to coal-based blast furnace routes, particularly where combined with efficiency measures.
- **Operational learning:** proponents view early operation using gas as a way to build workforce capability, operational experience and supply-chain familiarity ahead of hydrogen deployment.
- **Hydrogen supply:** affordable green hydrogen is not yet available at the volumes early projects need and the supply chain to deliver it does not yet exist. For some proponents, gas provides a way to begin while hydrogen supply develops.

These arguments frame gas as a transitional input rather than a long-term solution, with proponents typically emphasising flexibility and future conversion to hydrogen-based production.

While it is a commercial matter for project proponents as to whether they choose to use natural gas for iron-making, there is a material risk that gas-based iron-making becomes a default option by drift rather than by design. Government support for gas-based iron-making, whether through infrastructure investment, concessional finance or policy accommodation, risks locking in emissions, weakening incentives for hydrogen deployment and delaying the development of competitive green iron pathways.

5.5.2 Allocating gas to iron-making carries real opportunity risk

Natural gas has historically played a significant role in the Western Australian economy, underpinning LNG exports, supporting power generation, chemical feedstock and process heat, and providing employment. This context matters precisely because it constrains the case for gas in green iron: domestic gas supply in Western Australia is limited in the medium to long-term and subject to reservation policy settings. Allocating gas to new large-scale industrial uses therefore involves material opportunity costs. These include potential displacement of gas from dispatchable power generation, reduced availability for existing gas-dependent industries such as alumina, critical minerals processing, chemicals and fertilisers (often where there are very few, if any, non-fossil fuel alternatives), and impacts on LNG export volumes.

Gas-based direct reduced iron also has implications for emissions accounting. Emissions from gas combustion would occur within Australia and count towards national and State emissions budgets, even where total lifecycle emissions may be lower than coal-based iron production overseas. This creates additional policy complexity for domestic decarbonisation pathways.

From a comparative advantage perspective, Western Australia's global strengths differ across energy sources. While gas prices in Western Australia are lower than in eastern Australia, they are higher than in jurisdictions such as the Middle East, where producers benefit from abundant low-cost gas and established gas infrastructure. Competing on gas-based iron production would therefore place WA in direct competition with regions that hold structural advantages in gas and have been producing gas-based DRI for decades.

By contrast, Western Australia's renewable energy resources, particularly solar and wind, are world-class. These resources underpin the State's potential to produce competitive green hydrogen at scale, providing a foundation for longer-term advantage in near-zero emissions iron production.

These factors shape the context within which gas-based pathways must be assessed, including the trade-offs involved in allocating scarce energy resources and the implications for Western Australia's long-term industrial positioning.

Natural gas may play a limited transitional role in early green iron projects as a purely commercial choice, where proponents determine it reflects current technology readiness, infrastructure availability and cost considerations, but without public financial support. In some contexts, gas may support reliability or reduce costs during initial stages of industry development.

However, gas does not provide a pathway to deep decarbonisation or long-term competitiveness in green iron production.

5.5.3 Public funding should be directed at green pathways

TSI does not consider gas-based pathways to be a strategic focus for public support in the development of a green iron industry in Western Australia.

While gas may be used by proponents as a transitional input on a commercial basis, directing public resources towards gas-based iron production would not align with Western Australia's long-term competitive advantage or emissions objectives. WA's enduring strengths lie in world-

class renewable energy resources and the potential to produce competitive green hydrogen at scale, rather than in natural gas supply. Public support aimed at green alternatives would assist to 'level the playing field' between gas and more sustainable energy sources.

From a public policy perspective, gas-based pathways also present material risks. These include the potential for technology and infrastructure lock-in, the diversion of scarce gas from higher-value or harder-to-abate uses and the dilution of limited public resources away from pathways that face genuine market failures and coordination barriers.

For these reasons, TSI's view is that public support should be prioritised towards green hydrogen-based pathways that position Western Australia for long-term competitiveness in near-zero emissions iron production. Gas-based iron-making may proceed where it is commercially viable without public support.

The more durable response to gas-start proposals is to address the constraint on hydrogen supply, through the coordination of hydrogen systems discussed in section 8.2.

5.5.4 Government role where proponents choose to start on gas

Where proponents choose to start on gas, or to use gas as a transitional input, that is a commercial decision for them to make and fund. Government does not need to set transition pathways, triggers or milestones. Support tied to green production, such as innovation support, green iron production credits and the HPTI, only pays for green iron or qualifying hydrogen. Projects are therefore rewarded for moving off gas without government managing that transition.

Government should not support the use of gas in iron production in Western Australia. There may be advocacy for government to fund gas infrastructure and to subsidise gas use in iron-making. Consistent with the strategic framework in this *Roadmap*, these proposals should be rejected. They divert resources from resolving market failures and undermine WA's long-term comparative advantage in near-zero emissions iron.

5.6 Targeting government effort to minimise risk and maximise impact

Government capacity to coordinate, invest and manage risk is finite. To maximise effectiveness, early intervention should be targeted where green iron projects are most likely to succeed with the lowest public risk and the greatest system-wide benefit.

Targeting should be guided by clear principles rather than predetermined outcomes. These include expected production costs, infrastructure intensity, technology readiness, the ability to leverage existing assets and the preservation of future options as markets and technologies evolve.

Targeting does not imply picking individual project winners or excluding regions from future development. Rather, it reflects the need to focus early coordination and investment where it can reduce risk, support learning and enable scalable outcomes. It also does not mean

deferring the long-lead enabling work in higher-cost regions. That groundwork should proceed in parallel, so those regions are ready as their projects advance.

These principles inform how the strategic framework is applied in practice. Their indicative application in the Western Australian context is set out in Chapter 6.

Box 19: Targeting Government effort does not mean picking winners

Early regional focus reflects differences in readiness, cost and coordination requirements, not predetermined outcomes.

Targeting Government's effort is about sequencing coordination efforts, infrastructure planning and capability-building where they can deliver the greatest system-wide benefit and learning, while preserving future options as technologies and markets evolve.

This approach does not exclude regions or projects from future development, nor does it imply endorsement of specific proponents. It provides a disciplined basis for allocating finite government capacity during early phases of industry formation.

5.7 Three principles should guide how support is applied

The strategic framework set out in this chapter is intended to guide decision-making where trade-offs are unavoidable and conditions are evolving. It does not prescribe outcomes or replace commercial judgement. Rather, it provides a consistent basis for prioritising State effort and assessing where intervention can deliver the greatest system-wide benefit.

Three principles should guide how the framework is applied in practice.

1. **Enable rather than substitute for private investment:** The State's primary role is to create the conditions under which private investment can proceed efficiently and at scale. This includes addressing market failures, reducing coordination barriers and providing clarity where markets alone cannot. State action should crowd in private capital, not replace it or socialise commercial risk without clear public benefit.
2. **Sequencing intervention based on readiness and risk:** Effective industry development depends on aligning intervention with technology maturity, infrastructure availability and market conditions. State effort should therefore be directed towards activities that are able to proceed under current conditions, while accelerating long-lead enabling work and supporting capability development where constraints remain. Sequencing reduces the risk of premature investment and enables learning over time.
3. **Preserve optionality and avoid lock-in:** Given uncertainty around technologies, markets and project pipelines, early policy choices should preserve flexibility wherever possible. This includes technology-neutral settings within near-zero emissions pathways, infrastructure designed for multiple users and pathways, and avoiding exclusive arrangements that constrain future options unless there is a clear and enduring public interest rationale.

Applied together, these principles support a measured, adaptive approach to industry development that maintains fiscal discipline and enables Western Australia to respond as conditions evolve.

Part IV

Applying the framework

Applies the strategic framework to Western Australia's regions and to individual projects.

In this part

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06.

Western Australia's Indicative Industry Development Trajectory

Chapter 6 overview

> The development trajectory is indicative: a guide to sequencing and focus, not a commitment to specific projects or locations
>
> Development depends on energy, water, ports, hydrogen, workforce and approvals, and on partnership with Traditional Owners and host communities
>
> Development moves through foundation, scale-up and maturity phases, with long-lead enabling work beginning early so later scale is not delayed
>
> The regions progress in parallel, and government's role shifts from enabling, to facilitating scale-up, to system stewardship

Together, these give government a basis for timing coordination and investment while keeping options open as markets and technologies evolve.

This chapter applies the strategic framework set out in Chapter 5 to the Western Australian context. It presents a view of how green iron development may unfold across locations and over time, based on current information about markets, technologies, infrastructure and regional characteristics.

6.1 Purpose and limits of an indicative trajectory

The trajectory described is not a commitment to specific projects or locations. It illustrates how government coordination and investment could be sequenced to minimise risk, support early success and preserve flexibility as markets and technologies evolve.

Actual development will depend on proponents and the commercial viability of their projects. The trajectory is expected to be refined as projects and markets develop and should therefore be understood as a guide to sequencing and focus, rather than being set in stone.

By setting out an indicative application of the strategic framework, this chapter is intended to support coherent decision-making as opportunities emerge, while maintaining optionality and avoiding premature lock-in. Subsequent chapters address how this approach can be translated into project assessment and delivery processes.

Government effort needs to reflect the interaction of multiple system dependencies, which are often the responsibility of separate agencies, regulators or GTEs. Some are physical, such as energy, water and ports. Others are social: partnership with Traditional Owners and the support of host communities. Understanding how these interact is key to timing and coordinating government resources for the planning and delivery of common-user infrastructure. Figure 11 illustrates the different green iron system elements. Table 5 summarises them.

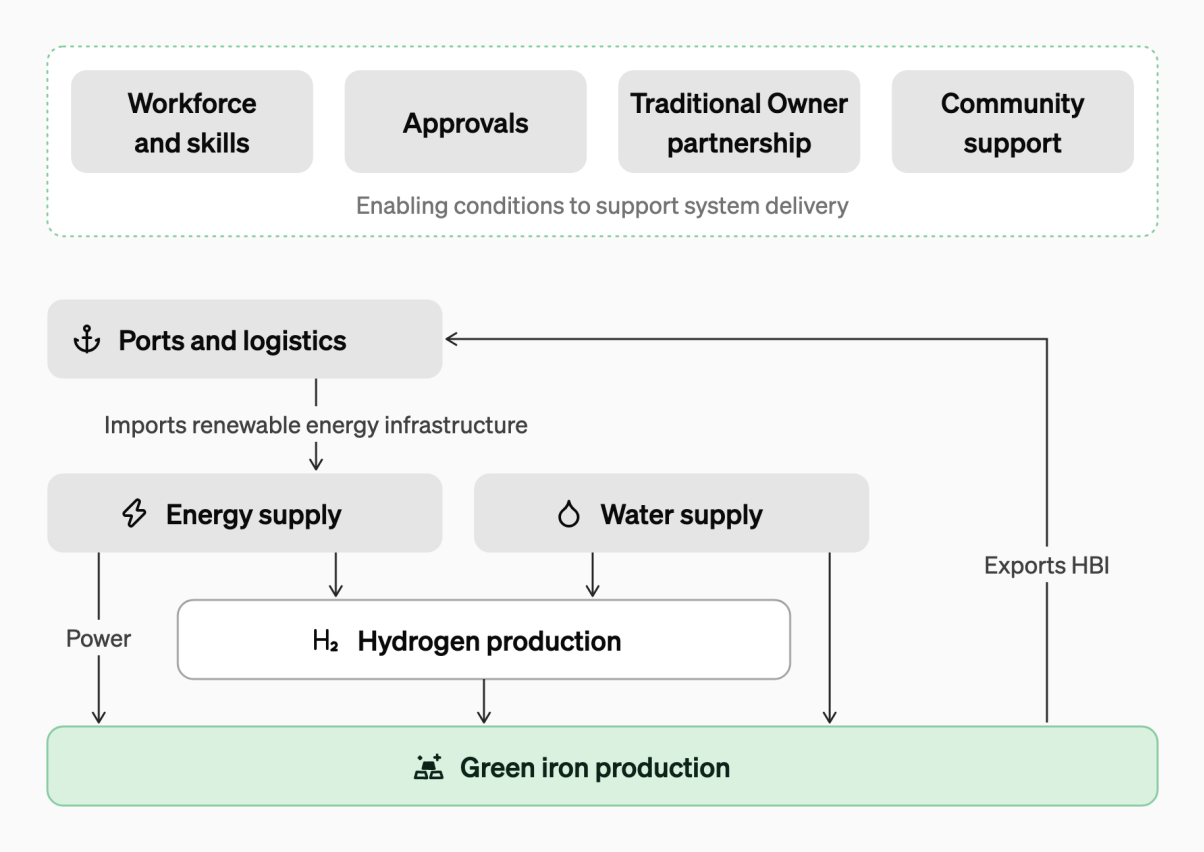


Figure 11: Green iron production system elements

Source: The Superpower Institute analysis.

Table 5: Green iron system dependencies and sequencing

System element	Dependency	Why this matters for timing
Energy supply	Access to firmed renewable generation and network capacity	Large industrial loads cannot be accommodated until generation, transmission and firming are aligned
Water supply	Desalination, pipelines and treatment systems have long lead times	Shared water solutions become more viable as multiple projects cluster
Ports and logistics	Export infrastructure must be designed for new products and volumes. Import infrastructure must be capable of supporting the inbound freight task associated with renewable energy generation.	Early projects may access limited existing capacity; later projects face higher costs without coordination of port upgrades
Hydrogen production	Electrolysers, storage and pipelines depend on energy, water and land	Simpler, modular configurations are more feasible before systems mature
Workforce and skills	Specialised operational skills are scarce	Training and capability must precede large-scale deployment
Approvals	Environmental, planning and heritage approvals; cumulative impacts increase as development scales	Precinct-level planning and strategic assessment reduce delay and conflict
Traditional Owner partnership	Agreements on land access, heritage protection and participation, including equity and benefit-sharing, take time to build and should reflect Traditional Owners' own priorities	Partnerships formed early, including for lighthouse projects, support durable outcomes and reduce the risk of delay as development scales
Community support	Host communities need clear information about impacts and benefits, and confidence that housing, services and local infrastructure can absorb new workforces	Early, regionally coordinated engagement builds support before cumulative impacts increase

6.2 Phases of industry development

Figure 12 summarises the three phases of industry development. Each phase relies on the dependencies in Table 5, including partnership with Traditional Owners and host communities. This applies even to a single lighthouse project.

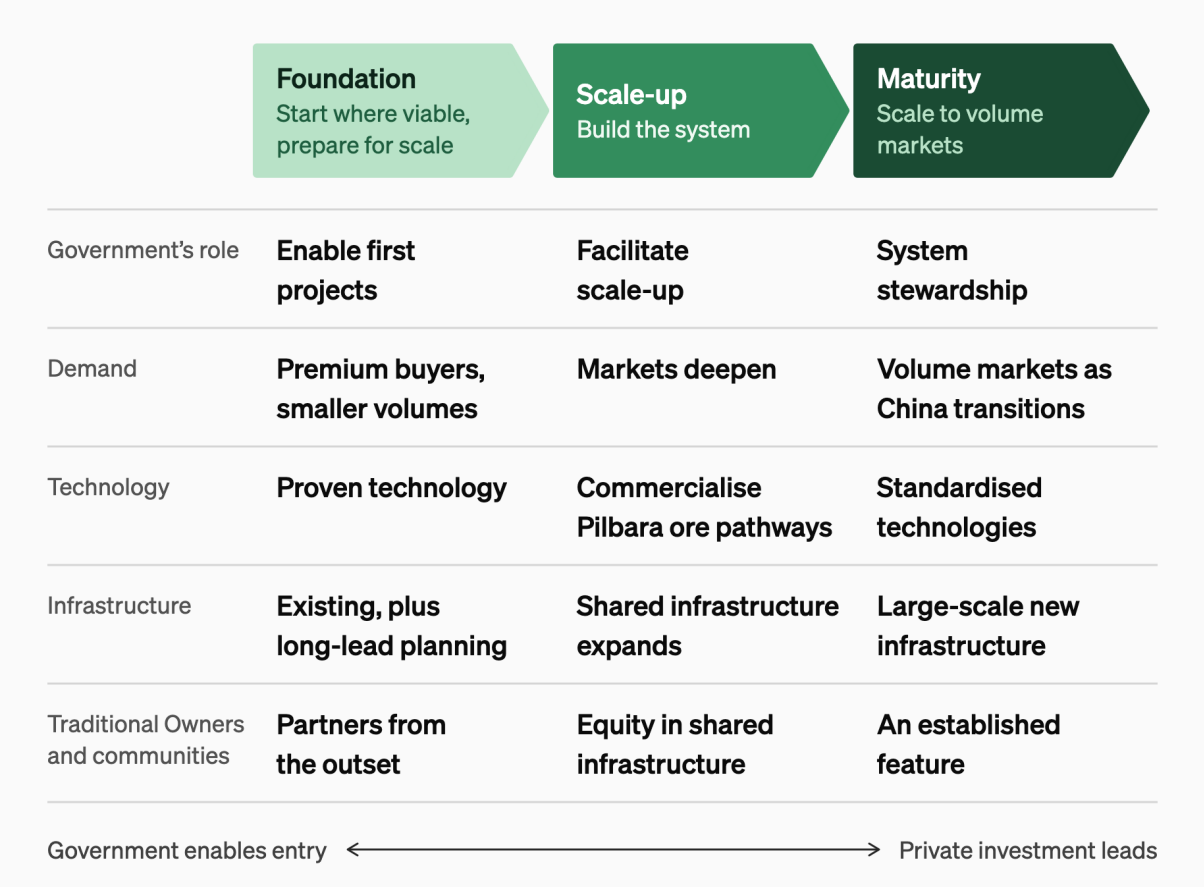


Figure 12: Phases of green iron industry development

Source: The Superpower Institute analysis.

6.2.1 Foundational development will locate where first-mover risk is lowest

Under current market and technology conditions, early green iron development is most likely to occur where "lighthouse" projects can proceed at smaller scale, rely on existing or readily adaptable infrastructure and use production pathways that are closer to commercial readiness. In this "start where viable" phase of development, uncertainty around future demand, technology costs and infrastructure utilisation remains high, increasing the importance of minimising system complexity and first-mover risk. Early demand is likely to come from high-value segments, such as automotive and advanced manufacturing supply chains, where buyers are more able to pay a premium for certified low-emissions iron (section 2.4). This favours smaller, certified volumes over scale.

Although early projects are smaller and less infrastructure-intensive, the enabling work for later large-scale deployment has long lead times. That groundwork, particularly in the more

infrastructure-intensive regions, should begin during this early phase in parallel with lighthouse projects, so that later scale is not delayed.

Early projects are likely to prioritise configurations that limit exposure to large, bespoke infrastructure investments and that can leverage existing energy systems, ports, workforce capability and regulatory pathways. Such projects can play an important role in building operational experience, developing skills, informing standards and supporting learning across the system.

Even a single lighthouse project depends on more than technology and economics. It needs the support of host communities and early partnership with the Traditional Owners whose land and water it will use. Partnership models that go beyond compensation, including equity in projects and common-user infrastructure, can build the trust that later scale will rely on (sections 5.3.3 and 8.5).

In this context, domestic-scale or capability-building activities may emerge alongside early export-oriented production. These activities can contribute to workforce development, technology learning and institutional capability, while reducing the risks associated with larger-scale deployment under conditions of high uncertainty.

6.2.2 Scale as markets deepen and technologies mature

As markets for low-emissions steel inputs develop and production technologies mature, the range of viable project configurations is expected to expand beyond early lighthouse applications. Improved clarity on demand, cost trajectories and standards reduces uncertainty and enables larger investments in enabling infrastructure and more capital-intensive production pathways.

In this phase, development can increasingly accommodate projects that require greater coordination across energy, water, logistics and port systems, as well as higher upfront capital expenditure. Learning from earlier projects supports more efficient infrastructure design, improved risk allocation and greater confidence among private investors. As development scales, cumulative impacts on land, water, heritage and communities increase, and precinct-level agreements with Traditional Owners, including equity and benefit-sharing in shared infrastructure, become more important.

Scaling green iron production under these conditions remains sensitive to intervention sequencing. The timing and scale of infrastructure investment, workforce development and planning decisions continue to influence costs and outcomes. Government coordination and investment therefore remain important, but the balance shifts toward facilitating system-wide scale-up rather than enabling initial entry.

6.2.3 Mature markets enable large-scale deployment

Under conditions of market maturity, green iron development is characterised by more standardised technologies, deeper markets, established supply chains and greater availability of private capital. Very large-scale production depends on the transition of major customer steel industries, particularly China's, which is likely to involve customer equity in iron-making (section 2.4). As that transition proceeds, large-scale production becomes increasingly feasible,

including in regions where development requires substantial new infrastructure and complex system integration.

In a mature market, the role of government narrows further. Investment decisions are led primarily by private proponents responding to market signals, while government focuses on system reliability, regulation, competition and long-term planning. Earlier investments in coordination, infrastructure and skills underpin the viability of large-scale deployment at this stage.

Maintaining flexibility and avoiding premature lock-in remain important throughout, as global demand, technology pathways and policy settings continue to evolve.

6.3 Regional roles across the phases of industry development

The phases described in section 6.2 will not unfold in the same way in each region. Each region's role reflects its ore type, infrastructure, energy systems and proximity to export facilities, as set out in Chapter 3. Table 6 summarises the expected role of the Pilbara, Mid West and South West in each phase, and the actions most likely to support it. Like the trajectory as a whole, it is indicative. It does not commit government to specific projects or locations, and it will be refined as real projects emerge.

The regions progress in parallel rather than in sequence. In the foundation phase, the Mid West is best placed to host first-of-a-kind projects using proven technology and existing infrastructure. Long-lead enabling work in the Pilbara, already underway, accelerates at the same time, so that the region is ready for commercial-scale hematite processing during scale-up and for volume exports at the maturity phase. The South West contributes throughout by building capability, testing technologies and developing the domestic market rather than producing green iron at scale. Across all three regions, government's role moves from enabling early projects towards system stewardship as private investment takes the lead, as discussed in section 6.4.

Table 6: Indicative regional roles across the phases of green iron industry development

Phase	**Foundation** Start where viable, prepare for scale	**Scale-up** Build the system	**Maturity** Scale to volume markets
Mid West	**Lighthouse projects** • Support 1–2 first-of-a-kind green iron projects using proven DRI technology, local ore, existing infrastructure and access to the WEM • Identify a location for a Mid West industrial hub and begin planning shared water, transmission and port infrastructure for later scale • Facilitate development of commercial models, supply chains, workforce and WA's credibility as a supplier • Engage Traditional Owners and the Geraldton community early on the location and design of a Mid West industrial hub *Existing port (Geraldton), road, rail and grid capacity may support the first 1–2 projects, subject to targeted upgrades*	**Build an industrial hub** • Coordinate activation of a Mid West industrial hub, leveraging existing Oakajee planning for port upgrades, large-scale desalination and pipelines, shared hydrogen infrastructure, transmission upgrades, and enhanced road and rail • Deploy financing models to crowd in private capital for infrastructure delivery • Extend Traditional Owner equity and benefit-sharing to shared infrastructure *Maturing green iron trade unlocks investment in large-scale magnetite resources and renewable generation*	**Established production ecosystem** • Mid West hub and supply chains benefit from economies of scale, led by private investment *Product differentiation may mean the region competes less directly with the Pilbara*
Pilbara	**Prepare the ground for scale** • Coordinate activation of project-ready land, heritage approvals, transmission construction and access arrangements, and develop finance models for delivery • Continue supporting pilots and demonstrations of technologies suited to Pilbara hematite • Work with Traditional Owners on land access, heritage and partnership models for shared infrastructure *Small to mid-scale commercial projects may emerge in the region*	**Commercialise hematite processing** • Facilitate deployment of technologies suited to Pilbara hematite at commercial scale as they mature • Expand shared infrastructure as markets deepen, staged to allow later expansion for volume markets • Extend Traditional Owner equity and benefit-sharing to shared infrastructure *Off-grid energy, long-distance water and remote construction remain the key constraints on how fast the region scales*	**Volume green iron exports** • Pilbara iron ore production diverted from direct shipping to green iron for volume markets, drawing on established infrastructure • Affordable, export-scale renewable energy is enabled, and economies of scale reduce costs *Volume production is likely to be led by iron ore majors, customer steelmakers or partnerships between them.*

Phase	Foundation Start where viable, prepare for scale	Scale-up Build the system	Maturity Scale to volume markets
South West	**Pilot, demonstrate and build capability** • Continue to attract and support technology pilots and demonstrations at Kwinana • Develop workforce skills, social licence and a domestic market for green iron *No commercial-scale green iron production expected*	**Expand domestic production and capability** • Continue green steel market development • Expand the scope of technology demonstration *Innovation spillover from earlier projects reduces risk across all technologies and regions*	**Domestic market and technology hub** • Ongoing domestic green steel production as the market deepens *Supplies skills, technology and capability to the broader industry*

6.4 Implications for government coordination and investment

The indicative sequencing outlined in this chapter has clear implications for the focus and timing of government coordination and investment. In early stages, the priority is enabling: improving information, reducing barriers to entry and supporting capability development. As markets deepen, the emphasis shifts toward facilitating scale-up through coordinated infrastructure investment and workforce expansion. Under market maturity, government's role narrows to system stewardship, regulation and long-term planning.

