

Green Hydrogen Organisation

AGHA
The Africa Green Hydrogen Alliance

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Unlocking the first commercial green iron projects in Asia Pacific:

An action plan for governments

About the Green Hydrogen Organisation and the Asia Pacific Green Hydrogen Alliance

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The **Green Hydrogen Organisation** (GH2) is the independent, non-profit, global voice for electrofuels made from renewables. Through industry and NGO partnerships we support governments and advocate for policy, standards and market conditions to take renewables to the industries that cannot be fully electrified.

Founded in 2021, GH2 has established a presence in Geneva, London, Jakarta, Nairobi and Oslo. GH2 is a founding member of the Global Renewables Alliance (GRA).

The **Asia Pacific Green Hydrogen Alliance** is a community that unites companies and organisations, across the Asia-Pacific (APAC) region in the mission of accelerated adoption of green and truly low-carbon hydrogen in our energy supply chains.

Established by the Green Hydrogen Organisation (GH2) and Breakthrough Energy, the alliance is a free membership network focused on scaling the green hydrogen ecosystem in APAC through enabling policy measures and financing incentives; accelerating sustainable production, use and trade of green hydrogen; and catalysing financing for green hydrogen projects and infrastructure.

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Executive summary

This report focuses on **what governments need to do to unlock the first commercial green iron projects in Asia Pacific.**

Every year that passes delays an essential transition. The global carbon budget is close to spent and alignment with 1.5 degrees is slipping out of reach. A big part of the problem is that “hard to abate” sectors like steel have barely started the transition.

Coal-based blast furnaces for steelmaking reach their first major relining at around twenty years, at roughly a tenth of the cost of a new plant. A blast furnace relined in the coming years will still be running in 2050 and possibly beyond, so each relining decision taken now sets the production route for a generation of assets. Existing coal-based plants could commit around 40 gigatonnes of carbon dioxide to 2070 if they run for their full lives. If we build the announced pipeline of blast furnaces and reline the younger ones, that rises to 58 gigatonnes, roughly a tenth of what remains for 1.7 degrees. Both are conditional estimates, resting on assumed asset lifetimes and investment trajectories, rather than emissions that will necessarily occur. This outcome is unacceptable rather than inevitable.

Green iron production is a relatively new concept in the steel and mining industry. It refers to iron produced in a low-carbon or carbon-free way, compared to traditional coal-based blast furnace processes. “Green” refers to using renewable electricity and green hydrogen to replace coal and natural gas in the reduction of iron ore. Green iron products include direct reduced iron (DRI) and hot briquetted iron (HBI) with minimal CO2 emissions. A combined DRI and electric arc furnace (EAF) process produces liquid (molten) steel and semi-finished steel (billets, blooms and slabs) after casting/rolling. For lower grade ores, a two-step green hydrogen-based DRI + electric smelting furnace process produces liquid hot metal (green pig iron) — an intermediate that can be refined into green steel.

The adoption of DRI and DRI+EAF utilising natural gas is increasing. However, the emission reduction potential of natural gas utilisation is limited, especially when the life cycle emissions associated with natural gas utilisation are properly accounted for. To date, no decoupled, export-oriented green iron project has reached final investment decision (FID). Green iron needs an estimated five to ten per cent of demand before learning, reference contracts and pricing mechanisms make the market self-sustaining.

Before considering the barriers to change, a key feature of the steel sector needs to be understood. For decades, the steel industry has earned returns below its cost of capital. The OECD's firm-level data shows why: capital follows state support rather than returns. Moreover, less-subsidised firms have lost market share to more-subsidised rivals, even when they have stronger finances. Governments are already spending at scale on assets unlikely to survive a carbon-constrained market. The recommendations in this report focus on reallocating state support to projects that have a sustainable future.

Seven barriers stand between the regional pipeline and a first investment decision:

01	In most markets, emissions are not properly priced;
02	Demand is uncertain and not yet bankable;
03	While the cost of renewable electricity and green hydrogen production continue to fall, the cost gap (sometimes called the green premium[1]) is substantial;
04	The cost of capital penalises the cleanest assets;
05	The standards and certification schemes that verify environmental attributes (including but not limited to the carbon footprint) of hydrogen, iron and steel are not agreed, interoperable or recognized across borders;
06	Most staged "low carbon" projects starting on natural gas have no credible path to hydrogen utilisation; and
07	Every part of the value chain must move at once, and regional coordination is weak.

The policy instruments to address these barriers are also well known. The OECD has catalogued 32 different policy tools. But countries throughout the region are applying these tools weakly, inconsistently, and often at cross purposes. Japan has arguably assembled more of the policy tools than any other economy in the region. Its electric arc furnace producers already sell scrap-based steel below the near-zero threshold using renewable electricity certificates and PPAs, but Japan does not produce or use near-zero iron. Its emissions trading scheme has no sector-wide cap, its blast furnace benchmarks barely move, and close to two-thirds of the Green Innovation Fund's steel-hydrogen budget is allocated to injecting hydrogen into blast furnaces which is not a sustainable solution. China has taken green steel deployment the furthest, but a decade of capacity replacement approved roughly three times as much new blast furnace capacity as electric arc furnace capacity.