The regional roles in Table 6 point to different priorities for government in each region during the foundation phase. In the Mid West, the priority is to resolve the specific constraints facing the first one or two projects, particularly grid connection, port access and water, while planning shared infrastructure for an industrial hub. In the Pilbara, it is to accelerate long-lead work on project-ready land, heritage approvals, transmission and finance models and to support demonstration of technologies suited to Pilbara ores. Some of this work is already under way, including planning for common-user transmission corridors under the Pilbara Energy Transition Plan and the Boodarie Strategic Industrial Area: the task is to accelerate it and set clear timeframes. In the South West, it is to support pilots, skills and a domestic market. These are different coordination problems, and they call for different responses rather than a single regional priority.

Across all stages, maintaining optionality is critical. Government coordination and investment should avoid prematurely locking in technologies, locations or production pathways and should remain responsive to information revealed through market engagement and project proposals. The next chapter sets out how this approach is reflected in project assessment and decision-making processes.

07.

Project Assessment Scorecard

Chapter 7 overview

> The scorecard gives government a consistent, transparent way to assess project proposals against the strategic framework and the phases of industry development
>
> Proposals are assessed on project fundamentals, strategic value and delivery capability applied holistically and without fixed weightings
>
> Assessment is iterative: proposals reveal information about costs, technologies and delivery capability that government cannot know in advance
>
> The scorecard is not a commitment to support projects, and does not replace commercial due diligence or regulatory assessment

The scorecard supports judgement; it does not replace it.

Government cannot support every green iron proposal, and it should not try to. Coordination capacity, infrastructure funding and senior leadership attention are finite. Chapter 5 argues they should be focused where they can reduce risk and deliver the greatest system-wide benefit. That means government will need to choose between projects. This chapter sets out a way to make those choices consistently, transparently and defensibly.

The project assessment scorecard adapts the due-diligence methods investors and project developers use to test a project's technical, commercial and delivery risks. It combines them with the tests public policy applies when prioritising public resources: whether support addresses a market failure, delivers benefits beyond the project itself and represents value for the State. The result is a tool that lets government assess proposals against the strategic framework in Chapter 5 and the industry development phases in Chapter 6 and explain the basis for its decisions to proponents and the public.

The scorecard does not prescribe weightings between criteria. The relative importance of each will depend on government's priorities, the phase of industry development and the proposals received, and those judgements properly sit with government. The scorecard organises the evidence and makes the trade-offs visible. It informs decisions; it does not make them. The detailed criteria and indicative considerations are set out in Appendix E.

7.1 Purpose of the scorecard

As green iron development emerges under conditions of uncertainty, government will benefit from a structured and transparent way to assess project proposals and inform coordination and investment decisions. The scorecard provides a consistent basis for evaluating proposals against strategic framework described in Chapter 5 and to be informed by the indicative sequencing outlined in Chapter 6. It supports decision-making by organising relevant information, clarifying trade-offs and ensuring alignment with long-term objectives, while remaining responsive to market-led proposals.

The scorecard does not constitute a commitment to support particular projects or locations, nor does it replace commercial due diligence or regulatory assessment. It is intended as a decision-support tool rather than a mechanistic ranking or funding formula.

7.2 Application of the scorecard

The scorecard can be applied to project proposals received through tender processes, expressions of interest or other engagement mechanisms. Proposals submitted by proponents reveal information about costs, technologies, locations and delivery capability that cannot be determined in advance by government.

Assessment is therefore iterative. As markets develop and information improves, the application of the scorecard can evolve to reflect changing conditions, technology maturity and strategic priorities. The scorecard is a tool that will assist with decisions about coordination, sequencing and the potential role of government support, rather than determining outcomes in isolation.

Final decisions are made in the context of broader policy, regulatory and fiscal considerations. The scorecard supports judgement; it does not replace it.

7.3 Assessment criteria

Assessment criteria are structured to reflect the strategic objectives of the *Roadmap* and the role of government in enabling a green iron industry. At a high level, these criteria consider:

- **Project fundamentals:** technology readiness, site access, infrastructure, hydrogen supply, offtake and project-on-project risk.
- **Strategic value:** alignment with government priorities, economic and fiscal impact, carbon reduction and shared infrastructure benefits.
- **Delivery capability:** financial viability, government support requirements, social licence, Traditional Owner partnerships and governance.

The criteria are intended to be applied holistically rather than as a checklist. No single criterion is determinative, and strong performance in one area may not compensate for fundamental weaknesses in others. Further detail on the assessment criteria in the scorecard is contained in Appendix E.

The criteria are intended to be applied holistically rather than as a checklist. No single criterion is determinative, and strong performance in one area may not compensate for fundamental weaknesses in others. Further detail on the assessment criteria in the scorecard is contained in Appendix E.

Table 7: TSI Green Iron Scorecard criteria

Domain	Criteria
Domain 1: **Project fundamentals**	Technology readiness and technical credibility, including ore type Land tenure and site access Access to existing infrastructure Hydrogen supply pathway Market positioning and offtake security Project-on-project risk management
Domain 2: **Strategic value**	Strategic alignment with government priorities Economic leverage and fiscal impact Clear and transparent carbon reduction pathways Infrastructure coordination and shared benefits
Domain 3: **Delivery capability**	Financial viability and capital structure Government support requirements Community engagement and social licence Traditional Owner partnerships Environmental and social governance (ESG)

7.4 Weighting and trade-offs

Trade-offs are inherent in assessing complex projects under uncertainty. Projects may perform well on some dimensions while presenting challenges on others, particularly in early phases of industry development.

For this reason, the scorecard does not rely on fixed weightings or thresholds. The relative importance of different criteria may vary depending on market conditions, technology maturity and the phase of industry development. This flexibility allows assessment to reflect evolving priorities while remaining grounded in the strategic framework. Setting the relative weight of criteria is a matter for government, and TSI makes no recommendation on weighting.

Explicit consideration of trade-offs supports transparent decision-making and helps ensure that government intervention remains proportionate and targeted.

7.5 Governance and transparency

Clear governance arrangements are essential to the effective use of the scorecard. Roles and responsibilities for applying the scorecard, advising decision-makers and coordinating across agencies should be clearly defined.

Transparency in the assessment process supports confidence among proponents and stakeholders. While commercial confidentiality must be respected, clarity about assessment principles, criteria and decision rationale is important to maintaining credibility and consistency.

7.6 Relationship to implementation and delivery

The project scorecard informs subsequent coordination, investment and delivery decisions. Insights from assessment processes can also inform refinement of the strategic framework over time, as markets develop and experience is gained.

The following chapter addresses how assessment outcomes are translated into delivery, coordination and partnership arrangements, ensuring alignment between strategic intent and practical implementation.

Part V

Delivery and action

Focuses on implementation: infrastructure, coordination, partnership and near-term priorities.

In this part

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08.

Enabling Infrastructure and Coordination

Chapter 8 overview

> Transmission planning, hydrogen supply and shared water and port infrastructure are the critical enabling systems
>
> Coordination is a capability that must be rebuilt and maintained
>
> Infrastructure, workforce, approvals and engagement must move together
>
> The State needs the capability to assess co-investment and financing structures for shared infrastructure
>
> Without early coordination, first-mover risk rises and scale stalls

This chapter focuses on the delivery systems and enabling infrastructure required to support green iron development in Western Australia. It addresses the practical requirements for energy, water, ports, workforce, approvals and coordination capability to function effectively at scale. The chapter does not introduce new strategic priorities or sequencing decisions; rather, it sets out the system-level considerations that must be addressed to translate the strategic framework, indicative industry development phases and project scorecard into delivery on the ground.

Section 8.1 begins with Western Australia's track record of large-scale project delivery and the lessons it offers.

8.1 Western Australia's delivery capability and institutional 'muscle memory'

Western Australia has a long track record of delivering large-scale, complex industrial and infrastructure developments involving multiple interdependent systems, long time horizons and significant coordination challenges. Over successive resource and energy cycles, the State has developed institutional capability, which we call "muscle memory", in coordinating

infrastructure, managing approvals, sequencing investment and sustaining delivery capacity over decades rather than project cycles.

This experience does not eliminate the risks associated with green iron development, which involves new technologies, new markets and different system configurations. However, it does mean Western Australia is not taking this on from a standing start. The coordination, governance and delivery challenges identified in this *Roadmap* are familiar in form, even if novel in detail. Much of the capability that delivered past developments has atrophied, however, and will need to be rebuilt (Box 20).

A key lesson from past experience is that delivery capability must be deliberate and sustained. Effective coordination requires clear mandates, specialist expertise, adequate resourcing and senior leadership over long periods. Where these elements have been present, Western Australia has been able to manage complexity, reduce first-mover risks and enable private investment at scale. Where they have not, costs and delays have followed. The challenge for green iron is therefore not simply one of ambition, but of applying this institutional muscle memory to a new industrial context.

TSI has developed the “muscle memory” concept in a separate publication. The key findings are captured in the following text box.

Box 20: Learning from WA’s Industrial Development History

Iron ore development showed that:

- Investment certainty can unlock rapid, large-scale development
- Private capital can deliver complex infrastructure in remote regions
- State Agreements can mobilise speed and scale
- But fragmented, project-by-project infrastructure creates inefficiencies
- Regulatory rigidity, inconsistent Traditional Owner outcomes and asset duplication increase long-term costs
- Value-adding and system optimisation can be missed

LNG development demonstrated that:

- Government *can* and *did* back projects of strategic importance
- Coordinated planning enables multiple projects to proceed efficiently
- Common-user infrastructure benefits from innovative financing
- State investment in shared enabling infrastructure reduces risk
- Early offtake agreements provide long-term investment certainty

Key lesson: Western Australia’s success has depended on the State’s willingness to make deliberate, strategic project decisions and to coordinate infrastructure, approvals and risk around them. Much of that institutional ‘muscle memory’ has atrophied. Rebuilding this capability is essential to delivering a green iron industry at scale.

Section 8.6 sets out what rebuilding the capability requires, including the critical success factors that coordination arrangements must meet.

8.2 Energy systems

Energy systems are a fundamental delivery requirement for green iron production, encompassing electricity generation and networks, firming and storage and hydrogen production, transport and storage. The scale and reliability of energy supply required for green iron exceed those of existing industrial activities in Western Australia, creating delivery challenges that must be addressed through system-level planning and coordination.

Electricity systems must be capable of supporting large, continuous industrial loads while integrating high levels of renewable generation. This raises issues relating to transmission access, system strength, network augmentation and the coordination of industrial demand with renewable energy zones. Both grid-connected and dedicated energy supply models may be relevant in different contexts, with implications for network planning and regulatory arrangements.

Current transmission planning and information provision are not well aligned with the needs of industrial developments of this scale. Proponents often have limited visibility of system capacity, upgrade pathways, connection processes and cost allocation. This uncertainty shifts risk onto proponents at the earliest stages of development, raises the cost of capital, penalises early movers and makes it harder to coordinate generation, network investment and industrial demand. It can delay or deter otherwise viable projects. Improving transmission transparency, planning alignment and access frameworks is therefore a core delivery requirement, not a technical detail. As owner of Western Power and Horizon Power, the State has direct means to act on it, in addition to its work through government departments. TSI's modelling shows that the lowest-cost connection size varies widely with a project's technology and operating profile, so connection planning needs to be done with proponents rather than assumed.

Hydrogen supply is one of the most significant constraints on early green iron projects. Affordable green hydrogen is not yet available at the volumes projects need. Producers are reluctant to invest without committed demand, while iron producers are reluctant to commit without secure supply (section 5.3.4). Hydrogen systems also add delivery complexity, including the location and scale of electrolysis, access to water and electricity, storage requirements and potential pipeline networks. These elements are interdependent and require coordinated development to avoid inefficiencies or stranded assets. The barriers are significant but not insurmountable. Hydrogen-based pathways remain the *Roadmap*'s preferred route and coordinated planning of supply, storage and demand is how they can be achieved.

Across both electricity and hydrogen systems, the key delivery challenge is coordination. Generation, networks and industrial load must be planned together, and scheduling must reflect realistic delivery timelines and system constraints. From a delivery perspective, improving transmission planning, access frameworks and information transparency is therefore integral to effective coordination. Effective coordination reduces risk for proponents and supports efficient investment in enabling infrastructure.

8.3 Water and transport coordination can benefit many

Applying the principles in section 5.3.1, water, port, road and rail infrastructure are among the strongest candidates for shared, coordinated delivery: they involve high capital intensity, long development timelines and strong public-good characteristics. This section sets out the delivery challenges each presents.

Water requirements for green iron production are significant and are most likely to be met through desalination, recycling and shared pipeline infrastructure. Where projects cluster geographically, shared water systems can reduce costs, improve efficiency and limit environmental impacts compared to project-by-project solutions. Delivery challenges include site selection, environmental approvals, pipeline corridors and governance arrangements for shared assets.

Port infrastructure is similarly central to delivery. Green iron production requires port facilities capable of handling new products, storage configurations and shipping requirements, as well as imports of renewable energy infrastructure. Delivery challenges include designing multi-user berths, storage and ship loading facilities that can expand as volumes grow and agreeing access and governance arrangements among users.

For both water and ports, the delivery task is to make decisions set out in section 5.3.1 (which assets should be shared, how they should be governed, and where public involvement may be required) early enough, and specifically enough for each precinct, to enable timely development. Clear coordination and governance arrangements are critical to avoid duplication, delays and inefficient investment.

Roads and rail will be required at two stages: first, to support the freight task of constructing energy generation and transmission assets, including reconfiguration of existing roads to accommodate turbine blades; and later, to move ores to processing facilities and green iron product to port for export.

8.4 Workforce and skills readiness before demand

Green iron production requires skills that are not currently available at scale in Western Australia, including expertise in direct reduced iron operations, hydrogen systems, advanced process control and specialised maintenance. Training programs, facilities and industry–education partnerships require lead times that are often longer than project development cycles, so workforce development must occur ahead of demand (section 5.3.4).

Government's role is to support workforce pipelines and training systems as an industry-building function, while employers remain responsible for recruitment, on-the-job training and workplace conditions. This could include enabling training pathways in DRI operations and maintenance, hydrogen systems, process control and metallurgy, electrical and instrumentation skills, environmental monitoring and industrial safety. Training infrastructure may include TAFE programs with green iron specialisations, university education and research programs, industry-led training partnerships and, where appropriate, shared training or demonstration facilities.

Workforce planning should focus on building scalable and adaptable capability rather than matching individual projects. This requires coordination with industry to understand emerging skill needs, investment in training provider capability and equipment and support for pathways including apprenticeships, graduate programs and, where necessary, targeted international recruitment for highly specialised roles. Workforce housing and services in regional centres such as Geraldton and Karratha will also need to be planned ahead of demand, as accommodation constraints can limit both construction and operational workforces. Planning must also remain adaptable to evolving technologies, dynamic project pipelines and market conditions.

The main delivery challenges are aligning training capacity with emerging demand, ensuring skills are portable across projects and coordinating industry and government investment in training infrastructure. Structured engagement with proponents (section 8.6) can help match training capacity to the project pipeline as it emerges. The Commonwealth's skills, migration and higher education levers (section 9.3) should be aligned with State effort through a jointly developed workforce strategy (section 9.4).

8.5 Approvals, community and Traditional Owner engagement are important pre-conditions

Approvals processes, community engagement and Traditional Owner participation are critical delivery enablers that directly affect project timelines, risk and social licence. For large-scale green iron development involving common-user infrastructure and cumulative impacts, project-by-project approaches are often insufficient.

Effective engagement must begin well before individual projects reach the approvals stage. Building community understanding of (and active participation in) Western Australia's green industrial transition requires early investment in narrative, economic literacy and cultural relationships at a regional level. This pre-project foundation shapes the conditions under which individual projects can proceed with confidence and broad support.

Nature-positive requirements, covering impacts on critical, vulnerable and endangered species, land use and ecosystem integrity, are gaining traction in green commodity markets globally, as customer requirements, consumer campaigns and investor due diligence expand beyond carbon. Western Australia's green iron industry will need to demonstrate high environmental standards in both the Mid West and the Pilbara, where development is likely to occur in areas of ecological sensitivity. Proponents and government should treat nature-positive considerations as an integral part of project planning and approvals from the outset, rather than a late-stage compliance requirement.

Environmental standards should be treated as a floor, not a ceiling. Green iron's credentials depend not only on emissions performance but on demonstrated commitment to restoration, landscape integrity and biodiversity outcomes. Streamlining approvals should mean removing duplication and delay, not weakening environmental rigour.

While recent reforms have improved coordination and efficiency (section 5.3.2), large-scale green iron development will place sustained pressure on planning, environmental assessment

and land access systems. When applied effectively, these reforms enable approvals to be coordinated at a precinct level, support early project designation and facilitate the planning and delivery of common-user infrastructure. Strategic and precinct-level approaches can help manage cumulative impacts and reduce duplication but require consistent implementation and resourcing. Clear timelines, coordination across agencies and alignment between strategic assessment and project-level approvals remain important to maintaining confidence and reducing avoidable delays as green iron development progresses.

Community engagement and Traditional Owner engagement are particularly important in this context. Early, transparent and regionally coordinated engagement can reduce conflict, improve outcomes and support durable development pathways. For Traditional Owners, this means participation as partners, including through equity and benefit-sharing arrangements in common-user infrastructure and precincts, rather than consultation alone. Frameworks that rely solely on late-stage consultation or compliance-based processes risk increasing delays and undermining confidence, even where projects are technically and commercially sound.

Clear and consistent industry engagement also supports more effective approvals and consultation processes, by improving information quality, aligning expectations and reducing duplication across projects operating within the same regions or precincts. From a delivery perspective approvals and engagement systems must function predictably and at scale. Delays, uncertainty or capacity constraints can become binding constraints on project delivery regardless of commercial readiness.

8.6 Coordination capability needs to be built, not assumed

The delivery of a green iron industry requires coordination across multiple systems, agencies and stakeholders over extended timeframes. No single proponent can efficiently manage the full set of interdependencies between energy, water, ports, workforce, approvals and community engagement.

Government coordination capability is therefore a core delivery requirement. This includes the ability to align planning across agencies, manage interfaces between common-user infrastructure and private projects and provide clear points of accountability. Different coordination models may be appropriate at different phases of industry development, ranging from enhanced use of existing structures to dedicated coordination units or independent facilitation arrangements.

What matters most is not the specific institutional form, but clarity of mandate, adequate resourcing and sustained senior leadership commitment. Coordination capability must also evolve over time, shifting from enabling early projects and managing uncertainty towards supporting scale-up and system optimisation as the industry matures.

Box 21: Critical Success Factors for Green Iron Coordination

1. Senior leadership commitment: Sustained political and executive support over project cycles

2. Clear mandate and accountability: Defined coordination responsibilities with appropriate authority

3. Authority to convene and escalate: Power to bring parties together and resolve blockers

4. Resources matched to role: Adequate staffing, budget and expertise

5. Regular stakeholder engagement: Structured industry-government dialogue mechanisms

6. Integration across levels: Effective State-Commonwealth coordination

7. Learning and adaptation: Regular review and adjustment as circumstances evolve

Without these elements, coordination efforts risk being ineffective or unsustained.

Western Australia is not starting from a blank slate in this regard. Previous industry advisory councils, regional working groups and structured industry–government forums established during earlier periods of industrial development have demonstrated the value of regular, disciplined engagement in improving information quality and delivery outcomes. While many of these arrangements were time-limited or sector-specific, they provide useful precedent for how government can remain informed by industry experience without ceding decision-making authority or creating standing governance bodies. The lesson from these past arrangements is not the need for permanence or formalisation, but the importance of maintaining structured channels through which delivery risks, sequencing constraints and emerging system pressures can be surfaced early and addressed pragmatically.

Building on this experience, effective coordination also depends on structured, ongoing engagement with industry. In emerging industries characterised by rapid learning, evolving technologies and uncertain markets, government cannot rely solely on static analysis or episodic consultation. Regular engagement with proponents and infrastructure providers is required to test assumptions, identify delivery constraints and understand how risks are evolving in practice.

Where industry engagement is ad hoc or reactive, information gaps persist and delivery risks are often identified too late. Conversely, disciplined and transparent engagement processes can improve information quality, support more realistic sequencing decisions and strengthen confidence in coordination frameworks, without implying project endorsement or preferential treatment.

The objective is not to create new governance bodies, but to ensure that coordination capability remains grounded in real-world project experience and that lessons from early developments are systematically incorporated into well-sequenced infrastructure planning and delivery

decisions over time. This learning and feedback function is central to maintaining effective coordination as the green iron industry evolves.

Without effective coordination capability, delivery risks increase, timelines extend and public and private investment is exposed to avoidable inefficiencies.

Box 22: Why coordination is central

The Challenge: Green iron requires simultaneous development of:

- Mining and ore processing
- Energy systems (renewable and hydrogen)
- Water supply (desalination for hydrogen)
- Port facilities (export capacity)
- Transport infrastructure
- Workforce and skills
- Approvals and regulatory pathways

Why Government Coordination is Essential:

- No single proponent can develop all systems alone
- Without coordination: duplication, competition for scarce resources, delayed timelines
- Risk: "valley of death" where initial projects succeed but pathway to scale stalls

Coordination enables shared infrastructure, reduced system-wide risk, orderly sequencing, multiple projects succeeding.

8.7 Investment risk literacy can mobilise capital

Green iron development places demands on capital that differ materially from previous resource projects in Western Australia. Projects involve higher upfront capital intensity, longer payback periods, greater exposure to technology and market uncertainty and stronger interdependencies with shared enabling infrastructure. These characteristics challenge conventional approaches to project finance and public–private interaction.

A central delivery challenge is the treatment of common-user infrastructure and shared systems. Energy, water, hydrogen and port assets may need to be developed ahead of demand and at a scale that exceeds the requirements of any single project. In this context, binary positions, in which infrastructure must be either fully publicly owned or entirely privately financed on a project-by-project basis, risk delaying investment, increasing costs or foreclosing viable development trajectories.

The role of the State is not to prescribe specific financing models, but to build the capability to assess and apply different investment structures in a disciplined way. This includes understanding how risk is allocated between proponents, infrastructure providers and government; how access and governance arrangements affect competition and future expansion; and where limited public participation may reduce system-wide risk without underwriting project-specific commercial outcomes.

Without this capability, delivery decisions risk becoming ad hoc, inconsistent or overly cautious, particularly where novel infrastructure or first-of-a-kind investments are involved. Developing robust internal processes for assessing capital structures, co-investment proposals and common-user infrastructure arrangements is therefore a necessary component of effective delivery, not an optional policy overlay.

Building this capability supports better coordination outcomes, improves confidence for private investors and enables the State to engage credibly with proponents and the Commonwealth on funding, financing and risk-sharing arrangements as the industry evolves.

09.

Commonwealth Partnerships

Chapter 9 overview

> Key levers sit with the Commonwealth: production and investment support, large-scale infrastructure co-investment, trade and standards, foreign investment review, export finance, research funding and skills and migration settings
>
> Commonwealth support should correct market failures, so it should be targeted, time-limited and conditional, tapering as costs fall and markets deepen
>
> Commonwealth support is essential but not sufficient: success also depends on Western Australia's coordination capability, effective use of State levers, sound projects and industry commitment

Green iron needs effective Commonwealth–State partnership, with priorities and roles that evolve as the industry develops.

This chapter outlines the policy instruments through which the Western Australian Government may partner with the Commonwealth to support the development of a green iron industry, where the conditions identified in Chapter 5 justify government intervention. It focuses on instruments that address market failures and coordination challenges that cannot be resolved by either level of government acting alone, including production and investment support, infrastructure co-investment and complementary measures relating to research, trade and skills. The chapter does not propose specific commitments or funding allocations; rather, it identifies areas where coordinated Commonwealth–State action can reduce risk, improve efficiency and support industry development in line with the strategic framework and indicative industry development trajectory set out earlier in this *Roadmap*.

9.1 Early Commonwealth production and investment support to address market failures

Production and investment support is primarily a Commonwealth lever, because the instruments that close the cost gap between green iron and fossil-based iron sit largely at the national level. The core problem is an unpriced carbon externality identified in section 5.1. Where global markets do not yet price emissions, green iron can cost more to produce than the incumbent product it replaces, even when a project is technically sound and well located.

Production and investment support is most relevant where this gap, together with first-mover risk and learning spillovers, prevents otherwise viable projects from proceeding.

Two kinds of support matter here. Production incentives reduce the ongoing cost gap and improve the bankability of early projects. Investment support, such as capital grants and risk-sharing arrangements, lowers the upfront capital burden that falls heaviest on first movers. The Commonwealth's $1 billion Green Iron Investment Fund, announced in 2025 as part of the Future Made in Australia agenda, is the principal existing instrument of this kind. Its National Development Stream provides at least $500 million in competitive grants to de-risk early-mover capital investment in commercial-scale green iron production and to crowd in private investment. It targets projects ready to begin commercial-scale production by 2031, with successful applicants required to reach a final investment decision within 18 months of contract execution. Applications to the first round closed in January 2026. These timeframes align closely with the foundation phase set out in Chapter 6, making the Fund directly relevant to Western Australia's first lighthouse projects. These are levers the State does not hold at the required scale, which is why Commonwealth participation is central rather than supplementary.

Support should be designed to correct market failures rather than to subsidise production indefinitely. Consistent with sections 5.4 and 5.7, it should be targeted, time-limited and conditional, tapering as costs fall, markets deepen and the carbon price signal in export markets strengthens. It should also be available to viable projects on their merits across all three regions, rather than favouring a single location. Because the cost gap is widest in more infrastructure-intensive regions, well-calibrated support can allow projects there to advance in parallel rather than wait, while lower-cost projects proceed with lighter assistance. Commonwealth support, including Green Iron Investment Fund grants, and State support, such as enabling infrastructure, can be combined predictably without duplicating effort or over-compensating individual projects. Judging how the two combine on a given project depends on the State's capability to assess capital structures and co-investment proposals (section 8.7).

Box 23: The Commonwealth has production support levers the State lacks:

- Hydrogen Production Tax Incentive (HPTI) for green hydrogen
- Hydrogen Headstart: funding halved to $1 billion in the 2026–27 Budget; two WA projects in the Mid West and Pilbara are on the Round 2 shortlist
- Potential Green Iron Production Tax Credit (if adopted)
- Capital grants for early movers, including the Green Iron Investment Fund, and other co-investment vehicles
- Risk-sharing mechanisms for early projects

Commonwealth support for production incentives would assist to de-risk first-mover projects and bridge cost gaps to commercial viability.

9.2 Infrastructure co-investment for public benefit

Infrastructure co-investment is a central area for Commonwealth–State partnership. The energy networks, water systems, hydrogen infrastructure and port facilities that green iron requires are capital intensive, long-lived and often shared (sections 5.2 and 5.3.1), and their scale can exceed what the State can efficiently fund alone.

In such cases, coordinated public investment can reduce duplication, lower system costs and improve investment timing. Commonwealth participation may be particularly relevant where infrastructure supports nationally significant industrial development, contributes to emissions reduction objectives or complements broader energy and industrial policy settings.

Consistent with the principles outlined in section 5.3.1, infrastructure co-investment should focus on shared assets, clear public benefits and governance arrangements that support efficient access and use and should not underwrite project-specific commercial risk. Public involvement is not a default position; rather, it should be considered where commercial incentives are insufficient to deliver timely investment despite strong system-wide benefits. The State's capability to assess co-investment proposals (section 8.7) will shape how effectively it can engage the Commonwealth on these arrangements.

Box 24: Commonwealth Infrastructure Co-investment Levers

The Commonwealth has unique capacity for large-scale infrastructure co-investment through:

- National Reconstruction Fund (NRF)
- Northern Australia Infrastructure Facility (NAIF) (for Pilbara projects)
- Rewiring the Nation fund
- Clean Energy Finance Corporation (CEFC)

Indicative areas where Commonwealth co-investment may be required include:

- Shared transmission infrastructure
- Port capacity expansion and transport infrastructure funding
- Common-user water infrastructure
- Hydrogen production and storage infrastructure

9.3 Research, development, trade and skills actions should be complementary

Research, development, trade engagement and skills formation represent complementary areas where coordinated Commonwealth–State action can support green iron development by addressing information gaps, capability constraints and market-building challenges.

Established technologies suit magnetite, but technologies for Pilbara hematite are still being demonstrated (section 3.3.1). Research and development can also support improvements in efficiency, integration and emissions measurement, particularly as production scales and standards evolve. Commonwealth research funding and institutions play an important role in this landscape, alongside state-based initiatives and industry partnerships. ARENA is already co-funding demonstration projects relevant to Pilbara ores, including Calix's ZESTY plant (section 3.2.4).

Box 25: Commonwealth Support for R&D

The Commonwealth funds research through ARENA and CSIRO. Priority areas for Commonwealth support could include:

- Ore processing and beneficiation for Pilbara ores
- Direct reduced iron technology advancement
- Hydrogen production and storage optimisation
- Emissions reduction pathway validation
- Integration of renewable energy and industrial loads

Trade engagement and standards development are similarly important to the emergence of green iron markets. Coordination between Commonwealth trade policy, international engagement and domestic industry development can help ensure that definitions, certification and market access arrangements support credible and competitive exports.

Foreign investment settings will also shape how the industry develops. Very large-scale green iron exports are likely to involve equity from customer steelmakers, including in China, as they seek to secure supply and manage the cost of iron (Chapter 2). Foreign investment in Australian iron-making and related infrastructure is subject to Commonwealth review, including national interest considerations. Early engagement between proponents, the State and the Commonwealth can help ensure these settings are understood well in advance and that investment proposals are assessed predictably.

Box 26: Commonwealth leadership on Trade and International Engagement

Commonwealth leads on:

- International trade agreements and market access negotiations
- Participation in international standards development
- Export finance through Export Finance Australia
- Trade promotion and buyer connections
- Foreign investment review, including national interest considerations

Commonwealth can provide leadership and support to:

- Negotiate market access for green iron products
- Ensure WA production pathways recognised in international standards
- Provide export finance for long-term contracts
- Assist state government economic diplomacy initiatives, trade missions and buyer relationships

Skills development also benefits from coordination across jurisdictions. Section 8.4 sets out the State's role in building workforce pipelines ahead of demand, but several levers that determine whether that effort succeeds sit with the Commonwealth (see Box 27). Aligning national skills, migration and higher education settings with State training effort, through the jointly developed workforce strategy identified in section 9.4, can help ensure specialised skills are available when the first facilities commission.

Box 27: Skills and Workforce

Commonwealth has levers on:

- National skills frameworks and qualifications
- Migration settings and skilled worker visas
- University research funding
- National training programs

Priority Commonwealth actions could include:

- Align migration settings with green iron skills needs
- Support curriculum development through universities
- Enable interstate workforce mobility
- Co-fund industry-university partnerships

9.4 Effective partnership relies on aligned priorities, timing and roles

Commonwealth support is essential but not sufficient. Even with every Commonwealth request granted, green iron succeeds only if:

- WA delivers coordination capability
- State policy levers are deployed effectively
- Projects demonstrate commercial fundamentals
- Industry proponents commit capital and execute well

This requires effective partnership rather than dependence, and a shared understanding that priorities and roles will evolve over time. Near-term priorities could include:

- Establish Commonwealth-State coordination mechanisms
- Develop joint infrastructure investment proposals
- Coordinate on HPTI accessibility for green iron hydrogen
- Align on standards and certification approaches
- Co-develop workforce strategy

Medium-term priorities could include:

- Secure Commonwealth co-investment in priority infrastructure
- Achieve Commonwealth support for production incentives
- Establish export finance arrangements
- Coordinate on international market access

Ongoing priorities could include:

- Maintain policy alignment across governments
- Coordinate regulatory settings
- Share research and data
- Joint engagement with industry

10.

From Roadmap to Action

Chapter 10 overview

> Action can start now: near-term effort should support a small number of commercial-scale lighthouse projects, most likely one or two in the Mid West, where early development can proceed at lower risk
>
> Long-lead enabling work in the Pilbara should accelerate in parallel, so the region is ready for volume production as technologies for its ores mature and China transitions its steel industry
>
> Immediate priorities are scoping and coordinating enabling infrastructure, structured engagement with proponents and market-revealing processes such as tenders and expressions of interest, all of which depend on a rebuilt State coordination capability
>
> Large-scale infrastructure investment, long-term production support and location-specific commitments should remain conditional on market responses, so that government enables private investment rather than replacing it
>
> Key decision points will emerge as uncertainty reduces, not on a fixed timetable, with the Scorecard helping government weigh trade-offs as they arise
>
> In the foundation phase, success should be judged by whether the conditions for an industry are improving, with progress towards final investment decisions on the first projects the clearest indicator
>
> The *Roadmap* should be updated as markets, technologies and projects evolve
>
> Acting early within a clear direction, prioritising green hydrogen pathways and building effective Commonwealth–State partnership, while adapting as information improves, gives Western Australia the best chance of turning opportunity into industry.

This chapter brings together the strategic framework, indicative industry development trajectory, the project scorecard approach and delivery considerations set out earlier in this *Roadmap* to provide guidance on near-term focus, key decision points and adaptation over time. It highlights

how government can maintain momentum while managing uncertainty, preserving flexibility and responding to information as markets, technologies and projects evolve.

10.1 Priority actions can start immediately

In the near term, government effort is most effectively directed towards actions that will support a small number of green iron projects currently under development in the state. TSI's modelling suggests that early projects are most likely to proceed in the Mid West, where energy, water, port access, workforce and approvals can be aligned at lower risk and cost, and that one or two commercial-scale lighthouse projects are a realistic near-term objective. The demonstration effect and the broader knowledge generation from this could deliver significant benefits for Western Australia and support industrial decarbonisation.

Immediate focus should include scoping and coordinating enabling infrastructure, improving information flows through engagement with proponents and supporting processes that reveal market information, such as tenders and expressions of interest. These actions help clarify future options without pre-judging outcomes. Such engagement will likely reveal the gaps and opportunities for the WA Government to play a role in supporting the early projects that could establish the industry.

Long-lead enabling work in the Pilbara should accelerate in parallel. The Pilbara holds the greatest potential for volume production, but that potential depends on technologies suited to its ores maturing and on volume markets emerging as China transitions its steel industry. Coordinating project-ready land, heritage approvals, transmission and finance models now will allow the region to move quickly when those conditions are met.

Delivering these actions depends on rebuilding the State's coordination capability (Chapter 8) and on establishing Commonwealth–State coordination mechanisms early, including aligning State support with Commonwealth instruments such as the Green Iron Investment Fund (Chapter 9). Table 8 sets out the priority actions that can start immediately.

Table 8: Priority actions that can start immediately

Coordinating delivery		Who	Why now
01.	Establish and resource a coordination function with a clear mandate, authority to convene and escalate and sustained senior leadership.	WA Government	Every other action depends on it, and the capability has atrophied.
02.	Maintain structured, ongoing engagement with proponents and infrastructure providers.	WA Government	Improves information flows and surfaces delivery risks early.
Testing costs and demand		**Who**	**Why now**
03.	Use market-revealing processes, such as tenders and expressions of interest, and apply the Scorecard to proposals.	WA Government	Reveals costs, demand and project readiness before major commitments.
Preparing enabling infrastructure		**Who**	**Why now**
04.	Scope and coordinate enabling infrastructure for early Mid West projects and identify a location for a Mid West industrial hub.	WA Government	Early projects are most likely where infrastructure can be aligned at lower risk and cost.
05.	Align transmission planning with industrial timelines and improve information on capacity, connection and access for proponents.	WA Government	Transmission uncertainty raises the cost of capital and penalises first movers.
06.	Accelerate long-lead enabling work in the Pilbara: project-ready land, heritage approvals, transmission and finance models.	WA Government	Lead times are long, and the region must be ready when technologies and volume markets mature.
07.	Coordinate hydrogen supply planning with early green iron projects, including links to Commonwealth hydrogen programs.	WA Government and Commonwealth	Hydrogen supply is a binding constraint on early projects and supply decisions have long lead times.
Partnering with the Commonwealth		**Who**	**Why now**
08.	Establish Commonwealth–State coordination mechanisms, develop joint infrastructure proposals and align State support with Commonwealth instruments, including the Green Iron Investment Fund and HPTI and align on standards and certification.	WA Government and Commonwealth	Key levers sit with the Commonwealth and early-mover funding decisions are being made now.
Preparing communities and the workforce		**Who**	**Why now**
09.	Begin regional community and Traditional Owner engagement ahead of individual project approvals.	WA Government	Late-stage consultation risks delay and loss of confidence.
10.	Co-develop a workforce strategy with the Commonwealth and invest in training ahead of demand.	WA Government and Commonwealth	Training lead times are longer than project development cycles.

Equally important is clarity about what is *not* a near-term priority. Large-scale infrastructure investment, long-term production support and location-specific commitments should remain conditional on market responses and the evolution of demand, technology and project proposals.

10.2 Key decision points are not fixed but will emerge

As green iron development progresses, government will face a series of decision points relating to coordination effort, infrastructure investment and the potential use of policy instruments. These decisions should be informed by information revealed over time, including project proposals, cost data, technology performance and evidence of market demand.

Key decision points are unlikely to occur at fixed intervals or according to a predetermined sequence. Instead, they arise as uncertainty reduces and options become clearer. Maintaining flexibility and avoiding premature commitment is therefore critical. This places a premium on decision-making processes that can incorporate new information without locking in pathways too early.

While their timing cannot be fixed, the likely decision points can be identified, along with the information that should trigger them. Indicative examples include:

- committing to shared infrastructure for a Mid West industrial hub, once one or two projects have secured offtake and are progressing towards FID
- committing to common-user transmission and precinct infrastructure in the Pilbara, once technologies suited to Pilbara ores have been demonstrated at scale and proponents commit to the region
- designing State support alongside Commonwealth production and investment support, as Green Iron Investment Fund outcomes and Commonwealth production incentive settings become clear
- settling arrangements for hydrogen supply to early projects, as hydrogen producers and green iron proponents move towards investment decisions

The project assessment framework described in Chapter 7, the ‘scorecard’, plays a central role in supporting these decisions by organising information, clarifying trade-offs and ensuring alignment with strategic objectives. Judgement remains essential, particularly where decisions involve balancing near-term risk reduction against longer-term opportunities.

10.3 Early success should be judged by whether conditions are improving

Success in the foundation phase of green iron development should be assessed broadly and qualitatively, rather than through narrow or prescriptive metrics. Indicators of progress include evidence of market emergence, such as credible project proposals and offtake interest, improvements in coordination and delivery capability, workforce and skills development, and learning that reduces uncertainty for subsequent projects. Progress towards final investment

decisions on the first projects, and ultimately those decisions themselves, is the clearest single indicator.

Other indicators include progress in planning and approvals processes, the effective coordination of shared infrastructure and the ability to adapt policy settings in response to new information. These signals provide insight into whether the conditions for industry development are improving, even if large-scale outcomes have not yet materialised.

Indicators should be used to inform learning and adaptation, not as fixed targets or performance measures.

10.4 An adaptive approach to risk can manage uncertainty

The development of a green iron industry involves material risks, including uncertainty about global demand, technology cost trajectories, infrastructure delivery, workforce availability and social licence. These risks cannot be eliminated, but they can be managed through sequenced interventions, coordination and adaptive policy design.

An adaptive approach requires regular reassessment of assumptions, openness to new information and a willingness to adjust focus as conditions change. The strategic framework set out in this *Roadmap* provides a stable foundation for such adaptation, ensuring that changes in direction remain grounded in clear principles rather than ad hoc responses.

This *Roadmap* should therefore be understood as a living document. Its value lies not in predicting outcomes, but in supporting coherent, disciplined decision-making as Western Australia navigates uncertainty and opportunity in the development of a green iron industry.

Western Australia has the resources, the industrial history and the early projects to build a green iron industry. Whether it does will depend on acting early, coordinating deliberately and adapting as information improves.

Glossary of Terms

AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
Beneficiation	Processing ore to increase its iron content and remove gangue, for example by crushing, grinding and magnetic separation.
BF-BOF (Blast Furnace-Basic Oxygen Furnace)	The dominant global method for producing primary steel. A two-step process whereby iron ore is reduced to molten iron in a blast furnace (BF) using metallurgical coal as both a fuel and a chemical reductant. The molten iron is then refined into steel in a basic oxygen furnace (BOF). The BF-BOF is highly carbon-intensive, generating over 2 tonnes of CO_2 per tonne of steel.
BF-grade (Blast furnace grade)	Refers to iron ore with an iron content less than 66 per cent or more than 3.5 per cent combined silica and alumina as gangue. Because of the high gangue content these iron ores are conventionally treated in a blast furnace to separate the gangue from the molten iron.
Carbon Capture and Storage (CCS)	Technology for capturing carbon dioxide emissions, from fossil fuels combusted in power plants or industrial processes and storing them underground to prevent release into the atmosphere.
Carbon Price	A cost imposed on emitting carbon to incentivise lower emissions. A price on carbon helps shift the burden for the damage from emissions back to those who are responsible for it.
CBAM (Carbon Border Adjustment Mechanism)	The European Union's mechanism that applies a carbon price to certain imports, including iron and steel, from 2026.
CEFC	Clean Energy Finance Corporation
Common-User Infrastructure	Shared infrastructure where capacity is shared between multiple users under a defined set of terms.
Comparative Advantage	A country with comparative advantage can produce a good or service relatively more cheaply than others (more precisely, at lower opportunity cost), such that specialising in and exporting that product generates gains for all. Australia has a comparative advantage in renewable energy production in a decarbonised world.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEED	Department of Energy and Economic Diversification

DER (Direct Electrical Reduction)	Iron-making technologies that use electricity directly, rather than hydrogen, to reduce iron ore, such as low-temperature and molten oxide electrolysis.
DR-grade (Direct reduction grade)	Iron ore with an iron content above 66 per cent and less than 3.5 per cent combined silica and alumina, also referred to as DRI-EAF-grade. The low gangue content makes the ore suitable for producing direct reduced iron (DRI) that meets the quality specifications of an EAF.
DRI (Direct Reduced Iron)	A form of iron produced by reducing iron ore into iron at lower temperatures than in traditional blast furnaces, typically using hydrogen or natural gas. The process creates a porous, solid material known as 'sponge iron,' which can be melted in electric furnaces to make steel. DRI generally contains between 86 and 94 per cent iron with 3.9 to 8.4 per cent gangue. DRI is most commonly used in electric arc furnaces and often blended with scrap.
DRI-EAF	The direct reduction-electric arc furnace route, in which iron ore is reduced to DRI and then melted with scrap in an EAF to make steel.
EAF (Electric Arc Furnace)	A furnace that melts scrap steel or direct reduced iron (DRI) using electrical energy. EAFs typically use high-grade DRI, as they cannot efficiently remove impurities (gangue) from lower-grade iron.
EFA	Export Finance Australia
ESF (Electric Smelting Furnace)	A high-temperature, continuous-operation furnace that melts direct reduced iron (DRI) using electricity, enabling the removal of impurities (gangue) from lower and mid-grade iron ores. Unlike electric arc furnaces, ESFs can process ores with higher impurity levels and operate more like blast furnaces, with molten metal and slag removed without interrupting the process.
EPA	Environmental Protection Agency
Externalities (Positive/Negative)	The unintended side effects of an economic activity that affect others and are not reflected in market prices. Positive externalities (e.g. innovation spillovers) provide value to others, while negative externalities (e.g. pollution) impose costs on others.
FID (Final Investment Decision)	The point at which a project's owners commit the capital to build it.
FIFO	Fly-In, Fly-Out
Flexible and inflexible technology	Inflexible iron-making technology operates continuously at a steady rate. Flexible technology can vary its output to match variable renewable electricity supply.
FOAK (First of a Kind)	A project or facility deploying a technology at commercial scale for the first time. FOAK projects often face higher capital costs, technical risks and financing challenges compared to later, proven deployments.
Gangue	The non-iron material in iron ore, such as silica and alumina, which must be removed during iron-making to produce high-quality metal. Ores with high gangue

	content are considered lower grade and require more processing energy to extract usable iron.
Green Hydrogen	Hydrogen produced with renewable energy, generally powered by renewable electricity. To qualify for the Australian Government's HPTI, hydrogen must be produced with emissions of no more than 0.6 $kgCO_2e$ per kilogram of hydrogen.
Green Iron	Iron produced using renewable energy and/or green hydrogen, with near-zero emissions.
GIPA (A Green Iron Plan for Australia)	TSI's 2025 publication, *A Green Iron Plan for Australia,* which modelled green iron production in various locations around Australia, estimated the levelised costs of production, analysed global markets and identified the policy settings needed to allow Australia to produce green iron and play a major role in global decarbonisation.
Green Premium	The cost gap between carbon-intensive products and green equivalents.
Green Steel	Steel made using green iron and electric arc furnaces powered by renewable energy.
GTE (Government Trading Enterprise)	A Western Australia state-owned public entity that operates on commercial principles while advancing public benefit. Under the *Government Trading Enterprises Act 2023*, GTEs combine commercial business practices with ministerial oversight and public accountability.
Guarantee of Origin (GO)	The Australian Government certification scheme that tracks and verifies the emissions associated with producing hydrogen and renewable electricity.
HBI (Hot Briquetted Iron)	Refers to direct reduced iron (DRI) which has been pressed into a briquette, while still hot exiting the reduction process. Pressing the hot DRI into briquettes increases the density of the iron product from around 3.5 t/m3 to the required 5.0 t/m3 to meet shipping regulations. The stabilised HBI is suitable for storage and transportation over extended times and distances. The principal market for HBI is electric arc furnace steelmaking.
Hematite	An iron oxide ore mineral (Fe_2O_3); pure hematite has an iron content of nearly 70 per cent. Most of Australia's iron ore exports are hematite. Hematite is less amenable to magnetic beneficiation than magnetite but can still be used in a variety of iron-making technologies depending on grade.
HILT CRC	Heavy Industry Low-carbon Transition Cooperative Research Centre
HPTI (Hydrogen Production Tax Incentive)	An Australian Government refundable tax offset of $2 per kilogram for eligible hydrogen produced from 2027 to 2040, with emissions intensity of no more than 0.6 $kgCO_2e$ per kilogram.
LCOI (Levelised Cost of Iron)	The average cost to produce a tonne of green iron across a project's life, accounting for capital, operating and energy costs. It enables comparison of cost competitiveness across technologies and locations.

Lighthouse (project)	An early commercial-scale project that demonstrates the operational and commercial viability of green iron production in a new location or supply chain, building confidence for later investment.
LNG	Liquefied Natural Gas
Locational Capital Cost Factor	Capital costs vary by location because of differences in equipment, installation, fuel connection, land and development, and operations and maintenance costs. Locational capital cost factors are applied to capital costs to reflect the comparative cost of building and operating in distinct locations. For example, Australian capital cities have lower cost factors than regional towns because they have better access to materials, skilled workforce, and established supply chains.
Market Failure	When markets fail to allocate resources efficiently, due to incomplete property rights, misaligned incentives, and/or asymmetries in information. The non-pricing of harmful CO_2 emissions is a classic example.
Magnetite	An iron oxide ore mineral Fe_3O_4; pure magnetite has an iron content over 72 per cent. Australian magnetite ore typically contains 20-30 per cent iron in its natural state and must be beneficiated (crushed, ground, magnetically separated) to increase the iron content for use as a feedstock for iron-making. It is well-suited to direct reduction due to consistent composition and amenability to pelletisation.
Magnetite Concentrate	Magnetite concentrate is the beneficiated export product. Traditionally, steelmakers pelletise the concentrate themselves to the specification required by their furnaces. Conventional magnetite beneficiation involves large volumes of water to create a slurry, and the concentrate is normally exported as a wet product with volumes reported as wet metric tonnes.
MRIWA	Minerals Research Institute of Western Australia
NAIF	Northern Australia Infrastructure Facility
NEM (National Electricity Market)	The interconnected electricity grid and wholesale electricity market covering Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania. It is operated by the Australian Energy Market Operator (AEMO). Western Australia and the Northern Territory are not connected to the NEM.
NRF	National Reconstruction Fund
NWIS (North-West Interconnected System)	A separate electricity grid located in the Pilbara region of Western Australia. It connects major mining and industrial operations but is not linked to the National Electricity Market or the SWIS.
OCG (Office of the Coordinator General)	A Western Australian Government body established within the Department of the Premier and Cabinet under the *State Development Act 2025* to streamline regulatory approvals and coordinate major State-significant projects and industrial precincts.

OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
Pig Iron	The resulting iron product from melting DRI in an electric smelting furnace (ESF) to separate metallic iron from non-ferrous gangue. Pig Iron has an iron content of at least 92 per cent iron with low gangue. It can be used for producing high-quality steel products in a range of furnaces.
PPA	Power Purchase Agreement
Primary Steel	Steel made from iron ore, rather than recycled scrap. It accounts for around 70 per cent of global steel production, with 90 per cent of that made using the carbon-intensive BF-BOF process. Steelmaking overall is responsible for more than 8 per cent of total greenhouse gas emissions.
Production Tax Credit (PTC)	A proposed government support mechanism that would provide a per-tonne subsidy for green iron production. The PTC will help to address key market failures - such as the absence of a global carbon price - closing the cost gap with carbon-intensive alternatives and stimulating early investment in low-emissions technologies.
Reductant	A substance used in iron-making to chemically remove oxygen from iron ore (iron oxide), producing metallic iron. Common reductants include carbon (from coal or fossil gas) and hydrogen. The choice of reductant determines the emissions profile of the process.
Reserve Capacity Mechanism (RCM)	Administered by the Australian Energy Market Operator (AEMO) under rules overseen by Energy Policy WA, the Reserve Capacity Mechanism ensures there is always enough electricity generation and storage available to meet peak demand on WA's main power grid (the South West Interconnected System).
SDA (State Development Area)	A designated precinct of land in Western Australia declared under the *State Development Act 2025* to support strategic economic development, coordinated infrastructure delivery, and streamlined approvals for major projects.
SIA (Strategic Industrial Area)	A designated industrial precinct planned and managed by the Western Australian Government for heavy and strategic industries.
Superpower Trade	The trade in clean energy embedded in energy-intensive goods, that relies on Australia's comparative advantage in clean energy production.
SWIS (South West Interconnected System)	The main electricity network in Western Australia, serving Perth and the south-west of the state, from Kalbarri in the north to Albany in the south and Kalgoorlie in the east. Western Power owns and operates the transmission and distribution network. The SWIS is not connected to the NEM.
TAFE	Technical and Further Education
Technology Readiness Level (TRL)	Technology Readiness Levels assess the maturity level of a technology as it progresses through the research, development and deployment (RD&D) phases to a commercially mature technology. TRLs are based on a scale from 1 to 9, with 1-

	3 indicating the research phase from desktop studies to laboratory experiments, 4-6 indicating development phase as laboratory prototypes progress to real world pilot facilities, and 7-9 being the deployment phase as demonstration facilities reach commercial scale deployment.
WEM (Wholesale Electricity Market)	The wholesale electricity market operating on the SWIS, run by AEMO. It includes a real-time energy market, markets for essential system services that keep the grid stable, and a capacity mechanism that pays providers to make capacity available when needed.