[1] It is important to recognize that there is both a green premium and a grey discount. First movers face genuinely high costs (the green premium). However, fossil iron and steel have never paid for their emissions, past, present or future. Most of the literature cited here prices the gap as a green premium only. This report does not accept that framing uncritically.

This report focuses on what governments need to do to unlock the first commercial green iron projects in the region. It makes five key recommendations to governments, development finance institutions and other investors:



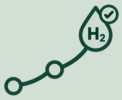
Build demand across borders, beginning with designating green iron and steel for public procurement.



Price GHG emissions. Global steel markets are distorted by massive direct and indirect subsidies for fossil fuels and underpriced GHG emissions. These have regressive social outcomes and devastating environmental impacts. Emissions trading, carbon taxes and border adjustment mechanisms are the only instruments that address the cause rather than the symptom. They are the single most effective and efficient policy measure.



Focus on measures that can reduce the cost of capital for early movers. Governments must create an enabling policy environment that lowers investment risk and rewards innovation. This should include offering targeted financial incentives, setting long-term emission and sustainability standards that give regulatory certainty, and investing in the critical infrastructure (including renewable energy and hydrogen supply chains) that these projects depend on.



Apply a hydrogen trajectory test, so that public support for staged gas-to-hydrogen projects is conditional on contracted volumes, a binding intensity trajectory, the cleanliness of the electricity behind the hydrogen, and independent verification. Hydrogen utilization should be planned, permitted and financed from the outset, not merely intended.



Support emissions accounting certification that is transferable and interoperable. Clear definitions, independent certification and labelling are needed to distinguish them from conventional production methods and products, with safeguards to prevent fraud and greenwashing.

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1. Introduction

Steel is critical in deciding whether the world meets its climate goals. The sector produces around 1 850 million tonnes of crude steel a year[2] and between seven and ten per cent of energy-system carbon dioxide emissions depending on whether indirect emissions from power and off-gas combustion are counted[3]. Roughly seventy per cent of that steel is made through the blast furnace and basic oxygen furnace route, i.e., with coal. Efficiency retrofits can help, but their remaining abatement potential is in the order of fifteen to twenty per cent, nowhere near enough. Near zero emissions steel therefore requires a change of production route, not an improvement of the existing one. Recycled scrap will play an important role, but it is constrained in quantity, quality and residual elements, and cannot serve the high-specification grades that many of Asia's manufacturers depend on. Primary iron will still be needed, and the question is how it is reduced. Green hydrogen-based direct reduction is the most advanced near-zero answer available.

The Asia Pacific region is where this transition will succeed or fail. Close to three-quarters of the world's steel is made in the region, and China alone accounts for more than half of global output: China produced 961 million tonnes in 2025, India 165 Mt, Japan 81 Mt and Korea 62 Mt [4]. Australia supplies more than half the world's seaborne iron ore and around half its seaborne metallurgical coal[5]. The region also holds the renewable resources, the shipping routes and the manufacturing demand that a green iron trade would need.

The long-term case has been made many times. Study after study has mapped the region's resource potential, modelled the cost curves and projected the trade flows. What has not happened is construction. According to the IEA Breakthrough Agenda Report[6] near-zero emissions production is about one tenth of one per cent of global steel output. Capacity for near-zero emissions iron by 2030 stands at roughly 10 million tonnes, while more than 80 million tonnes of announced capacity is only "near-zero capable", most of it starting on natural gas with no published timeline for conversion to green hydrogen. No commercial-scale green iron project has reached a final investment decision.

This report is therefore not another study of long-term potential. It asks a narrower and more urgent question: what do governments need to do to unlock the first commercial green iron projects in Asia Pacific?

2 World Steel (2026) World Steel in Figures 2026. https://worldsteel.org/data/world-steel-in-figures/world-steel-in-figures-2026/
3 IEA (2020) Iron and Steel Technology Roadmap. https://www.iea.org/reports/iron-and-steel-technology-roadmap
4 Worldsteel (2026). World crude steel production was 1 848.9 million tonnes in 2025, of which Asia accounted for about 1 353.4 million tonnes and Oceania 5.8 million tonnes. Measured on capacity rather than production the regional share is lower. OECD (2026) Steel Outlook 2026 Table 3.1 puts Asia and Oceania at 1 665.0 million tonnes of a world total of 2 445.1 million tonnes, or 68.1 per cent.
5 IEEFA (2026) Australia's Iron Ore Sector at a Crossroads. https://ieefa.org/resources/australias-iron-ore-sector-crossroads-business-usual-or-time-embrace-green-iron Reserve Bank of Australia (2019) The Changing Global Market for Australian Coal. https://www.rba.gov.au/publications/bulletin/2019/sep/pdf/the-changing-global-market-for-australian-coal.pdf
6 IEA (2025) Breakthrough Agenda Report 2025. https://www.iea.org/reports/breakthrough-agenda-report-2025