Appendices

Appendix	Title
Appendix A	Global Market Analysis
Appendix B	Regional Resource Profiles
Appendix C	WA Green Iron and Green Steel Projects
Appendix D	WA Modelling Methodology
Appendix E	TSI Green Iron Scorecard

Appendix A

Global Market Analysis

This appendix provides a high-level overview of global market conditions and demand drivers relevant to green iron. It summarises key decarbonisation trajectories, emerging policy signals and market dynamics across major steelmaking regions to inform Western Australia's strategic positioning and prioritisation of early projects.

Global market conditions shifted sharply in 2026 as this analysis was prepared. The war involving Iran, which began in February 2026, disrupted shipping through the Strait of Hormuz and the supply of energy and iron ore pellets from the Gulf.[15] Shifts in United States trade policy, including tariffs on steel, have unsettled established trading relationships and the outcome of the November 2026 US midterm elections may further change the direction of US trade and climate policy. Global trade patterns are in flux and are difficult to predict.

Given this geopolitical volatility, the appendix should therefore be read as a point-in-time overview rather than a forecast. The structural drivers it describes, including the decarbonisation strategies of major steelmaking economies, the limits of scrap and the growing importance of certification, are likely to persist through this volatility, although their pace and sequencing may change. A more detailed assessment of green iron demand, and of how commodity market volatility affects it, is needed. TSI considers this an important area for further work.

The following discussion is structured around regional demand outlooks, product segmentation and early-market dynamics.

1. Introduction

Western Australia is the world's largest producer and exporter of iron ore. Almost all of Western Australia's iron ore is exported to northeast Asia - more than 80 per cent to China, and around 7 per cent to Japan and nearly 6 per cent to Korea. No other country exports iron ore at the same scale as Australia: Brazil's share of global exports is about 20 per cent, and Canada and South Africa both contribute about 4 per cent of global exports.

In 2025 total world production of crude steel was over 1.8 billion tonnes.[16] Just over half of this crude was produced in China, with Korea and Japan contributing between 3 and 4 per cent respectively. Outside the northeast Asian region, India is the second largest producer of crude steel with a market share just below 9 per cent, while the United States and Russia both produce about 4 per cent.

[15] IEEFA. "Could the Middle East Conflict Help Australia Catch Up in Green Iron?" IEEFA Insight, 30 April 2026.

[16] World Steel Association, "Steel Data Viewer." World Steel Association webpage, accessed October 2026.

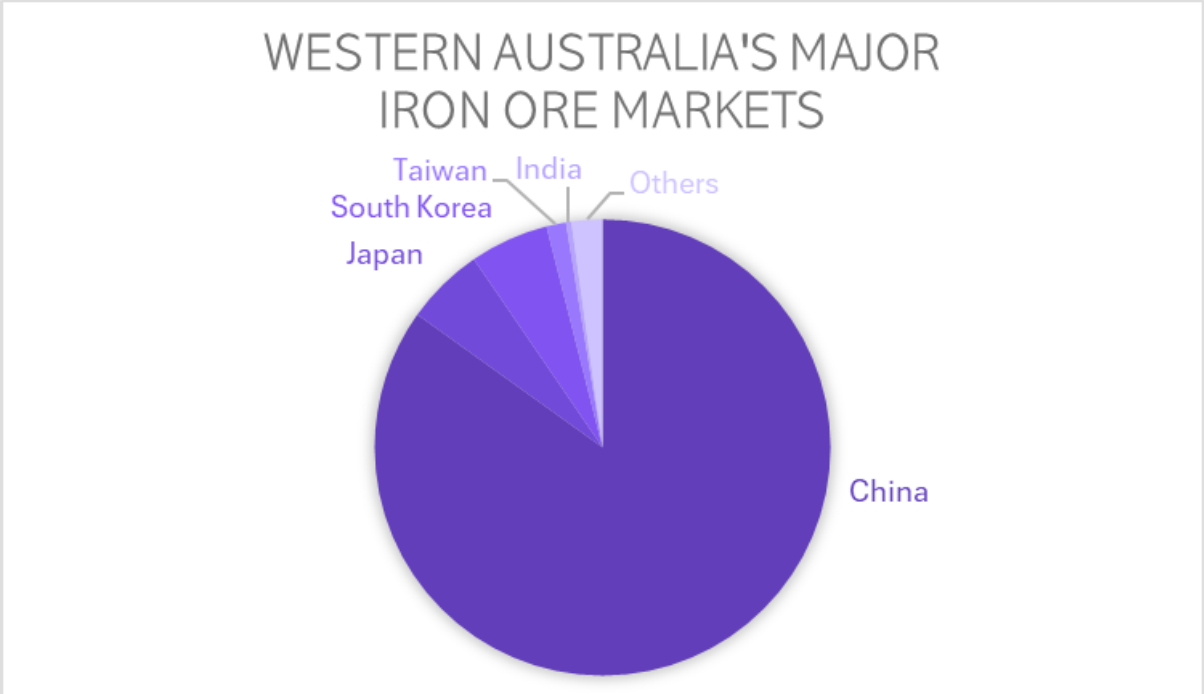


Figure A.1: Western Australia's principal iron ore markets by country.

Source: Department of Industry, Science and Resources, *Resources and Energy Quarterly*, December 2025.

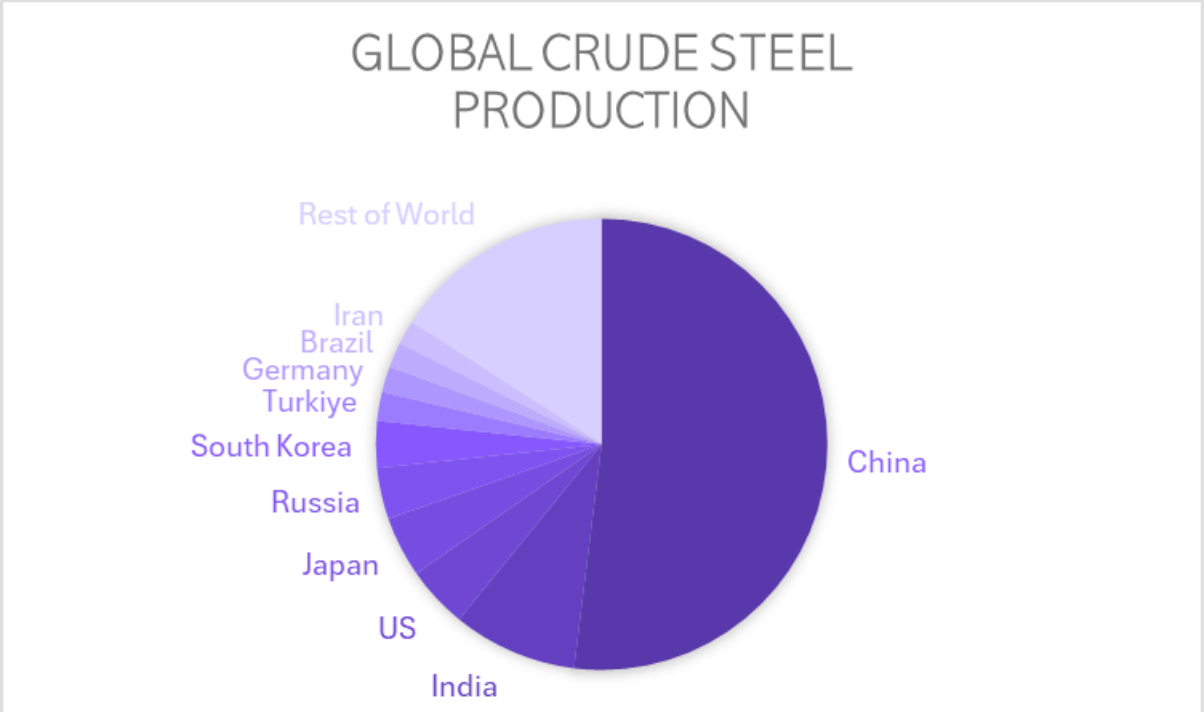


Figure A.2: Global crude steel production in 2025 by major producing countries.

Source: Based on World Steel Association, "Annual Production Steel Data 2025." World Steel Association webpage.

Western Australia's opportunity in green iron is grounded in a structural shift in the global steel sector driven by decarbonisation. This shift was first identified by Ross Garnaut in his *Superpower* series (2019), which argued that nations with abundant renewable energy could become preferred locations for low-emissions industrial production. TSI advanced the first integrated assessment of green iron's potential in *New Energy Trade* (NET) and expanded it in *A Green Iron Plan for Australia* (*GIPA*), which showed that renewable-energy-based iron-making could become one of Australia's largest export industries.

TSI is not alone in this assessment - strong global consensus has emerged. The OECD (Organisation for Economic Co-operation and Development), World Economic Forum (WEF), International Energy Agency (IEA), World Steel Association (WSA), Mission Possible Partnership (MPP), the Institute for Energy Economics and Financial Analysis (IEEFA), Agora Energiewende, RMI, WWF–Deloitte (World Wide Fund for Nature and Deloitte), BloombergNEF (BNEF), and Australia's own bodies including the Minerals Research Institute of Western Australia (MRIWA), the Clean Energy Investor Group/Baringa Partners (CEIG/Baringa) and Climate Energy Finance (CEF) all identify low-emissions iron as central to the steel transition.[17] A growing set of strategies in steelmaking nations including Japan, Korea, Europe, China and North America detail clear timelines for shifting towards hydrogen-enabled direct reduction and increased electric arc furnace use. This change is reshaping raw material demand, project development, capital allocation and global industrial strategy.

2. Decarbonisation Trajectories of Key Steelmaking Regions

TSI's NET and *GIPA* develop analytics that argue that countries with large, tradeable renewable resources and iron ore endowments would be natural locations for low-emissions iron-making, and that this would, over time, reshape global trade and production of iron and steel products.

Since then, a wide range of international institutions have reached similar conclusions. They all describe a broadly consistent picture: major steelmaking economies are planning for deep emissions cuts, and these plans depend on a gradual but persistent shift away from traditional, integrated blast furnace–basic oxygen furnace (BF-BOF) systems towards combinations of direct reduction, electric arc furnaces and higher scrap use. Modelling by MRIWA[18], CEIG/Baringa[19] and TSI aligns with this global literature and places Western Australia squarely inside that structural shift.

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[17] OECD, *Green Iron opportunities in Australia: A case study within the OECD's Global Green Iron Project*; International Energy Agency, *Iron and Steel Technology Roadmap*; World Economic Forum, *Industrial Clusters* series; Mission Possible Partnership, *Net Zero Steel Sector Transition Strategy*; IEEFA, *How to Spend a Billion Dollars* and *Scale of Investment Needed for Australia's Green Iron Ambition*; WWF-Australia and Deloitte, *Forging Futures: Changing the nature of iron and steel production*; Agora Energiewende, *12 Insights on Hydrogen*; RMI, *Green Steel: A Multi-Billion Dollar Opportunity*; BloombergNEF, *Decarbonising Steel: A Net-Zero Pathway*; Minerals Research Institute of Western Australia, *Western Australia's Green Steel Opportunity*; Clean Energy Investor Group and Baringa Partners, *Powering Australia's Green Export Future*; Climate Energy Finance, *Green Metal Statecraft* and *Arc of Ambition*; The Superpower Institute, *The New Energy Trade* and *A Green Iron Plan for Australia*.

[18] Minerals Research Institute of Western Australia. 'Western Australia's Green Steel Opportunity.' MRIWA Project M10471, 2023.

[19] Baringa Partners. 'Powering Australia's green export future.' Baringa for Clean Energy Investor Group, October 2025.

Although every steelmaking region is different, four broad patterns are visible.

In Europe, decarbonisation is most advanced. The EU Emissions Trading System and the Carbon Border Adjustment Mechanism (CBAM) have created strong price signals for low-emissions steel. European steelmakers such as ArcelorMittal[20], SSAB,[21] Salzgitter[22] and Thyssenkrupp[23] have all announced timelines to retire blast furnaces and replace them with hydrogen-ready direct reduction and EAF plants. Policy documents and project pipelines surveyed by the OECD, IEA and WEF show Europe moving quickly to secure access to low-emissions iron, while acknowledging that domestic constraints on renewable energy and hydrogen supply mean a substantial share will need to be imported. In European literature, green iron is generally treated as a tradeable intermediate that allows steelmakers to decarbonise even if they cannot host all upstream processing themselves.[24]

In Japan and Korea, the shift is less visible in regulatory instruments like the EU CBAM, but government policy and corporate strategy are a clear indication of their direction. Nippon Steel, JFE, POSCO and Hyundai Steel have all published decarbonisation roadmaps that feature hydrogen-based direct reduction, higher EAF shares, and explicit reliance on imported low-emissions DRI. *Japan's Green Transformation (GX)* package and Korea's industrial decarbonisation plans both treat access to green iron as a strategic input into their broader export-oriented manufacturing systems.

Japan's GX strategy aims to mobilise ¥150 trillion (estimated US$950 billion) in public and private investment to decarbonise heavy industry. Policy interventions operate across the green steel supply chain with an estimated ¥700 billion (US$4.5 billion) committed to hydrogen steelmaking, capital support for EAF conversions and a production tax credit mechanism.[25] Nippon Steel and JFE Steel are both being supported to expand their EAF capacity through government support valued at around ¥250 billion (US$1.6 billion) and ¥104 billion (US$653 million) respectively.[26]In October 2026, the Korea Government announced its K-GX green transformation strategy, which aims to mobilise around KRW 1,000 trillion (about US$747 billion) in public funding and climate finance between 2026 and 2035.[27] Steel is one of five priority

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[20] ArcelorMittal. "ArcelorMittal to Construct New DRI Plant in Gijón." Press release, July 2021; ArcelorMittal. 'Climate Action Report 2.' ArcelorMittal, July 2021; ArcelorMittal. "ArcelorMittal Plans Major Transformation in Germany." Press release, 2022.

[21] SSAB. 'Transforming the future of steel, Annual Report 2022.' SSAB, 24 March 2023.

[22] Salzgitter AG. "Strong signal for Salzgitter AG transformation program SALCOS." Salzgitter AG Press release, 15 September 2022; Salzgitter AG, "Partnerships for Hydrogen Supply."

[23] thyssenkrupp. "Federal Minister for Economic Affairs and Climate Action Robert Habeck visits thyssenkrupp: Hydrogen solutions along the entire process chain as a driver of the energy transition." thyssenkrupp Daily Press release, 22 February 2022; thyssenkrupp. 'EU-Commission approves German federal and state government funding for thyssenkrupp Steel's "tkH2Steel" decarbonization project.' thyssenkrupp Newsroom, 20 July 2023.

[24] European Commission, 'Transition Pathways for the European Metals Sectors,' 2025; European Commission, 'A Hydrogen Strategy for a climate neutral Europe,' 2020; European Commission, 'Renewable hydrogen production: new rules formally adopted,' News announcement, 2023; European Commission, 'Net Zero Industry Act,' 2023.

[25] Transition Asia. 'Japan Yearly Policy Review: Fiscal Year of 2025: Assessment of the GX Strategy in the Steel Sector.' Transition Asia Research, 15 May 2026.

[26] Nippon Steel, "Decision Is Made to Invest in the Conversion from the Blast Furnace Steelmaking Process to the Electric Arc Furnace Steelmaking Process" Nippon Steel Corporation News Release, 30 May 2025; JFE Steel. "JFE Steel to Introduce Advanced, High-Efficiency, Large-Scale Electric Arc Furnace in Japan." JFE Steel News Release, 10 April 2025.

[27] SteelOrbis. "South Korea Unveils KRW 1 Quadrillion Green Transformation Strategy Targeting Steel Decarbonization." SteelOrbis Steel News, 8 October 2026.

industries, and the strategy targets a 300,000 tonnes per year hydrogen-based iron-making demonstration by 2030. This builds on public funding committed in 2025 to POSCO's HyREX demonstration plant at Pohang. In October 2025, BHP and POSCO also agreed to trial BHP's iron ore in HyREX, which pairs an electric smelting furnace with hydrogen-based fluidised bed reduction.[28] These are strong signals of Korea's intent to invest in low-emissions iron-making using existing iron ore supplies which is directly relevant to Western Australia.

TSI's *GIPA* and the OECD green iron report both point to Japan and Korea as likely early anchor markets for traded green iron from renewables-rich jurisdictions, with more recent analysis identifying the interdependencies between Australia's green iron potential and these important trading partners steel decarbonisation plans.[29]

North America is taking a distinct pathway. The United States already operates a predominantly electric arc furnace–based steel sector, supported by abundant scrap and mature recycling systems. The *Inflation Reduction Act* (IRA) and federally funded hydrogen hubs triggered a wave of proposed investment; however, the policy environment has become less certain with the shift in federal administration. Most international analyses, including those by the IEA, OECD and MPP, now treat US federal policy settings as less predictable than those of Europe, Japan or Korea.

Even so, several factors are likely to endure regardless of federal shifts: state-level industrial decarbonisation programs, IRA project commitments already under way (although the hydrogen production credit now ends for projects beginning construction after 2027) and strong private-sector demand from automotive, defence and construction supply chains. For Western Australia, the main relevance of the North American trajectory is not as a long-term import market, but as a source of technological demonstration, market standards and competitive pressure and as an example of how high-scrap, EAF-dominant systems may evolve in other regions.

In India and Southeast Asia, the demand for steel is growing rapidly but much of the new capacity is in long-lived blast furnace assets. WWF–Deloitte and MPP both highlight India as a critical "swing region" for global steel emissions: its decarbonisation choices will be decisive, but its immediate focus remains on expanding supply. India's Ministry of Steel has outlined the potential pathways to greening the industry, which like some ASEAN countries includes piloting hydrogen steelmaking and tightening efficiency standards, yet most studies treat them as medium-term markets for traded green iron. Indian steelmakers such as Tata Steel[30], Adani[31] and JSW Steel[32] have announced plans to build green steel plants, but meeting the certification standards required for the early EU market in the near-term will be challenging. As green steel

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[28] BHP. "BHP and POSCO Partner to Advance Hydrogen-Based Iron-Making Technology." Media release, 30 October 2025.

[29] Observer Research Foundation, 'Green Steel and the Future of the Japan–Australia Resource Partnership'; Lowy Institute, "Australia's Green Iron Gamble Needs More Ambition to Convince Asia"; IEEFA, "Australia's Green Iron Opportunity Becomes Economic Necessity with End of China Steel Boom"; Solutions for Our Climate, 'Choosing a Green Steel Pathway: Implications for South Korea, Japan, and Australia.'

[30] South East Asia Iron and Steel Institute. "Tata Steel Invests $1.2 Billion in Green Steel Technology in Jharkhand." SEAISI Newsroom, 22 January 2026.

[31] Adani Group. "POSCO & Adani Sign MoU for Integrated Steel Mill." Adani Group Media release, January 2022.

[32] Bloomberg. "India's JSW Steel to Spend Over $1 Billion on Cutting Emissions." Bloomberg Exclusive, 25 January 2022.

markets mature, and standards are agreed, these regions could become volume buyers of low-emissions iron units in the 2030s and 2040s.

China's approach to steel decarbonisation makes it unlikely to be an early customer for small volumes of premium-priced green iron. The IEA[33], OECD[34], CEIG/Baringa and TSI all describe a dual steel decarbonisation strategy; gradual expansion of electric arc furnaces as scrap availability improves, alongside early hydrogen-DRI pilots.[35] Recent developments are consistent with this. China produced 961 million tonnes of crude steel in 2025, and its demand for steel appears to have plateaued as property construction contracts. Its 2026 national plan calls for orderly reductions in steel capacity and lower emissions per tonne of steel.[36] China is bringing steel into its national emissions trading scheme, although allowances are initially set on an intensity basis and place limited pressure on most plants.[37] Electric arc furnaces produced around 10 per cent of China's steel in 2025, well short of earlier targets, and hydrogen-DRI remains at demonstration scale, led by Baowu's 1 million tonne per annum plant at Zhanjiang.[38]

This makes China unlikely to be an early customer for small volumes of premium-priced green iron, but its long-term trajectory suggests an eventual role for large-scale imports of low-emissions iron products.

Taken together, the direction of global steel decarbonisation is clear, even if the pace and sequencing vary considerably by region. Early markets for green iron will be driven by regulatory pressure, particularly the EU CBAM, and by customers in Japan, Korea and Europe prepared to pay a premium for low-emissions products. Later markets will develop where a low-cost supply of renewable energy or scrap is constrained.

3. Market Segmentation by Steel Product Classes

Global demand for green iron cannot be understood without examining the structure of steel markets themselves. As the OECD and WSA emphasise, steel is not a homogenous commodity but a vast family of differentiated product classes, each with distinct metallurgical requirements, value drivers, regulatory pressures and capacity to absorb a green premium. This segmentation is also central to analyses by the IEA, WEF, MPP, Agora Energiewende, RMI, WWF–Deloitte, BNEF and TSI, as well as domestic work by MRIWA and CEIG/Baringa. Across this literature, a consistent message emerges: early demand for green iron will arise first in product classes where quality, certification and brand or regulatory pressure matter more than marginal cost differences.

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[33] International Energy Agency. 'Iron and Steel Technology Roadmap: Towards More Sustainable Steelmaking.' IEA, October 2020; International Energy Agency. 'Net Zero by 2050: A Roadmap for the Global Energy Sector.' IEA, May 2021.

[34] OECD. 'Green Iron opportunities in Australia: A case study within the OECD's Global Green Iron Project.' OECD Policy Paper, 22 October 2025.

[35] Center for Strategic and International Studies. 'Circular Economy Solutions for China's Steel Industry: Addressing the Dual Challenge of Overcapacity and Emissions." CSIS Commentary, 18 October 2024; Griffith Asia Institute, "Analysis – China's Newly Announced Steel Industry Work Plan 2025–26." Griffith University Blogs, 8 September 2025.

[36] Mysteel. "China to Curb Steel Capacity in 2026, Says NDRC in Approved Plan." Mysteel News Article, 16 March 2026.

[37] Rhodium Group. 'Furnaces, Fossils and the Future of Chinese Green Steel.' Rhodium Group Note, 30 September 2026.

[38] Climate Energy Finance. 'Green Metal Statecraft: Policy, Investment and Technology Trends in the Green Iron Evolution.' CEF, 30 April 2026.

Among these segments, flat steel products, including automotive sheet, appliance steels and engineered flat products, stand out as some of the most emissions-sensitive. Original Equipment Manufacturers (OEMs) in the automotive, electronics and consumer appliance sectors already face strong expectations from consumers, regulators and investors to demonstrate emissions reductions in upstream materials. Studies by WWF–Deloitte, WEF and BNEF show that the cost uplift associated with using near-zero or low-emissions inputs in these sectors is small relative to the value of the final product. These characteristics make flat steel producer's natural early adopters of green production routes and likely early customers for traded green iron. Steelmakers in Japan, Korea and Europe have signalled this explicitly, framing green iron as an essential input to meet their net zero commitments.

A second critical segment is specialty steels, encompassing defence-grade steels, aerospace alloys, energy infrastructure steels and rail products. These materials must meet stringent and highly specific performance and traceability requirements. Defence procurement agencies, rail manufacturers and large engineering contractors in Europe, Japan and Australia increasingly incorporate emissions performance and upstream certification into procurement processes. This is reflected in WEF and OECD analyses of "mission-critical materials" supply chains, which show rising sensitivity to embedded carbon, verified provenance and contamination risk. While smaller in tonnage, specialty steel markets place a high premium on consistency, certification and emissions performance: precisely the attributes associated with green iron products. This creates early opportunities for exporting jurisdictions capable of producing traceable, guaranteed, low-emissions iron.

The largest global segment by volume is long steel, covering reinforcing bar, structural sections and other construction materials. Construction steel markets are typically price-sensitive and dominated by procurement systems that prioritise lowest immediate cost. However, these markets are also heavily exposed to public-sector infrastructure spending. Research by WWF–Deloitte, Agora Energiewende and MPP highlights the emergence of "green construction materials" standards in Europe and parts of Asia, and growing interest from major engineering and infrastructure contractors in securing lower-emissions steel inputs. Long steel is unlikely to drive early international green iron demand, but it offers important domestic opportunities in Western Australia, particularly where government procurement frameworks or large fabrication customers begin specifying low-emissions inputs. These factors could create meaningful local demand for green iron even before broader export markets mature.

A further, technically distinct segment is stainless and alloy steels, which require precise control over impurities and often rely on blends of scrap, nickel, chromium and high-purity iron. The IEA, OECD and WEF note that stainless and alloy producers increasingly use high-quality DRI to manage scrap contamination constraints in EAF-dominant systems. Given their high sensitivity to chemistry, alloy steelmakers are acutely exposed to the quality advantages of DRI-EAF grade green iron inputs. This market is not large enough to anchor a multi-million-tonne export industry, but it represents a prospective stable niche for first-mover suppliers offering high-purity, low-emissions iron.

Across these segments, the global literature converges on a clear logic: the first markets for green steel will be those where consistency, certification and emissions integrity outweigh small cost differentials, and where the end-use product supports or requires a premium for low-

carbon materials. Analyses by OECD, IEA and WEF consistently identify Europe, Japan and Korea as the earliest and most technologically advanced markets for low-emissions iron products, driven by strong policy pressure, high-value manufacturing supply chains and clear commitments to steel decarbonisation. These customers will not absorb large volumes in the early years, but they will play a critical role in validating early production, creating supply chains, supporting certification systems and underpinning the commercial viability of first-mover projects.

4. The Green Iron Value Chain

Understanding global demand for green iron requires understanding the relationships between the upstream ore characteristics, downstream customer specifications and the economics across the green iron value chain.

4.1 From Iron Ore to Green Iron

Green iron production for green steel is based on using the established direct reduction iron - electric arc furnace process (DRI-EAF). The strict operational specifications of an electric arc furnace necessitate that the DRI fed into it is of high-quality, which ultimately relies on the quality of the iron ore feedstock. DR-grade pellets are the dominant feedstock globally. They are derived from magnetite ore beneficiated to a concentrate product with a minimum iron content of 66 per cent and less than 3.5 per cent combined silica and alumina gangue.[39] The concentrate and subsequent pellets must also meet stringent physical characteristics that impact its performance in the reducing environment of the furnace. These premium DR-grade pellets are the preferred feedstock for hydrogen-DRI production.

Global supply of DR-grade feedstock is limited because only a small percentage of global iron ore production is suitable for this purpose. For comparison, in 2024 the total DRI production was 144 million tonnes, compared to the 1293 million tonnes of pig iron produced in blast furnaces. DR-grade supply is also impacted by the structural constraints of the existing steelmaking asset base. The market for DR-grade pellets is primarily steelmakers who have or are building their own DRI capacity. Japanese and Korean integrated steelmakers, such as Nippon Steel, JFE, POSCO, Hyundai Steel, have announced plans to install hydrogen-ready direct reduction units at their existing sites. Rather than import DRI briquettes (HBI), these companies may prefer to import high-grade pellets and undertake the reduction step themselves, maintaining control over their production process and quality. European steelmakers pursuing similar strategies, particularly those with access to low-cost renewable electricity or hydrogen pipelines, represent another potential market.

WA has in situ resources of magnetite ore which could be beneficiated to DR-grade feedstock for local green iron production. While selling the DR-grade pellets could offer WA an entry point into the green iron value chain, the reduction step (where hydrogen removes oxygen from iron

[39] Midrex Technologies, 'Getting the Most from Raw Materials Via the Direct Reduction/EAF Route – Ore Selection (Part 1)'. *Direct from Midrex 4th Quarter 2019* newsletter.

ore) is where most emissions abatement occurs and it's also where much of the green premium is justified. Exporting pellets means foregoing the value-add of moving up the value chain.

4.2 From Green Iron to Green Steel

Hot briquetted iron (HBI) is DRI that has been compressed into dense, stable briquettes while still hot. The compression process makes HBI far less reactive than loose DRI, allowing it to be stored, handled and shipped safely over long distances. HBI is the primary tradeable form of green iron in international markets.

The market for HBI is steelmakers operating electric arc furnaces who need clean primary iron to blend with scrap, meet quality specifications, or expand production beyond scrap availability. This includes:

- European steelmakers transitioning from blast furnaces to EAFs under CBAM and EU ETS pressure, who need certified low-carbon metallics
- Japanese and Korean steelmakers who may build their own DRI capacity but still require supplemental HBI for blending or flexibility
- Emerging EAF capacity in Asia (China, India, ASEAN) as these regions gradually shift away from blast furnaces
- Specialty and high-value steel producers who need the purity and consistency that HBI provides
- Integrated steelmakers converting blast furnace sites, who may use electric smelting furnaces to process DRI made from lower-grade ores into iron for basic oxygen furnaces

HBI captures more value than pellets and carries the full green credentials, when produced with renewable hydrogen. This qualifies HBI as near-zero emissions iron and can command a green premium.

For Western Australia, HBI is the flagship product for export-scale green iron. Early projects require fully integrated facilities (renewable energy and/or hydrogen, direct reduction, briquetting) and high capital investment, but it positions WA as a supplier of processed green metallics, not just upgraded ore.

4.3 The Hematite Challenge

The Pilbara’s mid-grade hematite ores are not suitable for conventional DRI-EAF processing because they are not easily beneficiated to DR-grade. While they can theoretically be directly reduced in existing DRI (vertical shaft) technology, they would require an additional melting step to remove gangue to a level suitable for an EAF.

To unlock the potential of the Pilbara’s vast hematite resources for green iron production, technologies are emerging (fluidised bed, flash smelting, electric smelting and electrolysis) to process Pilbara fines products to iron.

The Pilbara's long-run green iron potential is substantial given its scale of ore reserves but realising it depends on technology development.

4.4 Customer Preferences and Certification

Demand for green iron products is increasingly shaped by buyer preferences relating to product quality, emissions intensity, certification and traceability, rather than volume alone. A number of international assessments indicate that early markets for low-emissions steel and iron are emerging unevenly across sectors, reflecting differences in end-use requirements, regulatory exposure and tolerance for cost premiums.

Analysis by the International Energy Agency and the OECD suggests that initial demand is most likely to arise in higher-value and more regulated applications, including automotive manufacturing, machinery and appliances, as well as publicly procured infrastructure. In these sectors, product specifications, reliability of supply and credible certification of emissions performance are becoming increasingly important for procurement decisions, particularly as firms seek to manage Scope 3 emissions and comply with emerging trade and procurement frameworks. In contrast, bulk and highly price-sensitive applications are expected to adopt lower-emissions inputs more gradually, as costs decline and standards mature.[40]

Across all segments, however, the growing emphasis on certification and traceability reflects a broader shift toward verifiable, product-level emissions claims as a prerequisite for market access in key jurisdictions.

4.5 Implications for WA's Product Strategy

This high level product-market analysis points to several conclusions:

1. **HBI is the priority export product.** It captures the most value, serves the largest addressable markets and positions WA as a supplier of processed green metal rather than just ore. Early-mover projects are likely to target integrated HBI production.
2. **Exporting DR-grade pellets does not capture the value and emissions reduction potential.** Local magnetite projects with ore amenable to beneficiation to DR-grade can offer a supply of the high-integrity feedstock required by a WA green iron industry.
3. **Pilbara product strategy depends on technology maturation**. Until emerging technologies suited to Pilbara ores are proven at commercial scale, the Pilbara's green iron contribution will be limited. TSI’s modelling indicates that processing Pilbara ore in the Mid West could cost less than processing it in the Pilbara under the modelled assumptions (Chapter 4), although the logistics and commercial arrangements are untested.
4. **Different customers may want different products.** European steelmakers moving to electric arc furnaces are the clearest early market for certified HBI. Japanese and Korean steelmakers building their own DRI capacity may prefer to import DR-grade pellets and reduce them at home, using HBI as a supplementary input. Specialty and alloy steelmakers value high-purity iron, but in smaller volumes. Longer-term volume markets such as China and India are likely to buy on cost, with demand shaped by mandatory emissions policy rather than voluntary premiums. WA’s product strategy will need to match the requirements

[40] International Energy Agency. ‘Iron and Steel Technology Roadmap: Towards More Sustainable Steelmaking.’ IEA, October 2020; OECD. ‘OECD Steel Committee: Decarbonizing the Steel Sector, Work Plan 2023-24.’ OECD, 2023.

of each market rather than assume one product serves all. This may create a tension with point 2: some early customers may prefer pellets, even though HBI captures more value for Western Australia.

5. **Certification and traceability are as important as cost**. WA proponents must invest in robust systems for guarantees of origin, lifecycle carbon accounting, and third-party verification. Products without credible certification will struggle to access premium markets regardless of cost competitiveness.

5. Scrap Dynamics and Constraints

Scrap will play an important role in the decarbonisation of steelmaking, but it cannot meet the global demand for green steel on its own. The availability of scrap is shaped by long product lifecycles, the pace at which built assets are scrapped and the maturity of recycling systems. These structural constraints mean that, even under optimistic circularity scenarios, scrap cannot substitute for the clean primary iron units required for deep decarbonisation.

5.1 Scrap availability grows slowly because steel stays in use for decades

Steel embedded in buildings, vehicles, machinery and infrastructure remains in service for long periods — often 30 to 60 years. This long turnover time limits the growth of global scrap supply, even as recycling systems improve. These constraints are most pronounced in the regions that consume the most steel. China, India and Southeast Asia have relatively young capital stocks, meaning that only a small share of the steel currently in use will become available as scrap before 2040. As a result, global scrap availability will increase, but not nearly fast enough to meet demand.

This dynamic is reflected across international literature. Analyses by the IEA, OECD, WEF, the WSA, MPP, Agora Energiewende, WWF–Deloitte, RMI, (BNEF), CEIG/Baringa and MRIWA all reach a similar conclusion: scrap is essential, but it cannot meet the scale or specification requirements of a near-zero steel system.

5.2 Quality constraints limit the use of scrap in high-value steel segments

Beyond availability, scrap quality presents additional challenges. Contamination, particularly copper from end-of-life products presents a further constraint. There is no commercial process to remove copper from steel once it enters the scrap stream. [41]Even sorted scrap can contain copper at levels too high for most high-value flat steels, specialty steels and advanced alloys.[42] These product classes require consistent chemistry to meet metallurgical specifications. Most steelmakers therefore blend scrap with primary metallics such as pig iron, DRI or HBI to dilute the impurities and meet quality specifications.[43] Even in scrap-rich jurisdictions like the United

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[41] Daehn EK, Serrenho AC and Allwood JM. “How Will Copper Contamination Constrain Future Global Steel Recycling?” Environmental Science & Technology 51, 2017.

[42] Sandbag. ‘Starting from Scrap: transition to low-carbon steel can go faster with increased use of second hand metal.’ Sandbag Press release, June 2022.

[43] US International Trade Commission, “Russia, Ukraine, and Pig Iron Supply,” *Executive Briefings on Trade,* USITC October 2022.

States, blends of pig iron alone is estimated to make up 20 to 25 per cent of the feedstock in electric arc furnaces producing flat products..[44] OECD, IEA and WWF–Deloitte each underline this point: scrap will support decarbonisation, but only in combination with clean primary iron.

5.3 Growth economies are structurally "short" of scrap

Scrap is unevenly distributed around the world. Mature economies such as the EU and North America have built up large stocks of steel over many decades and in theory could eventually hold enough end-of-life scrap to meet most of their own steel demand. Growth economies have not and will remain short of scrap for decades.[45]

China sits between these groups. Its use of scrap is increasing as its steel stock ages, reaching around 21 per cent of crude steel output in 2025, with a target of 30 per cent by 2030.[46] With steel demand now plateauing, scrap will meet a growing share of China's needs. Even so, its domestic scrap could meet only around half of its cumulative steel demand to 2050, leaving a very large requirement for primary iron.[47]

India and developing Asia face far more acute shortfalls. Their steel demand is rising quickly, and end-of-life scrap is projected to meet only around 10 per cent of their annual steel demand in 2050.[48] India already uses around 41 million tonnes of scrap a year, about 23 per cent of its crude steel production. The India Green Steel Coalition projects a shortfall of 40 to 50 million tonnes as the country moves towards its goal of 50 per cent scrap-based steelmaking by 2047.[49]

For these economies, deep decarbonisation will depend on new sources of low-emissions primary iron, not on recycled material alone. This reinforces TSI's conclusion that low-emissions DRI and HBI will become critical global feedstocks. It also helps explain why China, India and developing Asia are likely to be the long-term volume markets for green iron, as discussed in Chapter 2 of the *Roadmap*.

5.4 Scrap-based steelmaking as a complementary pathway for WA

While scrap cannot drive the global transition, it may complement green iron development in Western Australia, as discussed for the South West in Chapter 3. Several proponents in WA are exploring scrap-based EAF projects as early demonstrations of local green steel capability. These projects are relatively small-scale, technically mature and quicker to deliver than fully integrated green iron facilities. They can support early procurement for low-emissions construction materials, accelerate workforce development and build the operational systems required for certification, traceability and emissions reporting.

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[44] Sandbag. 'Starting from Scrap: transition to low-carbon steel can go faster with increased use of second hand metal.' Sandbag Press release, June 2022, citing S&P Global data 2019.

[45] Watari T, Giurco D and Cullen J. "Scrap Endowment and Inequalities in Global Steel Decarbonization." *Journal of Cleaner Production* 425, 2023.

[46] SteelOrbis. "China's Scrap-to-Steel Ratio Rises, Upward Trend Will Continue." SteelOrbis Steel News, 23 December 2025.

[47] Watari T, Giurco D and Cullen J. "Scrap Endowment and Inequalities in Global Steel Decarbonization." *Journal of Cleaner Production* 425, 2023.

[48] Ibid.

[49] India Green Steel Coalition. 'Closing the Loop: Scrap Markets to Power India's Green Steel Transition.' IGSC, March 2026.

Such a pathway reduces first-mover risk and creates a bridge between near-term capability and long-term competitiveness in traded green iron. It also aligns with international practice, where most EAF operations rely on blends of scrap and DRI/HBI to meet quality requirements.

6. Pricing, Green Premiums and CBAM Effects

Green iron's commercial viability depends not just on production costs but on the price customers are willing to pay for low-carbon metals. This price includes two components: the baseline commodity price (what conventional iron ore or metallics trade for) plus a "green premium", being the additional amount customers pay for certified near-zero emissions products. It is critical to understand how these premiums work, how they vary across markets and products and how policy mechanisms like the EU's Carbon Border Adjustment Mechanism (CBAM) create price floors.

6.1 How Green Premiums Work

A green premium reflects the value customers place on emissions reductions. This value comes from several sources:

- **Regulatory compliance:** Steelmakers subject to carbon pricing (EU ETS and emerging or expanding schemes in Japan, Korea or China) face direct costs for emissions. Using green iron reduces these costs. The premium they'll pay is capped by the cost of carbon they avoid: if green iron costs $100 more per tonne than conventional iron but saves $150 in carbon costs, it's economically rational to buy green iron.
- **Customer and investor pressure:** Automotive manufacturers, appliance companies and other downstream buyers increasingly demand low-carbon steel to meet their own Scope 3 emissions targets and corporate sustainability commitments. They push steelmakers to decarbonise and may accept cost pass-throughs in exchange for certified green products. The premium here depends on how much cost increase end-consumers will tolerate.
- **Brand value and market positioning:** Some steelmakers, particularly in premium segments like automotive, aerospace, or specialty steel, can differentiate themselves by offering certified green products. This allows them to command higher prices for their steel, creating headroom to pay premiums for green iron inputs.
- **Risk mitigation:** Forward-looking steelmakers recognize that carbon pricing will tighten globally over time. Investing in green iron supply chains now, even at a premium, reduces future exposure to carbon costs and regulatory uncertainty. The premium reflects insurance against future policy tightening.

6.2 Variability of Green Premiums Across Product Classes

Green premium tolerance varies dramatically by end-use. However, actual premium levels that customers will pay remain largely unknown. Most analysis is based on modelling, willingness-to-pay surveys, or theoretical calculations of carbon cost avoidance, not real market transactions. There are distinct challenges in discovering validated price points.

Automotive and appliance steel (flat products): are among the higher-tolerance segments identified. Steel is a small fraction of final product cost. Even a substantial green premium for the steel adds only marginally to the vehicle cost, well within the rounding error of consumer pricing. Studies by WWF-Deloitte, WEF, and BloombergNEF identify these segments as commercially viable for green iron, particularly where brand value or regulatory requirements justify decarbonisation. However, actual premium levels customers will pay remain largely unproven in real transactions.

Specialty steel (defence, rail, infrastructure): Likely high premium tolerance in principle. Defence procurement agencies and major infrastructure projects increasingly specify low-carbon materials as part of broader sustainability and security-of-supply criteria. Cost sensitivity is lower than mass-market products and emissions certification and traceability may be non-negotiable requirements. That said, specific premium thresholds are speculative until actual procurement contracts reveal what agencies and contractors will pay.

Construction steel (long products): Lower premium tolerance. Construction markets are highly cost-competitive, and steel is a significant project cost. However, public procurement standards are shifting. European governments, some Asian jurisdictions, and increasingly Australian state and federal agencies, are introducing "green construction materials" requirements. This creates a floor: projects meeting these standards will be required to use low-carbon steel regardless of cost, within limits. But the premium range that triggers voluntary adoption versus mandated adoption remains unclear.

Stainless and alloy steel: Moderate to high tolerance in principle. These are high-value products where steel input costs are already elevated. Customers value purity and consistency, which green iron provides. The literature suggests commercial viability, particularly in markets with strong sustainability drivers, but again actual willingness-to-pay data from offtake negotiations is scarce.

6.3 The Carbon Border Adjustment Mechanism: Creating a Price Floor

The EU's Carbon Border Adjustment Mechanism (CBAM) is the most significant policy development shaping green iron economics. It began with a reporting-only transitional period in 2023, entered its definitive period on 1 January 2026 and phases in fully by 2034. CBAM prices the carbon embedded in energy-intensive imports, including iron and steel, at the EU Emissions Trading System (ETS) price. This "levels the playing field" between EU producers, who pay carbon costs under the EU ETS, and importers, while creating incentives for exporters to decarbonise. The regulatory framework and impact assessments for CBAM are set out in EU policy documents, and the OECD, IEA, WEF and other international bodies have examined its implications for global steel trade.[50]

In *GIPA*, TSI outlines CBAM's operation as follows:

[50] Regulation (EU) 2023/956 establishing a carbon border adjustment mechanism, and its implementing acts; see also Herbert Smith Freehills Kramer, "Operationalisation and Simplification of the EU CBAM." HSF Kramer Competition Notes, 19 January 2026.

- **Embedded emissions are calculated** for imported products based on actual production data (preferred) or default benchmarks
- **A carbon price is applied** equivalent to the EU ETS allowance price, phasing in progressively until 2034
- **Importers must purchase CBAM certificates** to cover the embedded emissions
- **The cost advantage of green iron increases** as EU ETS prices rise

Analysis cited in *GIPA* estimates that EU companies will need to import up to 13 million tonnes of green iron by 2030, and up to 18 million tonnes by 2045.[51]*GIPA* tests how carbon pricing changes the competitiveness of green iron by asking what would happen if producers paid the expected EU carbon price in 2030. Forecasts of the EU ETS price in 2030 range from $110 to $225 per tonne of carbon dioxide, with an average of $155 (in 2024 Australian dollars).[52] At that price:

- blast furnace iron, which emits about 2 tonnes of carbon dioxide per tonne, would rise in cost by more than $300 per tonne
- fossil-based DRI, at about 1.1 tonnes, would rise by about $170
- Australian gas-based iron, at about 0.5 tonnes, would rise by about $80[53]

GIPA finds that this would narrow the green premium and allow more producing locations to compete internationally. It recommends a production credit of $170 per tonne in 2030 as the policy equivalent of a carbon price, rising over time to maintain equivalence with the EU carbon price.[54]

These figures show the full effect of the carbon price. Under CBAM, the carbon price applies to imports in step with the phase-out of free allocation to EU producers, which is not complete until 2034. The advantage CBAM gives green iron in 2030 will therefore be smaller than these figures suggest and will grow as free allocation is withdrawn.

The CBAM alone doesn't guarantee competitiveness. While **it** creates a price advantage for low-carbon iron, green iron produced in WA still needs to be cost-competitive relative to other low-carbon suppliers. Producers in the Middle East and China, drawing on low-cost solar and potential hydrogen subsidies, are also targeting CBAM-driven EU markets. The 2026 conflict in the Gulf has also highlighted supply security risks for buyers relying on Middle Eastern iron units, which may strengthen the case for diversifying supply. WA's comparative advantage in access to iron ore and established trade relationships matters, but cost competitiveness remains essential.

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[51] Torres-Morales, Maltais and Gong, *Demands for Renewable Hydrogen and Electricity to Drive the EU's Green Iron and Steel Transition*, cited in The Superpower Institute. 'A Green Iron Plan for Australia.' TSI Report, May 2025, section 6.1.

[52] The Superpower Institute. 'A Green Iron Plan for Australia.' TSI Report, May 2025, section 4.7.

[53] Ibid., section 5.1.1.

[54] Ibid., executive summary and Recommendation 1.

6.4 Green Premiums in Voluntary Markets

Major steelmakers in Japan, Korea and Taiwan are developing an early market for green steel and already offer low-carbon steel products which attract a premium. Nippon Steel[55], JFE Steel[56], Hyundai Steel[57] and POSCO[58] all market products with emissions intensities below 1.3 tCO2 per tonne of steel which are tracked against an Asian price index. Since 2023 these premiums have been tracked with some as high as US$300 per tonne[59]. All have plans to continue decarbonising their operations and eventually offer genuine near-zero steel products as the market differentiates premiums for different emissions intensities.

Demand for these early low-carbon steel products is primarily driven by voluntary corporate commitments by OEMs. The major steelmakers also have voluntary net-zero targets and are investing in hydrogen-DRI technologies and DRI capacity that can transition from gas to hydrogen. In the mid-term, green iron imports will be required to meet their targets, particularly where affordable hydrogen supply is constrained. Premiums here depend on corporate willingness to pay and tightening domestic carbon pricing. Analyses by OECD and IEA suggest meaningful voluntary premiums are plausible in these markets, particularly for automotive and export-oriented manufacturing supply chains, but specific values await actual offtake negotiations.

In China, near-term voluntary premiums are limited and poorly quantified; meaningful price signals may emerge in the 2030s, but it is more likely that green iron demand will be driven by mandatory emissions policy.

In Australia, State and Commonwealth government procurement standards, major infrastructure projects and corporate construction commitments could create niche demand for green steel. Where policy mandates exist or where project proponents have strong sustainability drivers, premiums appear viable, but the actual premium range that Australian customers will pay remains to be demonstrated through procurement processes and project delivery.

Despite growing consensus that green premiums will support green iron markets, significant uncertainty remains:

Premium projections are not guaranteed prices: Most cited figures come from modelling studies, scenario analyses, and expert interviews and not actual market transactions. As TSI's submission to the WA Parliament's Economics and Industry Standing Committee notes, "most potential buyers, particularly international steelmakers, are not yet prepared to sign long-term contracts at the price premium currently associated with green products." Real offtake

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[55] Nippon Steel has the NSCarbolex Neutral product. Nippon Steel. “NSCarbolex Neutral.” Nippon Steel webpage. Accessed October 2026.

[56] JFE Steel offers a JGreeX product. JFE Steel. “About JFE’s GX Steel JGreeX.” JFE Steel webpage accessed October 2026.

[57] Hyundai Steel will commence mass production of its HyECOsteel in 2026. Hyundai Steel. “Carbon Neutrality: Pathway to Green Steel.” Hyundai Steel webpage accessed October 2026.

[58] South East Asia Iron and Steel Institute. “POSCO Launches Green Steel Brand.” SEAISI Newsroom, 6 June 2023.

[59] Stockhead. “Bulk Buys: Green Steel Is Turning Real as Fastmarkets Launches Asian Green Steel Premium Index.” Stockhead Mining news, 13 September 2023.

negotiations may reveal lower willingness-to-pay, particularly in early years when volumes are small and certification systems immature.

Premiums may narrow over time: As green iron production scales, renewable energy and hydrogen costs fall, and technology improves, the cost gap with conventional iron is expected to narrow. In *GIPA*, TSI cites analysis suggesting European green iron could reach cost-competitiveness with carbon-intensive iron by 2035 at a carbon price of around $240 per tonne, indicating that even as costs fall, some form of carbon pricing or policy support will likely remain necessary through the 2030s.

CBAM evolution is uncertain: While CBAM is now law, its implementation details, default benchmarks, verification requirements, sectoral coverage expansions, continue to evolve. Future EU governments could weaken enforcement or provide exemptions. Other jurisdictions considering similar mechanisms (Japan, Korea, UK, California) may adopt different structures that don't provide equivalent advantages.

Customer willingness-to-pay varies by contract structure: Premiums that look feasible in principle may not materialize in practice if customers can negotiate long-term fixed-price contracts, play suppliers off against each other, or pass costs down to smaller suppliers. Actual offtake agreements will reveal how premiums are structured, indexed, and allocated across the value chain.

7. Conclusions and Further Work

This appendix points to a clear direction. Major steelmaking economies are planning to decarbonise, and scrap cannot meet the demand for clean primary iron, particularly in growth economies. Early demand for green iron is likely to come from customers in Europe, Japan and Korea who value certified low-emissions products, while larger volume markets in China, India and developing Asia are likely to develop later. Policy instruments such as the EU CBAM, and tightening carbon pricing elsewhere, will shape the price advantage green iron can command. Together, these findings have informed the direction of this *Roadmap*.

The analysis is, however, deliberately light touch. It draws largely on published literature and modelling rather than market evidence and it reflects conditions at a single point in time. Global steel and commodity markets are complex and changing quickly, and much of what matters most to Western Australia remains uncertain or untested. This includes:

- how much green iron each market will buy, when and at what price
- what premiums customers will pay in practice, as distinct from what modelling and surveys suggest
- which products different customers will want, whether HBI, DR-grade pellets or iron produced through electric smelting
- how certification standards will develop, and whether they will recognise Western Australian production pathways
- how geopolitical events, trade policy and shifts in China’s steel industry will affect demand and investment

These questions warrant considerable further work, including direct engagement with steelmakers and end-users in key markets, testing of real offtake terms and closer analysis of demand in China and India. This work is needed soon. Customers and governments are making investment and procurement decisions now, and Western Australia's first projects will need credible evidence of demand to reach final investment decision. TSI considers this one of the most important areas for further research, and would welcome the opportunity to work with government, industry and research partners to take it forward.

Appendix B

Mid West Iron Ore Resource Profile

Regional Profile[60]

Number of operating iron ore mines 2024	1 magnetite 5 hematite
Current operators	Karara Ansteel, Fenix Resources, Newcam Minerals, GWR Group
Current production	8Mtpa magnetite concentrate ~13Mtpa hematite DSO
Total estimated resource pipeline*	8.2 billion tonnes identified magnetite resource ~465 million tonnes identified hematite resource
Companies progressing projects	Sinosteel Mid West, Hancock Prospecting, Athena Resources, Asia Iron Australia, FI Joint Ventures, Macarthur Minerals, Fenix Resources

** projects at approvals stage of development*

Project Details

Project	Location	Status	Scale	Proponent
Karara	220km southeast of Geraldton, Mid West	Operating	8Mtpa capacity producing magnetite concentrate 62-66% Fe **BF-grade**	Karara Mining (Ansteel Group and Gindalbie Metals JV) Partners: Progressive Green Solutions
Iron Ridge Mine	350km east-northeast of Geraldton, Mid West	Operating	1.3Mtpa **DSO** averaging 63% Fe	Fenix Resources
Shine Iron Ore Mine	230km east of Geraldton, Mid West	Operating	1.2Mtpa **DSO** capacity	Fenix Resources

[60] Based on Geological Survey of Western Australia, "Mines and Mineral Deposits (MINEDEX)", and ASX-listed company annual reports.

Project	Location	Status	Scale	Proponent
Wiluna West Iron Ore Project	570km east-northeast of Geraldton, Mid West	Operating	Forecast production capacity up to 7Mtpa **DSO**	GWR Group Partners: Pilbara Resource Group
Mt Gould Iron Ore Mine	680km northeast of Geraldton, Mid West	Operating	Forecast production capacity around 0.5Mtpa **DSO**	Newcam Minerals
Extension Hill (Mt Gibson) Project	280km south-east of Geraldton, Mid West	Commissioning	5Mtpa capacity to produce magnetite concentrate 65.2% Fe, 8.3% SiO2+Al2O3. **BF-grade**	Asia Iron Australia, Terra Mining Partners: Fenix Resources (transport partner)
Byro FE1 Project	340km north-east of Geraldton, Mid West	Approved	5Mtpa capacity to produce magnetite concentrate 70.61% Fe, 2.2% SiO2+Al2O3. **DR-grade**	Athena Resources Partners: Fenix Resources
Jack Hills Expansion Project	380km north-east of Geraldton, Mid West	Approvals	22Mtpa capacity to produce magnetite concentrate 68.5% Fe, 3.03% SiO2+Al2O3. **DR-grade**	Sinosteel Midwest Group.
Mount Bevan	250km north of Kalgoorlie, Mid West	Approvals	12Mtpa capacity to produce magnetite concentrate 67.44% Fe, 6.0% SiO2+Al2O3. **BF-grade**	Hancock Prospecting Partners: Legacy Iron Ore and Hawthorn Resources
Yogi-Yalgoo Project	250km east-northeast of Geraldton (Yalgoo), Mid West	Approvals	5Mtpa capacity to produce magnetite concentrate 67% Fe, 5.9% SiO2+Al2O3. **BF-grade**	FI Joint Ventures Partners: Green Steel of WA (gas-DRI project MOU)
Lake Giles Project	150km north-west of Kalgoorlie, Mid West	Feasibility	~3Mtpa capacity to produce magnetite concentrate 66.2% Fe, 6.65% SiO2+Al2O3. **BF-grade**	Macarthur Minerals
Weld Range Iron Ore Project	350km northeast of Geraldton, Mid West	Feasibility	Beebyn-W11 forecast 1.5Mtpa **DSO** at full production	Fenix Resources (operator) Sinosteel Mid West (owner) Partners: Sinosteel Midwest Corporation is a subsidiary of China Baowu Steel Group
Blue Hills Mine - Extension Project	225km east of Geraldton, Mid West	Care and maintenance	7Mt **DSO** resource	Sinosteel Mid West

Approvals: environmental assessment, Native Title Approvals (Land, Water) and Aboriginal Heritage Assessment.

Project notes

Karara. Estimated capex spend of $4 billion including $1 billion in common-user infrastructure comprising an 85 km rail line, a dedicated 16Mtpa export facility in Geraldton Port, a 330 kV power transmission line and a 140 km water pipeline. 951Mt JORC reserve. Agreement to supply PGS green iron facility with 8Mtpa concentrate.

Iron Ridge Mine. 2025 Annual Report reports 4.3Mt @ 65.9% Fe (Indicated) and 9.0Mt @ 64.4% Fe (Inferred)

Shine Iron Ore Mine. The Shine Mineral Resource comprises 5.1Mt Measured, 6.3Mt Indicated and 3.6 Inferred.

Wiluna West Iron Ore Project. 2004 JORC Code compliant Resource totalling 130Mt at an average iron grade of 60% Fe including C4, C3 and Bowerbird deposits. Production is ramping up and export via Geraldton Port.

Mt Gould Iron Ore Mine. 2025 Stage 3 Mining Proposal reports 4.53Mt @ 62.1% Fe

Extension Hill (Mt Gibson) Project. Inferred resource of 431Mt with concentrate transported by road and rail to Geraldton Port. Offtake agreement with Baowu.

Byro FE1 Project. Mining lease and heritage agreement approved. 2024 scoping study estimates total resource for FE1 deposit is 29.3Mt @ 24.7%Fe. Capex is estimated at $111 million. Hybrid gas-solar-battery proposed and the concentrate to be transported by road to Geraldton Port.

Jack Hills Expansion Project. 2011 EPA report proposes 2.9Bt magnetite resource with 110Mt DSO hematite resource. Iron product will initially be transported via road to Geraldton Port. As production increases the proposed Oakajee rail and port would be used. Capex is estimated at $3.7 billion.

Mount Bevan. Estimated capex of $5.03 billion to develop the 380Mt indicated JORC resource. Plans to freight concentrate to Esperance.

Yogi-Yalgoo Project. 543Mt inferred resource. concentrate will be transported to the Port of Geraldton via a slurry pipeline. A hybrid gas-renewables power system is proposed for the operations.

Lake Giles Project. Feasibility studies and heritage agreement in progress; mining lease granted. Total reserve for the Moonshine and Moonshine North deposits is estimated at 236Mt. Capex estimated at $810 million with concentrate to be transported by rail to Port of Esperance. A 2022 feasibility study estimated total operating costs of $109/tonne concentrate.

Weld Range Iron Ore Project. Feasibility studies at Weld Range; Beebyn-W11 is operating. Weld Range contains 290Mt @ 56.8% Fe DSO. Fenix 2025 Annual Report estimates 10Mt @ 62.2% Fe for Beebyn-W11 resource. The Weld Range project was put on hold in June 2011 by SMW pending clarification on the development timeline of a port and rail project at Oakajee. In 2025 SMW agreed to a 30-year exclusive Right to Mine Agreement with Fenix who will leverage their existing transport logistics and export infrastructure at Geraldton Port.

Blue Hills Mine - Extension Project. Pending approvals. The project commenced operations in April 2013 and went into care and maintenance in May 2015 due to delays in receiving environmental approval to mine an extension of the resource.

Pilbara Iron Ore Resource Profile

Regional Profile[61]

Number of operating iron ore mines 2024	2 magnetite mines >30 DSO mines
Current operators	BHP, Rio Tinto, Fortescue, Hancock Prospecting, Mineral Resources, Atlas Iron, CITIC Pacific
2024 production	Total magnetite concentrate production 26 Mt Total DSO fines production 680 Mt Total DSO lump production 237 Mt

[61] Based on Geological Survey of Western Australia, “Mines and Mineral Deposits (MINEDEX)”, and ASX-listed company annual reports.

Total estimated resource pipeline	4.1 billion tonnes identified magnetite resource BHP and Rio Tinto have 7 billion tonnes hematite Ore Reserves

Project Details

Project	Location	Status	Scale	Proponent
Sino Iron Project	100km south west of Karratha, Pilbara	Operating	24Mtpa capacity to produce magnetite concentrate 65% Fe. **BF-grade**	Citic Pacific Mining Partners: Mineralogy
Iron Bridge	145km south of Port Hedland, Pilbara	Operating	Initial 5-9Mtpa magnetite concentrate 67% Fe, 5.9% SiO2+Al2O3. **BF- grade**	Fortescue Partners: Formosa Steel IB
Roy Hill	340km south of Port Hedland, Pilbara	Operating	64Mtpa **DSO** capacity	Hancock Prospecting Partners: POSCO
Pilbara Hub	75-80km northwest of Newman	Operating	10Mtpa **DSO** capacity	Mineral Resources
Onslow Iron Project	130km east-southeast of Onslow, West Pilbara	Operating	35Mtpa **DSO** capacity	Mineral Resources Partners: Baowu, AMCI, POSCO
Mt Webber- Sanjiv Ridge - Miralga mines	120-170km south-southeast of Port Hedland	Operating	Combined 10Mtpa **DSO**	Hancock Iron Ore (previously Atlas Iron)
McPhee Creek	200km southeast of Port Hedland, Pilbara	Construction	Planned 9.5Mtpa **DSO** capacity	Hancock Iron Ore (Atlas Iron)
Pardoo-Ridley Project	60km from Port Hedland, Pilbara	Approvals	3Mtpa start-up capacity to produce magnetite concentrate 68.9% Fe, 4.125% SiO2+Al2O3. **BF-grade**	Atlas Iron, Hancock Prospecting. Partners: Atlas Iron, Hancock Prospecting.
Cape Lambert Magnetite Project	20km east of Karratha, Pilbara	Approvals	3Mtpa capacity to produce magnetite concentrate 61.8% Fe, 10.9% SiO2+Al2O3. **BF-grade**	SunMirror AG
Balmoral South Project	80km south-west of Karratha, Pilbara	Approvals	5Mtpa capacity to produce magnetite concentrate 69% Fe, 4.0% SiO2+Al2O3. **BF-grade & DR-grade**	Mineralogy
Balla Balla Magnetite, Vanadium and Titanium Project	10km northwest of Whim Creek, Pilbara	Approvals	6Mtpa capacity to produce magnetite concentrate 57.7% Fe, 3.0% SiO2+Al2O3. **BF-grade**	Forge Resources Swan

Project	Location	Status	Scale	Proponent
Mount Oscar Project	40km southeast of Karratha, Pilbara	Approvals	5Mtpa capacity to produce magnetite concentrate 60.54% Fe, 13.0% SiO2+Al2O3. **BF-grade**	Oscar Resources

Approvals: environmental assessment, Native Title Approvals (Land, Water) and Aboriginal Heritage Assessment.

Project notes

Sino Iron Project. Estimated $51 billion to develop the 806Mt measured resource. Product is exported from the company's Port Preston port via a transhipment method.

The Cape Preston Concentrate can deliver up to 10% net reduction in carbon emissions intensity compared to Platts 62 Pilbara hematite fines.

Iron Bridge. Estimated capex of $6.2 billion to develop 832Mt JORC reserve. Wet concentrate is delivered to Port Hedland via a 135km slurry pipeline. Iron Bridge is scheduled to become the first magnetite operation powered by renewables by 2030.

Roy Hill. Roy Hill supplies around 20% of POSCO's annual iron ore needs.

Pilbara Hub. Includes the Iron Valley and Wonmunna mines with the Lamb Creek operation under development. Product is transported by road for export from Port Hedland. Total estimated resource in 2025 reported as 161Mt @ 57% Fe including 50Mt @ 57.6% Fe Ore Reserve.

Onslow Iron Project. 2024 Ore Reserves 359Mt at 57.5% Fe

Pardoo-Ridley Project. FID delayed. Stage 2 expansion of up to 16.5Mtpa

Cape Lambert Magnetite Project. Retention Licence. A 2009 technical review report estimates a total indicated resource of 1,434Mt @ 30.7%Fe and estimates capex at $3.7 billion. The current retention licence status means paused exploration and mineral definition drilling.

Balmoral South Project. A 2015 ASX release reports an ore reserve estimate of 859Mt @ 31.2%Fe. The ore reserve consists of 3.6Mtpa BF-grade and 8.4Mtpa DR-grade concentrate. Capex is estimated at $4.1 billion and operating cost at $42.59/tonne concentrate. An invalid development proposal in 2012 led to a legal dispute between Mineralogy and the WA government.

Balla Balla Magnetite, Vanadium and Titanium Project. A 2013 EPA report documents a proposed 10km slurry pipeline to transport concentrate to a new port between Port Hedland and Karratha.

Mount Oscar Project. 83Mt indicated resource.

Rio Tinto Pilbara Iron Ore[62]

Total Proved Ore Reserve 2024: 839Mt @ 60.2% Fe

Total Probable Ore Reserve 2024: 1826Mt @ 61.1% Fe

(Pilbara-wide, 100% basis across all joint ventures, by ore type; dry tonnes of marketable product within the current production schedule, as at 31 December 2024)

[62] Rio Tinto, *Annual Report 2024*, 280–81.

Project	Location	Status	Proponent / partners	Notes
Greater Paraburdoo Hub	80km southwest of Tom Price, Pilbara	Operating	Rio Tinto Partners: Mitsui, Nippon Steel, China Baowu Steel Group	Includes the Paraburdoo, Eastern Range, Channar and Western Range operations. Western Range total resource reported to ASX as 232Mt @ 61.2% Fe (2021)
Robe Valley Hub	200km southwest of Karratha, Pilbara	Operating	Rio Tinto Partners: Mitsui, Nippon Steel	Includes the Mesa A and Mesa J mines.
Tom Price Hub	Various locations within 50km of Tom Price	Operating	Rio Tinto	Includes the Tom Price, Maradoo and Western Turner Syncline mines.
Greater Nammuldi Hub	100km northwest of Tom Price, Pilbara	Operating	Rio Tinto	Includes the Nammuldi, Brockman 2 and Silvergrass mines.
Hope Downs Hub	50-100km northwest of Newman, Pilbara	Operating	Rio Tinto, Hancock Prospecting	Includes Hope Downs 1 and Hope Downs 4 mines, with Hope Downs 2 under development.
West Angelas	110km west of Newman, Pilbara	Operating	Rio Tinto	The hub includes state-of-the-art power generation and refuelling facilities that support East Pilbara mine sites.
West Angelas Sustaining Project	110km west-northwest of Newman, Pilbara	Under construction/ committed	Rio Tinto Partners: Mitsui, Nippon Steel	Planned 35Mtpa DSO capacity
Gudai-Darri	110km northwest of Newman, Pilbara	Operating	Rio Tinto	Solar farm supplies around ⅓ of the mine's electricity needs.
Yandicoogina Hub	95km northwest of Newman, East Pilbara	Operating	Rio Tinto	Produces a standalone Hamersley Iron Yandi fines product.
Brockman Hub	60km from Tom Price, Pilbara	Operating	Rio Tinto	The Brockman Syncline is under development and will add to the current Brockman 4 mine production. Total estimated resource ?
Rhodes Ridge Hub	40km northwest of Newman, Pilbara	Feasibility	Rio Tinto Partners: Mitsui, Wright Prospecting	This resource represents roughly one-third of Rio Tinto's current Pilbara resource base. The 2022 Annual report published a total resource estimate of 6800Mt at an average grade of 61.6% Fe including 5.3 billion tonnes at 62.2% Fe and 0.6 billion tonnes at 63.9% Fe.

BHP Pilbara Iron Ore (WAIO)[63]

Total Proved Ore Reserve 2024: 2012Mt @ 62.2% Fe

Total Probable Ore Reserve 2024: 2313Mt @ 61.5% Fe

(Pilbara-wide, 100% basis across all joint ventures, by ore type; wet tonnes of ore delivered to the process facility within current production schedules, as at 30 June 2024)

Project	Location	Status	Proponent / partners	Notes
Jimblebar Hub	40km east of Newman, Pilbara	Operating	BHP Partners: Mitsui, Itochu	Total estimated resource 1622Mt @ 60.4% Fe (2008) including Ore Reserves 425Mt @ 62.7% Fe.
Newman Operations	Newman, Pilbara	Operating	BHP Partners: Mitsui, Itochu	Formerly known as Mt Whaleback. Total estimated resource >4000Mt at average grade 60% Fe (2008) including Ore Reserve 878Mt averaging 62% Fe.
Mining Area C - South Flank Hub	120km northwest of Newman, Pilbara	Operating	BHP Partners: POSCO	MAC consists of 8 open cut mines. South Flank began operating in 2021. MAC total estimated resource >2000Mt at an average grade 60% Fe (2008) including Ore Reserve 576Mt averaging 62% Fe.
Yandi	178km northwest of Newman. Pilbara	Operating	BHP Partners: Mitsui, Itochu	Between 1991 and 2017 Yandi produced 1 billion tonnes of iron ore. Total estimated resource 1844Mt @ 56.6% Fe (2008) including Ore Reserve 1092Mt @ 57.2% Fe.
Western Ridge Crusher	21km southwest of Newman, Pilbara	Under construction	BHP	Will replace production from depleting orebodies around Newman

Fortescue Pilbara Iron Ore[64]

Probable Ore Reserve (magnetite) 2024: 832Mt @ 29.9% Fe

(Probable Ore Reserves, Iron Bridge JV only, 100% basis, Fortescue 69%; dry in-situ tonnes before processing, yielding 248 Mt of 67.3% Fe concentrate; as at 30 June 2024 based)

Total Proved Ore Reserve (hematite) 2024: 1102Mt @ 57.5% Fe

Total Probable Ore Reserve (hematite) 2024: 599Mt @ 57.1% Fe

(Ore Reserves, operating properties only – Chichester and Western hubs; dry product tonnes including mine stockpiles; as at 30 June 2024)

[63] BHP. 'Annual Report 2024.' BHP, 27 August 2024, p222, 228–29.

[64] Fortescue. 'Fortescue 2024 Annual Report.' Fortescue, 28 August 2024, p46–48.

Project	Location	Status	Proponent / partners	Notes
Chichester Hub	100km north of Newman, Pilbara	Operating	Fortescue	Includes the Christmas Creek and Cloudbreak mines.
Solomon Hub	60km north of Tom Price, Pilbara	Operating	Fortescue	

Other Iron Ore Resources

Project	Location	Status	Scale	Proponent
Irvine Island Project	140km north of Derby (Irvine Island), Kimberely	Approvals	3.6Mtpa capacity to produce magnetite concentrate 69.11% Fe, 3.4% SiO2+Al2O3. **DR-grade**	Cockatoo Island Mining (previously Pluton Resources)
Southdown Project	90km northeast of Albany, Great Southern	Approvals	5Mtpa capacity to produce magnetite concentrate 69.4% Fe, 2.7% SiO2+Al2O3. **DR-grade**	Grange Resources Partners: Sojitz Corporation and Shagang Group (offtake rights)

Approvals: environmental assessment, Native Title Approvals (Land, Water) and Aboriginal Heritage Assessment.

Project notes

Irvine Island Project. MINEDEX reports a 2011 inferred resource of 17Mt @ 32%Fe for the Isthmus deposit and an indicated resource of 368Mt @ 21%Fe for the Hardstaff deposit.

Southdown Project. The 2025 feasibility study reported a 412Mt ore reserve and estimated capex of $2.34 billion. Operating costs are estimated at $117.1/tonne concentrate. A 110km slurry pipeline is proposed to transport wet concentrate to Albany Port for export and a renewable PPA is being considered to power the operations. Grange has halted approvals from progressing while they seek to attract an equity partner to raise the necessary capital to develop the project.

Appendix C

WA Green Iron and Green Steel Projects

Information based on publicly available sources as of 13 November 2026

Project	Location	Status	Scale	Proponent
Green Metal Project	Christmas Creek, Pilbara	Commissioning	Pilot facility with 1,500tpa capacity.	Fortescue
Port Hedland Iron Project	Boodarie, Port Hedland, Pilbara	Approvals	Commercial 2.0Mtpa green iron HBI + 0.7Mtpa pellets	POSCO Partners: Marubeni, China Steel Corporation and BHP
Mid West Green Iron	100km east of Geraldton, Mid West	Feasibility	Commercial 2.5Mtpa green iron (HBI) + 3.5Mtpa pellets	Progressive Green Solutions (PGS) Partners: Karara Mining, ThyssenKrupp Nucera, Hyundai
Collie Steel Mill	Collie, South West	FID anticipated Q1 2027	Commercial 450 ktpa steel rebar	Generation Steel Australia Partners: Danieli (technology partner)
NeoSmelt	Kwinana, Perth	FID anticipated H2 2026	Pilot 30 ktpa	BlueScope Partners: AMB Holdings, BHP, Mitsui Iron Ore Development, Rio Tinto, Woodside
Zesty Green Iron Demonstration Project	Kwinana, Perth	Detailed design	Pilot facility with 30,000tpa hydrogen DRI capacity.	Calix Partners: ARENA, Rio Tinto, Perdaman
Mid West Green Iron	165km south of Geraldton, Mid West	Concept	Commercial green iron	Athena Resources Partners: Warradarge Energy, Fenix Resources
Mid West DRI	Mid West	Concept	Commercial 2.5Mtpa HBI	Green Iron and Steel (formerly Green Steel of WA) Partners: FI Joint Ventures, Tempest Minerals, Meranti Green Steel
BioIron	Kwinana, Perth	Paused	Lab	Rio Tinto Partners: University of Nottingham, Metso

Project	Location	Status	Scale	Proponent
Green Iron Electroreduction Demonstration Module	Malaga, Perth	Not stated	Pilot	Element Zero Partners: ARENA
Clean steel smelter module	Port Hedland, Pilbara	Not stated	Commercial 1Mtpa green pig iron	Metal Logic

Approvals: environmental assessment, Native Title Approvals (Land, Water) and Aboriginal Heritage Assessment.

Project notes

Green Metal Project. The project is located at the Green Energy Hub at Christmas Creek. The plant will use green hydrogen in a reduction furnace to convert local hematite iron ore into sponge iron, which is further processed in an electric smelting furnace (ESF), to produce high purity green pig iron. The first hot metal production from the ESF was announced 19 August 2026.

Source: Fortescue. “Fortescue Produces First Hot Metal in Milestone towards Australian Green Iron.” Fortescue News, 19 August 2026.

Port Hedland Iron Project. Stage 1 iron ore processing facility comprising one pellet and one HBI plant producing approximately 2Mtpa of HBI and 0.7Mtpa of iron ore pellets for export. Stage 1 has received State and Commonwealth approvals including for the facility to use a Midrex gas-based shaft furnace which will transition to hydrogen by 2049 assuming a commercially available supply of renewable hydrogen is available.

POSCO intends to complete a demonstration facility of their HyREX technology in Korea by 2028. The HyREX technology will enable the use of lower grade hematite ores via a green hydrogen DRI pathway.

Sources: Phiron. “Project Description.” PHI webpage, accessed October 2026; EPBC Act Public Portal, Port Hedland Iron Project – Stage 1 (formerly Port Hedland Green Steel Project – Stage 1), Assessment number 2381; Minister for Environment (WA), Ministerial Statement 1268.

Mid West Green Iron. Phase 1 proposed scale 2.5Mtpa green HBI + 3.5Mtpa green DR-grade green pellets for export by Q4 2030 through Karara’s berth at Geraldton Port. Phase 2 to scale up to 50Mtpa DR-grade green pellets and 10Mtpa green HBI by 2032.

PGS and Karara Mining (Ansteel) signed a Heads of Agreement for a PPA for PGS to supply Karara mine from its Three Springs Renewable Energy Project.

Source: Progressive Green Solutions, LinkedIn post, July 2026.

Collie Steel Mill. The Collie Steel Mill is Australia's most advanced green steel mill project, with construction and technology partners in place, a renewable power purchase agreement (PPA) with BHP and backing from the state government.

Production includes an Electric Arc Furnace (EAF) capable of being run on 100% renewable energy with continuous casting and rolling to produce 450,000 tonnes a year of low-emissions steel.

Generation Steel Australia announced pre-construction work began on 30 October 2026 with the construction contract expected to be awarded in the first quarter of 2027 subject to the proposal and to financial close.

Source: Generation Steel. ‘Collie Steel Mill begins pre-construction work after Clough and Danieli join the project.’ Generation Steel media release 30 October 2026.

NeoSmelt. The NeoSmelt pilot facility aims to investigate the feasibility of the novel DRI-ESF route to address the use of Pilbara ores in lower-carbon emissions steelmaking. In this route, impurities are removed after the direct reduction step in an ESF which has greater flexibility to use lower grade Pilbara ores compared with an EAF. Hot metal produced from an ESF can be refined downstream in existing BOF infrastructure or an EAF to produce lower carbon-emissions steel.

If successful, the pilot could enable the proliferation of industrial scale DRI-ESF into existing and new customer markets to accelerate a pathway to near zero emissions intensity steelmaking utilising Australia’s Pilbara ores.

ARENA has committed $19.8 million to support a Front-End Engineering Design (FEED) study and the WA Government has invested $75 million and awarded it Priority Project status.

Sources: NeoSmelt, website; Government of Western Australia, "Nation's Largest Ironmaking Electric Smelting Furnace Set for WA"; Department of the Premier and Cabinet (WA), "Project NeoSmelt."

Zesty Green Iron Demonstration Project. The ZESTY Demonstration Plant is designed to provide an industry-wide facility for the non-exclusive toll processing of iron ores from a range of sources into a hydrogen direct reduced iron product. The technology uses a combination of electric heating and hydrogen reduction to produce green iron. It provides a high degree of temperature control allowing highly flexible production rates making it compatible with renewable energy sources. It uses a theoretical minimum H2 use of 54kg/t iron and can directly process fines and lower-grade ores without pelletising.

The demonstration project is supported by a $44.9m grant from ARENA, a Joint Development Agreement with Rio Tinto that includes over $35m of cash and in-kind contributions to the project, an agreement with Perdaman to deliver the engineering and design of a hydrogen supply solution and a supply agreement with Generation Steel to supply DRI to their Collie steel mill.

Sources: Calix, "ZESTY Green Iron Demonstration Project", Calix webpage accessed October 2026; Calix. "Calix and Perdaman Partner to Develop Hydrogen Supply for ZESTY Green Iron Demonstration Project." Calix News, 27 August 2026; Calix. "Generation Steel Signs Agreement to Buy ZESTY-Produced DRI for Collie Mill." Calix Investor Centre, 29 October 2026.

Mid West Green Iron. Project intends to transform the high-grade magnetite from Athena's Byro Project into green iron via a green hydrogen DRI pathway.

Sources: Athena Resources, "Mid West Green Iron Project"; ASIC. Warradarge Energy Pty Ltd. ASIC Published Notices, 15 September 2026.

Mid West DRI. Green Iron and Steel have been developing partnerships with steel manufacturers and Mid West magnetite resource companies since 2023 to develop a gas to hydrogen DRI project and a magnetite processing hub.

Sources: Meranti Green Steel. "GSWA and MGS Launch Cooperation on Green HBI Project in Western Australia." Meranti Green Steel blog, 5 December 2023; FIJV. "FIJV Has Signed an MoU with Green Iron and Steel Australia." FI Joint Venture News, 15 April 2025; Tempest Minerals. "Option Agreement with Green Steel to Acquire Remorse Project." Tempest Minerals Investor Hub announcement, 10 December 2025.

BioIron. BioIron™ uses raw biomass and microwave energy instead of coal to convert Pilbara iron ore to iron. When combined with renewable energy and carbon-circulation by fast-growing biomass, BioIron™ has the potential to reduce CO2 emissions by up to 95% compared with the current blast furnace method. Research and development of the technology continues however the proposed pilot scale facility at Kwinana has been paused.

Source: Rio Tinto. "Rio Tinto Partners with Calix to Test Low-Emissions Steel Making in Western Australia, Pauses BioIron." Rio Tinto News Release, 17 November 2025.

Green Iron Electroreduction Demonstration Module. Element Zero currently operates a 10 kg per day continuous high-purity iron plant using renewable energy at its technology facilities in Perth. The next phases are supported by $26m from ARENA and aim to scale the technology to 1 then 10 tonnes per day, subject to ARENA approval. establishing the modular plant design that we ultimately intend to deploy at commercial scale in the Pilbara

Electrochemical reduction process can flexibly utilise various grades of ore and is designed to use 30–40% less energy per tonne than conventional coal- or gas-based processes.

Sources: Element Zero. "Element Zero Secures Up to $26 Million from ARENA for Green Iron." Element Zero News, 2 September 2026; Element Zero, "Technology."

Clean steel smelter module. Metal Logic has developed a clean smelter technology as its test facility in Victoria. The company aims to deploy an initial 1Mtpa 'fee for service' facility of their modular array smelting technology at their site near Port Hedland. Focusing on thermodynamic efficiency to minimise costs and lower emissions, Metal Logic's initial product focus is rebar for the construction sector, targeting demand from government infrastructure projects.

Sources: Metal Logic. "Metal Logic Purchases Pilbara Site to Deploy Grade-Agnostic, Scalable Modular Clean Steel Smelter." Metal Logic Media Release, 13 March 2026.

Appendix D

WA Modelling Methodology

This appendix describes the modelling approach used for the *Western Australia Green Iron Roadmap* (*Roadmap*) and its companion document, *Digging Deeper: Modelling green iron in Western Australia* (*Digging Deeper*). The model was first developed for *A Green Iron Plan for Australia* (*GIPA*) and has since been adapted for Western Australian conditions.

This appendix sets out the model structure, scenarios, inputs and assumptions for regional processing pathways and facility interactions with the WEM.

The appendix supports transparency and interpretation. It does not present results or recommend preferred technologies or project configurations. Results are reported in Chapter 4 of the *Roadmap*. Broader implications for policy are addressed in the main body of the *Roadmap*.

1. Model Approach

For *GIPA*, TSI partnered with Bivios to develop a model of green iron investment and production. The model identified the lowest-cost combination of capital investment, technology choice and production volumes for each location, ore type and production technology. *Digging Deeper* uses the same model, adapted for Western Australian conditions.

The *GIPA* model also showed how costs respond to key variables, including location, renewable resource quality, capital costs, ore type and production technology. It also quantified the value of trading surplus or deficit energy through an electricity market, largely assumed to operate on the same basis as the National Electricity Market.

Each modelled project integrated renewable electricity generation, green hydrogen production and green iron production. Each plant was assumed to produce 2.5 million tonnes of iron per year, a likely scale based on commercially available plant sizes. The model used forecast capital costs for 2030, reported in 2025 dollars. Production costs reflected those of producers in an established green iron industry, rather than first-of-a-kind producers who face higher borrowing costs.

The main output was the levelised cost of iron (LCOI), which allowed costs to be compared across locations, ore types and technologies. The model also reported energy flows, capital costs and emissions intensity.

Each scenario was modelled for two production technologies:

- **Inflexible technology,** operating continuously at a steady rate.
- **Flexible technology,** able to vary its output to match variable renewable electricity supply.

Digging Deeper retains *GIPA*'s model structure and production technologies. Almost all other inputs and assumptions have been updated to reflect the specific circumstances of WA's two iron ore regions, the Mid West and the Pilbara, including the electricity systems and markets available (or not) at each location.

Costs for renewable energy, hydrogen production, transmission, iron ore, transport and natural gas have been updated for currency. New inputs, including electricity and gas network connections, port fees and road construction, give a more complete picture of project costs in the local context. Historic WEM bid data have been added, and hourly solar and wind data now draw on improved and more localised sources.

The most significant change is how a plant interacts with the WEM. *GIPA* quantified the value of trading surplus or deficit electricity through a market assumed to operate largely on the same basis as the National Electricity Market (NEM). The two markets have significant structural differences and *Digging Deeper* therefore models the WEM directly. Together with revised locational costs, these refinements allow the model to better reflect conditions in the Mid West and the Pilbara.

There has also been a significant revision made to locational capital cost factors. *GIPA*'s figures were drawn from limited publicly available information, published in 2018.[65] To ensure a more contemporary set of figures, TSI engaged with organisations currently delivering large capital works programs in regional WA (particularly in electricity transmission).

These refinements build on the model used in *GIPA*, tailoring it to the unique WA context. By more accurately reflecting conditions in the Mid West and Pilbara, particularly locational costs and energy market characteristics, the model indicates where state and Commonwealth initiatives can most effectively support green iron project development.

1.1 Updated inputs

The following inputs were updated in the *Digging Deeper* model:

- **Unit capital costs for renewable energy generation, hydrogen production and battery storage.** GenCost 2025-26 shows notable increases on GenCost 2024-25 (used in *GIPA*) including an 18 per cent rise in solar costs and a 28 per cent rise in electrolyser costs. [66]
- **Locational capital cost factors (see also** section 1.5). Updated following consultation with Horizon Power, Western Power and other stakeholders. TSI also analysed cost stacks from publicly available data from the Chichester Hub solar farm, Greenough River solar farm Stage 2, Warradarge wind farm Stage 1 and Yandin wind farm
- **Transmission costs.** Following consultation with Western Power, the levelised cost of transmission lines (in $ million per km per GW) is double that used in *GIPA*. Connection

[65] GHD, *AEMO Costs and Technical Parameter Review*, 116 and appendix A.

[66] Graham and Hayward, *GenCost 2025-26*. Notable increases compared with the GenCost 2024-25 used in GIPA include an 18 per cent rise in solar costs and a 28 per cent rise in electrolyser costs.

costs have also been substantially updated, both for variable and fixed network tariffs[67] and for capital investment.[68]

- **Iron ore costs.** Iron ore costs are specific to each scenario and come from the same source used in *GIPA*. The Mid West BF-grade magnetite scenario, processed via a DRI-ESF route, uses the 65 per cent Fe benchmark price. The Mid West DR-grade magnetite scenario adds a beneficiation premium of around $20 per tonne iron ore to the 65 per cent Fe benchmark. The Pilbara hematite scenario uses a 62 per cent Fe benchmark.
- **Transport costs.** Sea and road freight costs for HBI from the plant to on board for export are treated as export costs and specifically relate to the Oakajee and Boodarie scenarios.
- **Natural gas costs.** Pelletising, which prepares iron ore for the inflexible DRI process, uses natural gas. Gas unit costs are sourced from the ACIL Allen industrial forecast with relevant pipeline tariffs included.[69]
- **Historic hourly solar and wind data.** Updated to reflect revised locations of renewable generation sources and most recent Bureau of Meteorology atmospheric reanalysis model.[70]

More information on the updated inputs is available in the *Digging Deeper* report.

1.2 New inputs

Digging Deeper adds the following inputs :

- **Electricity grid connection capital costs.** These cover the capital equipment needed to connect to the electricity grid at the connection point. These are based on indicative Western Power data and the TRT1 network tariff from the Three Springs Terminal.[71]
- **Port export costs** (per tonne of iron). These cover the cost of shipping through the existing ports at Geraldton and Port Hedland, following consultation with the Mid West Ports

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[67] As they relate to Reference Tariff TRT1 at Three Springs Terminal exit point. Western Power. '2025/26 Price List for the Western Power Network.' Western Power report, approved by ERA 16 May 2025.

[68] Consists of a 330kV terminal to be installed at the plant end of the Three Springs Terminal transmission line. This is a conservative (i.e. upper bound) estimate with a comprehensive network analysis needed to determine actual plant-end infrastructure. Additional scaled costs associated with existing terminal upgrades, communications, all line and site location work.

[69] We modelled natural gas costs based on ACIL Allen industrial gas forecasts for capital cities (Adelaide, Brisbane, Perth), which are also used in AEMO's Gas Statement of Opportunities. ACIL Allen, 'ACIL Allen Fuel Price Report: Wholesale natural gas prices for AEMO Final Report.' Australian Energy Market Operator, 14 November 2025; Australian Energy Market Operator, 'Gas Statement of Opportunities.' AEMO, March 2025.

[70] Solar capacity factors are from Renewables.ninja (MERRA foundation) for a single-axis tracking solar panel. Wind traces are from the BARRA-C2 reanalysis model, with capacity factor calculations based on a Vestas V162-7.2MW wind-to-power conversion curve at a hub height of 100 metres and assuming an air density of 1.2250kg/m^3. BARRA-C2 is on average superior to MERRA, ERA5 and BARRA as per a CSIRO validation study. This has been confirmed by TSI's own analysis of sodar instrument readings in central Queensland. Renewables.ninja, "About"; Bureau of Meteorology, BARRA-C2 reanalysis; Vestas. 'Performance Specification EnVentus V162-7.2 MW 50/60 Hz, Document no. 0114-3777 VO2.' Vestas report, 31 March 2022; Palmer G, Dargaville R, Su C, Wang C, Hoadley A, Honnery D. "Validation of BARRA2 and comparison with MERRA-2 and ERA5 using historical wind power generation." *Journal of Southern Hemisphere Earth Systems Science* 75, ES24028, 2025.

[71] Western Power. '2025/26 Price List for the Western Power Network.' Western Power report, approved by ERA 16 May 2025, p27ff.

Authority. The cost of iron is reported on a Free on Board basis (on board the export vehicle).

- **Road export costs** (per tonne of iron). Added to incorporate the cost of road freight between the iron-making plant and relevant port.[72]
- **Historic WEM bid data**. Dispatch interval supply curves from AEMO's WEM case files.[73]
- **Natural gas pipeline.** Added capital cost for a small gas lateral (i.e. 3-7 TJ/day depending on ore type) to supply pelletising.[74]

1.3 Scenarios

The *Digging Deeper* scenarios were updated to align with current government initiatives and infrastructure programs in the Mid West and Pilbara. As in *GIPA*, all scenarios assume integrated renewable energy, hydrogen and green iron production.

In the Pilbara, green iron production is located at the Boodarie Strategic Industrial Area, using off-grid renewables located 80 km south of Eighty Mile Beach. Local hematite fines are processed at the green iron facility.

In the Mid West, green iron production is located at the Oakajee Strategic Industrial Area, 20 km north of Geraldton. It is connected to the SWIS, with behind-the-meter renewable generation located near Mullewa. The Oakajee scenarios test three ore types:

- high-grade (DR-grade) magnetite concentrate
- lower-grade (BF-grade) concentrate and
- Pilbara hematite fines shipped through Geraldton Port.

The two magnetite grades reflect beneficiation limits and the magnetite products currently exported from Western Australia. The hematite scenario tests processing Pilbara ore in a grid-connected location.

Table D.1: Updated characteristics of different iron-making locations based on refined assumptions and additional scenarios

Location	Connected to WEM	Locational capital cost factor	Iron ore type	Inflexible technology processing	Flexible technology processing
Boodarie (Pilbara)	No	1.55	Pilbara lower-grade hematite	Pelletisation + vertical shaft furnace DRI + ESF	Flash smelting DRI + ESF
Oakajee (Mid West)	Yes	1.15	Pilbara lower-grade hematite	Pelletisation + vertical Shaft Furnace DRI +	Flash smelting DRI + ESF Furnace

[72] Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, "Supply Chain Transport and Logistics Dashboard."

[73] Australian Energy Market Operator, "Market Data WA," case files.

[74] GHD. 'Gas Infrastructure Cost, Building Block costs for gas infrastructure.' GHD for AEMO, 15 May 2025.

Location	Connected to WEM	Locational capital cost factor	Iron ore type	Inflexible technology processing	Flexible technology processing
				ESF	
Oakajee (Mid West)	Yes	1.15	Mid West DR-grade magnetite	Pelletisation + vertical Shaft Furnace DRI	Flash smelting DRI
Oakajee (Mid West)	Yes	1.15	Mid West BF-grade magnetite	Pelletisation +vertical Shaft Furnace DRI + ESF	Flash smelting DRI + ESF

1.4 Additional scenarios not modelled

Digging Deeper focuses on the green iron pathways where WA has a comparative advantage. The following were not modelled:

- **Pilbara magnetite processed in the Pilbara:** The Pilbara scenario uses hematite, the region's dominant ore type. Magnetite-based production is represented by the Mid West scenarios.
- **Transitional gas-based DRI pathway:** *GIPA* identified that gas-based DRI is currently a lower-cost pathway than a green hydrogen production pathway but has a greater emissions profile. TSI's position is that gas-based production does not align with WA's long term comparative advantages or emissions objectives and is unlikely to be globally competitive. WA's enduring strengths lie in world-class renewable energy resources and the potential to produce competitive renewable hydrogen at scale, rather than in natural gas supply.
- **Scrap-based green steel pathway (EAF recycling model):** A scrap-based EAF plant would need some DRI feedstock. It was not modelled because of constraints on scrap supply and a lack of suitable capital cost data for an integrated EAF and rebar plant.
- **No Kwinana Scenario:** *GIPA* modelled production at the Kwinana Industrial Area. *Digging Deeper* did not update this scenario because of site constraints and the limited likelihood of a commercial-scale green iron plant being located there.

1.5 Locational capital cost factors

Capital costs can vary by location because of equipment, installation, fuel connection, land and development, and O&M costs. Locational capital cost factors capture these differences and are applied to GenCost capital costs.

GIPA drew on limited publicly available information: the most recent national study of locational capital cost factors that provided detail across all these components, published in 2018.[75]

[75] GHD. 'AEMO Costs and Technical Parameter Review, Report Final Rev 4 (9110715).' GHD report, September 2018, p116 and appendix A.

For *Digging Deeper*, to obtain more contemporary figures, TSI consulted organisations currently delivering large capital works programs in regional WA, particularly in WA. These included Horizon Power, Chamber of Minerals and Energy WA and Western Power. The consultation focused on how projects are treating locational cost variation in the Mid West and Pilbara. As a result, *Digging Deeper* saw the 'Pilbara premium' increase from 1.34 to 1.55, while the Mid West moderated from 1.24 to 1.15.

These factors, and the GenCost data to which they are applied, reflect the costs generally available to a new project in each region. Some established operators in the Pilbara have indicated they can build renewable energy assets at materially lower cost, drawing on existing infrastructure, scale, supply chain relationships and access to finance. These advantages are unlikely to be available to every proponent, particularly new entrants.

1.6 Updates to interaction with the Wholesale Electricity Market

GIPA assumed unconstrained access to a wholesale market operating largely like the National Electricity Market (NEM). *Digging Deeper* models the WEM more directly, using historic market data. This better approximates both the cost of importing electricity and the value of exporting it. It remains an approximation of a more complex commercial reality. Further detail is provided in the *Digging Deeper* report, available on the TSI website.

1.6.1 The WA electricity market

The model is based on the WEM's merit order dispatch system where:

1. **Supply offers** are ranked by price (lowest to highest)
2. Offers are **dispatched** in order until demand is met
3. The **clearing price** is set by the most expensive offer dispatched (marginal pricing)
4. All dispatched participants receive the clearing price

The WA model will seek to **import** electricity when there is insufficient electricity generated from the renewable assets directly connected to the green iron plant to meet the total demand for electricity which includes the needs of water, hydrogen and iron production. The import of electricity is limited by the emissions constraint of the HPTI (0.6 kgCO_2e per kg of hydrogen) over the course of the simulated year.

In applying this constraint, the model uses the physical emissions intensity of electricity drawn from the grid. In practice, this limits grid imports to around 2 to 3 per cent of the plant's annual electricity demand. The model does not test renewable power purchase agreements or surrendered certificates, which could allow greater use of the grid.

The model will seek to **export** electricity when all the requirements for electricity have been met, and there is still additional electricity available from the directly connected renewables (i.e. electricity which would otherwise be curtailed). Electricity demand from hydrogen production may also be reduced by the system if electricity prices are high enough that the value of the electricity exported is greater than the value of iron that can be produced from the hydrogen.

For both cases, the model uses historic market data in each hour to recreate the dispatch of all facilities in the WEM, based on the prices and volumes they offered. For the import case, the

total system demand is increased by the demand from the green iron facility, which may increase the clearing price. For the export case, an export volume is offered into the market. This may reduce the clearing price.

1.6.2 The Reserve Capacity Mechanism

The Reserve Capacity Mechanism (RCM) is designed to ensure that there is sufficient generation capacity available to meet demand during peak periods in a year.

The RCM imposes costs on loads which operate during peak periods and provides revenue to generators which are available to provide capacity during peak periods. Revenue can also be generated by loads which are able to guarantee a certain level of turn down during peak periods.

The *Digging Deeper* model assumes that the flexible technology would not incur RCM costs because it reduces its demand for grid electricity during peak periods. To approximate this, we include as inputs into the model a flag for the peak periods for the year of historic weather and market data. During these periods iron production is curtailed to avoid incurring an RCM liability.

For the inflexible iron plant, we assume that it is not possible to reduce production to avoid the RCM liability.

The full *Digging Deeper* analysis and associated inputs and supplementary materials are available for download from the TSI website.

Appendix E

TSI Green Iron Scorecard

Introduction: Why a Scorecard?

This appendix operationalises the project assessment scorecard outlined in Chapter 7. While Chapter 7 establishes the strategic purpose and high-level application of the Scorecard, this appendix provides the detailed assessment criteria, governance processes and implementation guidance required to put the Scorecard into practice.

Chapters 5, 6 and 8 establish the strategic framework, indicative sequencing and infrastructure requirements for Western Australia's green iron development. This appendix addresses the operational question that follows: how should government prioritise among competing projects when infrastructure capacity and coordination resources are finite?

The challenge is simple: More projects will seek more government support than government can accommodate simultaneously. Infrastructure coordination, prioritised approvals, policy support and public investment all require choices. Without transparent criteria, those choices appear arbitrary, creating uncertainty for proponents and political risk for government.

A Scorecard provides the framework for defensible prioritisation. It makes trade-offs explicit, guides infrastructure allocation decisions and establishes clear expectations for proponents. This is particularly important for green iron where government is coordinating system-level infrastructure rather than simply approving individual projects.

What the Scorecard Does

The Scorecard is a framework for assessing projects against strategic criteria aligned with this *Roadmap*. It determines priority tiers for government coordination and support rather than providing binary approval or rejection decisions. Projects can proceed through private pathways regardless of Scorecard assessment, but public resources should flow to highest-priority projects.

This appendix presents an indicative framework. The Scorecard is intended for application in the Western Australian context and should be refined through Government's planning processes and developed in consultation with industry. What follows is TSI's assessment the criteria that could be incorporated. TSI makes no recommendation on how they should be weighted, which is a matter for Government. Government should operationalise this through its own processes.

Relationship to Existing Government Processes

Critical clarification: The Scorecard is intended to complement existing assessment processes; it does not replace them. Multiple Western Australian government entities already have project assessment methodologies, including:

- **Department of Energy and Economic Diversification (DEED):** Major project assessment methodologies for industrial projects
- **Treasury:** Business case evaluation frameworks for infrastructure and investment decisions
- **Western Power:** Critical Projects Framework with readiness assessment criteria for network connection projects
- **EPA and other regulatory agencies:** Standard assessment and approvals processes

Projects still require environmental approvals, Native Title agreements, development approvals and standard regulatory compliance. The Scorecard adds a strategic prioritisation layer that:

- Aligns with the *Roadmap's* strategic framework
- Adopts project finance due diligence rigour
- Guides infrastructure coordination and government support allocation
- Makes strategic trade-offs transparent and defensible
- Integrates with (rather than duplicates) existing assessment frameworks

Government ultimately retains all decision-making authority. The Scorecard is a tool for Government's use, not an external constraint on government discretion.

Consultation and Refinement Process

Industry consultation is essential. Scorecard criteria, weighting and assessment processes should be developed transparently with input from potential proponents and other key stakeholders. This serves multiple purposes:

- Ensures criteria are practical and assessable
- Builds industry understanding of government priorities
- Identifies potential unintended consequences or perverse incentives
- Creates buy-in for the scorecard

Scorecard development itself should be a transparent, consultative process to guide infrastructure allocation decisions as projects advance. Early external engagement is essential, particularly where the Scorecard is used to guide resource allocation. It should be reviewed regularly and updated as circumstances change.

A Fundamental Question: What Is the Scorecard Actually For?

Before this tool can be effectively applied, government must resolve a critical conceptual question: **What is the fundamental purpose of the Scorecard?**

This is not merely a technical question about assessment methodology. It is a foundational policy decision about government's role in green iron development and one that should be clarified through policy development and strategic planning before the Scorecard is operationalised. This question directly relates to the strategic framework and rationale for government involvement established in Chapter 5.

At its core, the Scorecard must answer one of two distinct (though related) questions:

1. The Due Diligence Question: "Is this project viable on its own merits?"

- Can the proponent deliver technically and financially?
- Is the technology proven? Is ore available? Is offtake credible?
- Would project finance lenders fund this project?
- Is this a sound commercial proposition?

2. The Strategic Prioritisation Question: "Is this where Government should focus its limited resources?"

- Which projects advance government priorities most effectively?
- Which deliver greatest economic leverage and fiscal return?
- Which build capability most valuable for subsequent phases?
- Which projects warrant bespoke lighthouse support vs standard processes?

Ideally, these would be separate assessments. Due diligence determines viability. Strategic prioritisation determines where government focuses limited coordination resources among viable projects.

However, in practice, they merge, particularly when governments provide financial support through agencies like the Clean Energy Finance Corporation (CEFC) or government trading enterprises (GTEs). In many instances, governments are simultaneously assessing viability AND making strategic resource allocation decisions. Financial participation can blur the line between "viable project that happens to receive government support" and "project made viable by government support."

This convergence creates fundamental policy questions across three dimensions:

Due diligence approach:

- Should government assess projects the way project finance lenders would?
- Is government screening for commercial viability before deciding where to lean in?
- Or is government's role to de-risk projects that wouldn't otherwise proceed?

Prioritisation philosophy:

- Does government prioritise the most commercially attractive projects (least government support needed)?
- Or does government prioritise projects with greatest strategic value, even if they require more support?
- How does government weigh "project that doesn't need much help" vs "lighthouse project requiring bespoke support but advancing critical priorities"?

Blended finance role:

- When Government provides capital, is it filling a market gap or making strategic bets?

- Does government capital validate commercial viability or substitute for it?
- Should government-backed projects meet same viability standards as purely private projects?

TSI's position: Different policy stances lead to fundamentally different Scorecard designs and weighting emphasis. Government must choose its approach before operationalising the tool.

Government as "backer of the strongest projects":

- Scorecard emphasises commercial viability criteria heavily
- Due diligence questions dominate
- Government prioritises projects most likely to succeed independently
- Bespoke support minimised; standard processes apply broadly

Government as "enabler of first-movers":

- Scorecard emphasises strategic value alongside viability
- Government accepts that lighthouse projects require bespoke support
- Some projects receive priority precisely because they need coordination to succeed
- Economic leverage and capability building weigh heavily

Government as "system builder":

- Scorecard emphasises infrastructure coordination, sequencing, system benefits
- Early projects may score highly despite requiring more support because they enable subsequent projects
- System-level benefits valued alongside project-level viability

Most likely: government's role will vary by phase of industry development and by project type (Chapter 6). In the foundation phase, lighthouse projects may warrant an enabling or system-building approach. In the scale-up phase, projects should demonstrate stronger commercial viability with less bespoke support. In the maturity phase, government mostly facilitates commercially driven development. These phases describe the maturity of the industry, not an order between regions: early projects in the Mid West and long-lead work in the Pilbara proceed in parallel.

This *Roadmap*'s approach: Present a comprehensive range of criteria, covering both due diligence and strategic prioritisation. Government determines emphasis through policy development. Depending on the position government takes, the Scorecard could emphasise or include any number of the following criteria, with differing weights and assessment approaches.

The criteria below are organised to help government navigate this question. Some criteria are fundamentally about viability (technology readiness, financial credibility). Some are fundamentally about strategic value (economic leverage, capability building). Some bridge both (carbon pathways are both viability requirement AND strategic priority). Government must determine the balance.

Indicative Scorecard Criteria

TSI proposes criteria for project assessment across three domains: **Project Fundamentals** (the hard practical requirements), **Strategic Value** (alignment with government priorities and economic benefits), and **Delivery Capability** (capacity to execute). These are high-level at this stage and require detailed development through government's process. Government should determine weightings through its own processes and consultation.

The detailed assessment criteria that follow in this appendix represent TSI's indicative Scorecard for project assessment. This framework represents TSI's initial thinking on what might be assessed and how. It should be treated as a starting point for consultation with industry and government refinement, not as a final assessment tool.

Assessment approach: Each criterion below includes assessment factors, due diligence requirements and rationale for its importance. This provides both conceptual structure and operational detail for implementation.

The 15 criteria at a glance

Domain 1: Project fundamentals		
1	**Land Tenure and Site Access**	Projects without secure land tenure cannot proceed regardless of other merits.
2	**Access to Existing Infrastructure**	Infrastructure access determines project cost and timing.
3	**Hydrogen Supply Pathway**	Hydrogen is the largest operating cost component.
4	**Technology Readiness and Technical Credibility**	Unproven technology or weak partners create delivery risk regardless of other factors.
5	**Market Positioning and Offtake Security**	Without credible offtake, revenue assumptions are speculative.
6	**Project-on-Project Risk Management**	Projects with high dependencies on other uncertain projects carry higher delivery risk.
Domain 2: Strategic value		
7	**Strategic Alignment with Government Priorities**	Government coordination resources should flow to projects advancing government priorities.
8	**Economic Leverage and Fiscal Impact**	Projects delivering greater economic leverage provide stronger return on government investment.
9	**Clear and Transparent Carbon Reduction Pathways**	Carbon credentials are fundamental to the value of green iron.
10	**Infrastructure Coordination and Shared Benefits**	Coordination efficiency, but assessment must not penalise necessary early infrastructure.
Domain 3: Delivery capability		
11	**Financial Viability and Capital Structure**	Distinguishes projects with credible financing from those without.
12	**Government Support Requirements**	Government resources are finite. Understanding support requirements helps prioritise efficiently.

13	**Community Engagement and Social Licence**	Social licence is essential. Projects facing community opposition face delays and reputational risk.
14	**Traditional Owner Partnerships**	Essential for social licence and industry success, as emphasised in section 8.5.
15	**Environmental and Social Governance (ESG)**	ESG performance affects social licence, regulatory approval and reputational risk for government association.

Each criterion is set out below with its assessment factors, the due diligence it needs and why it matters.

Domain 1: Project fundamentals

These are the "hard" practical requirements that determine whether a project can physically proceed.

Criterion 1: Land Tenure and Site Access

Assessment factors:

- **Land tenure security:** Freehold ownership, long-term lease, tenure arrangements adequate for project life
- **Site control:** Legal rights to occupy and develop the site
- **Native Title:** Status of Native Title processes, agreements reached or pathway to agreement
- **Access rights:** Road access, infrastructure corridors, easements secured or planned
- **Third-party approvals:** Landowner consents, access agreements with neighbouring operations

Due diligence required:

- Title searches and/or tenure verification
- Native Title agreement status and negotiation progress
- Access agreement review
- Site inspection and confirmation of physical access

Why this matters: Projects without secure land tenure cannot proceed regardless of other merits. This is a fundamental gate.

Criterion 2: Access to Existing Infrastructure

Assessment factors:

- **Water infrastructure:** Access to existing water systems or clear pathway to new supply (desal, pipelines)
- **Ports:** Access to existing port capacity (Geraldton, Pilbara ports) or timing aligned with new infrastructure (Oakajee)
- **Road and rail:** Access to existing transport networks or requirements for new infrastructure

- **Pipelines and services:** Access to existing services or requirements for new development
- **Proximity to infrastructure:** Distance to existing infrastructure and cost implications

Due diligence required:

- Infrastructure capacity analysis (can existing infrastructure accommodate the project?)
- Access agreement status with infrastructure owners (port authorities, transport operators, pipeline or electricity system operators)
- New infrastructure requirements and costs if existing infrastructure insufficient
- Infrastructure timing alignment with project schedule

Why this matters: Infrastructure access determines project cost and timing. Projects requiring entirely new infrastructure face higher costs and longer timelines.

Criterion 3: Hydrogen Supply Pathway

Assessment factors:

- **On-site production vs procurement:** Is hydrogen produced on-site or procured from third parties?
- **If on-site production:**
  - Renewable energy source and access (grid, off-grid, PPAs)
  - Electrolyser technology and supplier
  - Water supply for hydrogen production
  - Scale and cost of hydrogen production infrastructure
- **If procured:**
  - Supplier identification and credibility
  - Supply agreements or MOUs
  - Pipeline infrastructure or transport logistics
  - Price and supply security
- **HPTI eligibility:** Does the hydrogen pathway qualify for Commonwealth HPTI support?
- **Transition pathway:** if beginning on gas, public support limited to green production elements (see criterion 9)

Due diligence required:

- Hydrogen supply pathway technical review
- Supplier due diligence if procuring hydrogen
- Energy supply agreements if producing hydrogen
- Cost assumptions validation
- HPTI eligibility assessment

Why this matters: Hydrogen is the largest operating cost component. Hydrogen supply pathway credibility is essential for project viability. See also criterion 9.

Criterion 4: Technology Readiness and Technical Credibility

Assessment factors:

- **Technology maturity:** Technology Readiness Level (TRL), operating examples internationally, commercial deployment track record
- **Technology partner credibility:** Track record, financial strength, operating experience, performance guarantees
- **Ore availability and suitability:** Ore reserves certified, quality-assured, test work demonstrating ore-technology match
- **Integration complexity:** How many new or unproven elements? Technical risk factors?
- **Development stage:** Pre-FEED, FEED completed, detailed engineering stage

Due diligence required:

- Independent technical assessment
- Technology partner financial and operational due diligence
- Ore reserve certification review
- Test work validation
- Development stage documentation review
- Risk assessment of technical integration

Why this matters: Unproven technology or weak partners create delivery risk regardless of other factors.

Criterion 5: Market Positioning and Offtake Security

Assessment factors:

- **Target markets:** Premium vs volume markets, timing appropriateness
- **Offtake agreements:** Binding commitments, MOU quality, commercial terms
- **Customer due diligence:** Financial strength, track record, credit risk
- **Product specifications:** Match to customer requirements
- **Price assumptions:** Realism of pricing and green premium assumptions
- **Market risk management:** Exposure to price volatility, hedging strategies

Due diligence required:

- Offtake agreement detailed review
- Customer financial due diligence

- Market analysis validation
- Price stress testing

Why this matters: Without credible offtake, revenue assumptions are speculative. Strong link to form of public support/capital provided.

Criterion 6: Project-on-Project Risk Management

Assessment factors:

- **Infrastructure dependencies:** Does project depend on other projects proceeding? What happens if they don't?
- **Shared infrastructure coordination:** If using shared infrastructure, what coordination mechanisms exist?
- **Sequencing risks:** Is project timing dependent on other projects or infrastructure?
- **Contingency planning:** What alternatives exist if shared infrastructure delayed or other projects don't proceed?

Due diligence required:

- Infrastructure dependency mapping
- Coordination agreement review
- Contingency plan assessment
- Risk allocation analysis

Why this matters: Projects with high dependencies on other uncertain projects carry higher delivery risk. Can inform government decisions on prioritisation of common-user infrastructure.

Domain 2: Strategic value

These criteria assess the project's contribution to government objectives and economic benefits.

Criterion 7: Strategic Alignment with Government Priorities

Assessment factors:

- ***Roadmap* alignment:** Does project align with sequencing and strategic framework in this *Roadmap* (particularly in Chapters 5-6)?
- **Technology pathway priorities:** does the project use technology suited to its ore and phase, whether proven technology for early commercial projects or the demonstration of technologies suited to Pilbara ores?
- **Regional development:** Contribution to priority regions (early projects in the Mid West, long-lead enabling work and technology demonstration in the Pilbara, and capability in the South West, as detailed in Chapters 3 and 6)

- **Policy alignment:** Alignment with HPTI, industrial decarbonisation priorities, economic diversification
- **Timing appropriateness:** Does project timing align with infrastructure development phases?

Why this matters: Government coordination resources should flow to projects advancing government priorities.

Criterion 8: Economic Leverage and Fiscal Impact

Assessment factors:

Private capital mobilisation:

- Total private investment attracted
- Ratio of private to public investment
- Equity and debt commitments
- International capital participation

Employment:

- Construction jobs (numbers, duration, skill levels)
- Operational jobs (permanent, skill levels, local content)
- Indirect employment through supply chains

Fiscal impacts:

- Royalty revenue projections (production-based royalties)
- Tax revenue (corporate tax, payroll tax, other taxes)
- Net fiscal impact considering government support provided
- Long-term revenue profile

Local supply chain participation:

- WA supplier commitments
- Local content targets
- Supply chain development contributions
- Regional economic benefits

Due diligence required:

- Economic impact modelling
- Employment forecasts verification
- Fiscal impact analysis
- Supply chain commitment assessment

Why this matters: Projects delivering greater economic leverage provide stronger return on government investment.

Criterion 9: Clear and Transparent Carbon Reduction Pathways

Strategic context: Some early projects may choose to begin on gas, because renewable hydrogen is not yet available at the scale they need and building that supply will take years (section 5.5). This is a commercial decision. These projects are not excluded from government coordination support, but public resources should not be spent on gas subsidies or gas infrastructure. Support should be limited to the elements related to green production.

Assessment factors:

Reduction pathway:

- Does the project use renewable hydrogen or other near-zero emissions reduction from the outset, or does it plan to begin on gas?

For projects beginning on gas:

- Public support relates only to green production, such as production credits, HPTI-eligible hydrogen, innovation support, renewable generation, electrolysis or hydrogen storage, and not to gas supply or gas infrastructure.

All projects:

- HPTI eligibility: alignment with Commonwealth support for renewable hydrogen
- Certification: a credible pathway to recognised low-emissions certification
- Emissions transparency: willingness to disclose emissions accounting methodology and trajectories

Due diligence required:

- Energy system and plant design review
- Assessment of whether the support requested relates only to green production elements
- Emissions accounting validation and certification pathway assessment

Why this matters: Carbon credentials are fundamental to the value of green iron. Limiting public support to green production lets government support early projects that start on gas, without public money going to gas itself or government needing to manage the transition.

Criterion 10: Infrastructure Coordination and Shared Benefits

Assessment factors:

- **Geographic clustering:** Located where future sharing possible?
- **Early-mover infrastructure:** Justifies infrastructure benefiting subsequent projects?
- **Willingness to coordinate:** Open to shared systems where viable?
- **Common-user proposals:** Supports multi-user infrastructure?

- **Timing alignment:** Project timing aligns with infrastructure development?

Due diligence required:

- Infrastructure requirements mapping
- Coordination willingness assessment
- Cost-benefit analysis of coordination

Why this matters: Coordination efficiency, but assessment must not penalise necessary early infrastructure. Chapter 8 addresses the enabling infrastructure and coordination mechanisms in detail. Can assist government to determine where to prioritise public investment in common-user infrastructure.

Domain 3: Delivery capability

These criteria assess whether the proponent can actually deliver the project.

Criterion 11: Financial Viability and Capital Structure

Assessment factors:

Proponent financial strength:

- Track record and financial resources
- Project delivery experience
- Corporate financial health

Capital structure:

- Equity commitments (amount, sources, credibility)
- Debt financing pathway (lender interest, debt structure)
- Government support requirements (quantum, type, timing)

Cost estimates:

- **Capex estimates:** Benchmarked, realistic, independently verified
- **Opex estimates:** Benchmarked, stress-tested
- Financial model quality and stress testing

Asset delivery model:

- BOOT, EPCM, EPC, other models
- Risk allocation appropriateness
- Contractor capability if EPC/EPCM

Due diligence required:

- Detailed financial model review
- Capital and operating cost verification
- Funding source validation

- Stress testing under adverse scenarios
- Independent expert assessment
- Asset delivery model assessment

The critical challenge: This requires proponent financial disclosure ("open books"). It is open to Government to consider adopting project finance standards: proponents seeking priority support should expect transparency similar to market lender requirements. Those unwilling can proceed privately without priority support.

Why this matters: Distinguishes projects with credible financing from those without.

Criterion 12: Government Support Requirements

Assessment factors:

- **Type of support sought:** Infrastructure co-investment, policy support, approvals coordination, land access, other
- **Quantum of support:** Scale of government investment or coordination required
- **Timing of support:** When support needed relative to project milestones
- **Bespoke vs standard:** Highly bespoke lighthouse support vs standard coordination
- **Additionality:** Would project proceed without government support? What does government support enable?
- **Use of support:** is support confined to near-zero or hydrogen-enabling project elements

Due diligence required:

- Detailed support requirements specification
- Comparison with government capacity and resources
- Additionality assessment (value of government support)
- Benchmarking against international lighthouse projects

Why this matters: Government resources are finite. Understanding support requirements helps prioritise efficiently. Lighthouse projects may warrant bespoke support; later projects should require less.

Criterion 13: Community Engagement and Social Licence

Assessment factors:

- **Early engagement:** Has proponent engaged communities early or waiting for regulatory requirement?
- **Engagement quality:** meaningful consultation vs tick-box compliance
- **Benefit-sharing:** Local employment, community investment, infrastructure benefits
- **Transparency:** Willingness to share information about project impacts and benefits

- **Track record:** Proponent's history of community relationships on other projects

Due diligence required:

- Community engagement plan review
- Consultation activities verification
- Benefit-sharing commitments assessment
- Track record review

Why this matters: Social licence is essential. Projects facing community opposition face delays and reputational risk.

Criterion 14: Traditional Owner Partnerships

Assessment factors:

- **Partnership approach:** Economic participation and genuine partnership vs compliance
- **Native Title status:** Agreements progressed, clear pathway, early engagement
- **Heritage protection:** Adequate frameworks for cultural heritage protection
- **Economic benefits:** Employment, contracting, potential equity participation
- **Capacity building:** Support for Traditional Owner organisation capacity

Due diligence required:

- Native Title agreement status review
- Partnership approach assessment
- Economic participation commitments review
- Heritage protection framework adequacy

Why this matters: Essential for social licence and industry success, as emphasised in section 8.5. Can also indicate where Government may need to provide additional support to Traditional Owner groups.

Criterion 15: Environmental and Social Governance (ESG)

Assessment factors:

Environmental performance:

- Environmental management standards
- Water efficiency, tailings management, rehabilitation
- Biodiversity and land management
- Cumulative impact considerations

Corporate governance:

- Governance structures and capability

- Management experience and track record
- Safety management systems
- Transparency and disclosure practices

Reputational risk:

- Corporate reputation and track record
- ESG ratings and performance
- Previous regulatory issues or controversies
- Stakeholder relationships

Due diligence required:

- ESG assessment and ratings review
- Track record investigation
- Regulatory compliance history
- Stakeholder feedback

Why this matters: ESG performance affects social licence, regulatory approval and reputational risk for government association.

Application and Governance

How Scoring Works

The Scorecard assesses projects across the selected criteria through structured due diligence. Each criterion is assessed against its factors and the results across criteria inform a judgement about each project's priority tier. Scores are not aggregated into a single number that determines the outcome.

Critical point: Scoring is not binary (approved/rejected). It determines priority tiers for government coordination and support. Projects can proceed regardless of score, but government resources flow to highest-priority projects.

Priority Tiers

Tier 1 - High Priority: Projects demonstrating strong performance across criteria receive priority for:

- Coordinated infrastructure support (transmission, water, port access)
- Expedited approvals coordination where appropriate
- Policy support and Commonwealth partnership facilitation
- Government attention and resources

Tier 2 - Standard Assessment: Projects meeting basic criteria but not scoring as high priority receive:

- Standard government assessment processes
- Access to available infrastructure (non-priority)
- Normal regulatory pathways
- Limited coordination resources

Tier 3 - Private Pathway: Projects not meeting criteria or unwilling to undergo assessment can proceed through:

- Entirely private development pathways
- No government coordination or infrastructure priority
- No prohibition, just no priority support
- Standard regulatory requirements apply

This tiered approach allows government to focus resources while not prohibiting any projects. Proponents choose whether to seek government support (requiring Scorecard assessment) or proceed privately.

Who Applies the Scorecard

Potential cross-agency assessment: A working group including relevant agencies (DEED, OCG, Treasury, infrastructure agencies) could conduct assessment with:

- Independent expert input on technical matters
- Independent financial due diligence experts
- Market and offtake analysis specialists
- Environmental and social impact specialists

Industry consultation in development: As noted in introduction, Scorecard development should involve industry consultation on criteria, weighting and assessment processes.

Government retains decision authority: The Scorecard informs decisions; it does not make them. Ministers and government retain final authority on prioritisation and support allocation.

When the Scorecard Is Applied

- **Infrastructure allocation decisions:** When determining which projects receive priority for shared infrastructure
- **Policy and financial support prioritisation:** When allocating government investment, coordination resources and attention
- **Periodic review:** Annual review or as circumstances change (new information, project modifications, market changes)

The Due Diligence Process

Rigorous assessment requires structured due diligence that integrates with existing government frameworks:

1. **Technical assessment:** Independent engineering review of technology, process design, integration risk
2. **Financial due diligence:** Detailed review of costs, funding, financial model, stress testing (requiring proponent disclosure)
3. **Market and offtake validation:** Independent review of market assumptions, offtake agreements, price projections
4. **Environmental and social impact review:** Assessment of environmental management, Traditional Owner partnerships, community engagement
5. **Integration with existing assessment processes:** Coordination with:
    - DEED major project assessments
    - Treasury business case evaluations
    - Western Power Critical Projects Framework assessments
    - EPA assessment processes
    - Native Title and heritage processes
    - Other relevant regulatory approvals

Resource requirements: Due Diligence requires government capacity: internal expertise or external consultants. Government must resource assessment adequately. Where possible, leverage existing assessment work from DEED, Treasury, Western Power and other agencies to avoid duplication.

Transparency and Review

- **Proponent feedback:** Projects assessed can review findings and provide additional information
- **Regular criteria review:** Annual consultation on whether criteria remain appropriate
- **Updates as needed:** Criteria and weighting adjustments as circumstances change (market evolution, technology maturation, policy changes)

Transparency balance: Assessment results should be transparent to extent possible while protecting confidential commercial information. The process must be seen as fair and defensible.

Critical Policy Question: Financial Disclosure Requirements

The most significant governance challenge is financial disclosure. **How much financial transparency can government require?** This question has no easy answer:

- **Proponents argue:** Commercial confidentiality, competitive sensitivity, unwillingness to disclose to government (vs private lenders)
- **Government needs:** Credible financial assessment to justify priority support and infrastructure investment

- **TSI's position:** Adopt project finance standards where significant financial or general government support is requested: those seeking priority government support should expect commensurate transparency.

Government must develop clear policy on:

- What financial information is required for Scorecard assessment
- Confidentiality protections
- Consequences of non-disclosure (ineligible for priority support but can proceed privately)
- Access to confidential information within government

These policy questions must be resolved early in Scorecard development.

The Resourcing Challenge: Avoiding Scorecard as Handbrake

A critical risk: The Scorecard itself becomes a bottleneck.

The assessment criteria listed above, 15 with comprehensive due diligence, technical reviews, financial analysis, independent experts, could be simple and efficient or it could be complex and resource intensive. Government must navigate this carefully.

The spectrum of resourcing approaches:

Light-touch assessment:

- High-level review of documentation proponents already prepared for lenders/regulators
- Leverage existing assessments (DEED, Treasury, Western Power, EPA)
- Cross-agency working group reviews materials, scores projects, recommends priorities
- External experts only for specific technical questions
- Timeline: Weeks to couple of months per project
- Resources: Modest government staff time, limited external consultants

Comprehensive assessment:

- Detailed independent technical reviews
- Full financial due diligence (forensic-level review of models, assumptions, funding sources)
- Independent market analysis and offtake validation
- Extensive stakeholder consultation (community, Traditional Owners, industry)
- Multiple rounds of proponent engagement and information requests
- Timeline: Many months per project
- Resources: Significant government staff time, extensive external consultants, potential for delays

TSI's assessment: Government must find the middle path.

The dangers of too-light assessment:

- Inadequate due diligence leading to support for unviable projects

- Government infrastructure investment and coordination benefiting projects that fail
- Reputational damage and wasted public resources
- Loss of industry confidence in government's assessment capability

The dangers of too-comprehensive assessment:

- **Scorecard becomes the handbrake it is meant to remove**
- Proponents face year-long assessment processes before receiving priority determination
- Government lacks capacity to assess multiple projects simultaneously
- First-mover advantage goes to whoever enters assessment process first (potentially wrong priority order)
- Assessment costs and timelines deter credible proponents
- Industry loses confidence in government's ability to move at pace

TSI's recommendations for managing this tension:

1. Phased assessment approach:

- **Stage 1 - Desktop screening (weeks):** High-level review against basic criteria using proponent-supplied documentation
- **Stage 2 - Detailed assessment (months):** Full due diligence for projects passing screening
- This prevents comprehensive assessment of clearly unsuitable projects

2. Leverage existing work:

- Do not duplicate DEED, Treasury, Western Power, EPA assessments
- Request copies of assessments already conducted
- Focus Scorecard assessment on gaps and strategic prioritisation questions not covered elsewhere
- This dramatically reduces assessment burden

3. Materiality-based approach:

- Assessment depth proportional to government support requested
- Projects seeking minimal government involvement: lighter assessment
- Projects seeking major bespoke support: comprehensive assessment
- Projects seeking standard coordination: moderate assessment

4. Build government assessment capacity early:

- Do not wait for projects to arrive before building capacity
- Recruit or contract experts during Scorecard development phase
- Establish assessment protocols and templates
- Pilot assessment process on hypothetical projects before real applications

5. Clear information requirements upfront:

- Publish detailed information requirements with Scorecard launch
- Proponents know what is needed before entering process
- Reduces back-and-forth and information requests
- Allows proponents to prepare comprehensive submissions

6. Transparency on timelines:

- Commit to assessment timelines and publish them
- If government cannot assess within timeline, acknowledge publicly and explain why
- This prevents indefinite assessment limbo

7. Ongoing process, not one-time gate:

- Projects are assessed when they are ready
- Periodic reassessment as projects evolve
- Not "wait until all projects ready then assess simultaneously"
- Enables rolling assessment as projects develop

The key principle: Assessment rigour must match the stakes. Government investing millions in bespoke lighthouse project support warrants comprehensive assessment. Government providing standard approvals coordination for a commercially driven project warrants lighter assessment.

Resourcing reality check: Comprehensive assessment of even one project requires a wide range of potential subject matter experts. Government staff time coordinating can also be substantial

For multiple projects simultaneously, costs and complexity multiply. Government must either resource this adequately or accept lighter assessment. The middle path of "comprehensive assessment without adequate resourcing" leads to delays and bottlenecks.

TSI's bottom line: The Scorecard should be a prioritisation tool, not a new approval layer. Keep it focused on strategic questions ("where should government lean in first?") and leverage existing viability assessments from other processes. Otherwise, the solution becomes the problem.

Next Steps for Scorecard Development

This appendix has presented an indicative Scorecard framework. Operationalising it requires a structured development process. Many workstreams ***can progress in parallel***:

1. Industry Consultation (~3 months):

- Engage proponents on proposed criteria

- Seek feedback on weighting and assessment approaches
- Identify practical challenges and unintended consequences
- Build industry understanding and buy-in

2. Government Refinement (~3 months):

- Detailed criteria development informed by consultation and tender insights
- Establish assessment protocols and information requirements
- Resolve financial disclosure policy questions
- Develop confidentiality protections and governance

3. Due Diligence Protocols (~3 months):

- Establish technical assessment processes
- Engage financial due diligence experts
- Develop market analysis frameworks
- Integrate with existing government assessment processes

4. Governance Structure (~3 months):

- Establish cross-agency working group
- Define decision-making authority and escalation
- Create appeals and review mechanisms
- Clarify transparency and confidentiality rules

5. Pilot and Refine (~6 months):

- Apply Scorecard to initial project assessments
- Refine based on practical experience
- Update criteria or processes as needed
- Prepare for full implementation

Timing matters: Scorecard development should occur early to guide infrastructure allocation decisions as projects advance toward FID. Waiting until projects are ready to proceed before developing assessment frameworks creates uncertainty and delays.

Conclusion: A Tool for Transparent Prioritisation

The Scorecard provides government with a structured, transparent framework for prioritising projects competing for coordination and support. It makes trade-offs explicit, applies project finance rigour and aligns prioritisation with the strategic framework established in Chapters 5 and 6.

What the Scorecard is not:

- Not an approval mechanism (regulatory processes remain)
- Not a binary gate (projects can proceed through private pathways)
- Not a final, rigid framework (requires consultation, refinement, regular review)
- Not a replacement for existing government assessment frameworks (DEED, Treasury, Western Power Critical Projects Framework)

What the Scorecard is:

- A prioritisation tool for allocating government coordination resources
- A due diligence framework ensuring credible assessment
- A transparency mechanism making decisions defensible
- A dynamic tool updated as circumstances change
- A complement to existing assessment processes, adding strategic lens

The path forward: Government should prioritise Scorecard development and initiate structured consultation with industry, detailed criteria development and establishment of assessment processes. This investment in transparent prioritisation will pay dividends in efficient resource allocation and industry confidence.

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