Why now? The asset window

A blast furnace runs for thirty-five to forty years and reaches its first major relining at around twenty years. Relining costs in the order of a tenth of the original investment, which is precisely what makes it hard to displace. The cheap option is always to spend a little and run the asset for another decade or more. It is not a cheap option for anyone else. Modelling of the steel lock-in finds that achieving comparable emission reductions in other sectors would cost nearly USD 1 trillion in China and USD 400 billion in India, almost twice the additional cost of making those reductions in steel itself.[7]

Existing coal-based steel plants could already commit some 40 gigatonnes of carbon dioxide to 2070 if they run for their full lives. Build the announced pipeline and reline the young furnaces and a further 19 gigatonnes follow, taking the total to 58 — about a tenth of the carbon budget remaining for 1.7 degrees. If current policy and investment trends continue beyond today's announced plans, committed emissions reach 114 gigatonnes, consuming a fifth of that budget[8]. In 2023, 57 per cent of blast furnace–basic oxygen furnace plants had been operating for between eight and twenty-four years, placing them within their relining window, which places much of the global fleet at or approaching its reinvestment decision now. Two windows need to be distinguished here. The relining window is set by the investment cycle of the existing asset. The technology substitution window is set by whether the alternative route is technically and commercially viable in that place at that time, which turns on hydrogen and electricity costs, feedstock quality, expected demand, carbon pricing and the cost of finance. The two do not necessarily coincide, and aligning them is the central task of transition policy: where the substitution window has not yet opened, the question for government is how to bring it forward, not simply how to prevent the reline.

China faces a stock decision: whether to retire or replace furnaces before their next refurbishment, which the modelling shows would more than halve its blast furnace output by 2040. India faces a new-capacity decision: whether planned coal-based investment is redirected towards hydrogen-ready direct reduction before it is built, with 22 gigatonnes avoidable by redirecting some USD 50 billion of investment this decade. Together the two account for 43 of the 73 gigatonnes that could be avoided.

7 Bachorz et al. (2026) Averting the steel carbon lock-in through strategic green investments. Nature Climate Change 16, 681–689. https://www.nature.com/articles/s41558-026-02635-8
8 Ibid. The three figures are not competing estimates of one quantity. Forty gigatonnes covers the fleet already operating; 58 adds the announced pipeline and the relining of young furnaces; 114 extends to a continuation of current policy and investment trends beyond announced plans. All are conditional on assumed asset lifetimes and investment trajectories rather than emissions that will necessarily occur.

Japan and Korea sit between the two: on Agora's tracking[9], 76 per cent of Japan's coal-based blast furnace capacity and 72 per cent of Korea's reaches the end of its campaign life by 2030. In both cases, securing sufficient renewable resources (including imports) to serve a hydrogen-based replacement in a cost effective way will be very challenging. Avoiding both planned new blast furnace capacity and the relining of young furnaces could almost halve committed emissions, to 31 gigatonnes.[10]

These decisions are being taken now, by companies that will not revisit them for twenty years or more. That is what makes the next two to three years decisive, and it is why this report concerns itself with first projects rather than long-run potential.

Industry's default expectation is that clean iron demand scales only after 2035, and often into the 2040s. Mission Possible Partnership and RMI argue[11] that this consensus is an assumption rather than a fact, and an expensive one: clean iron needs to capture an estimated five to ten per cent of demand before learning effects, reference contracts and pricing mechanisms make the market self-sustaining. Activation does not require mass adoption, only enough volume to reach that tipping point. Agora Industry and Cambridge Econometrics[12] reach the same conclusion about timing from the opposite direction: capturing the economic benefits of a green iron trade by mid-century requires that trade to scale by 2035, which means the infrastructure, investment and trade partnerships have to be put in place now.

Who is this report for?

This report is addressed primarily to governments, development finance institutions and other investors: the actors who can create demand, carry risk and set the terms on which the first projects are financed. It will be of obvious relevance to industry, both to legacy producers weighing reinvestment in existing assets, and to early movers seeking offtake and finance for new ones. Several of the instruments discussed here only work where a producer and a buyer are willing to structure a contract around them.

How was this report prepared?

This report was prepared following GH2's APAC seminar[13] and the IEA Hydrogen TCP Task 52 Oxford Workshop[14] in September 2026. These events brought together industry, research, policy, finance and standard-setting leaders. It also draws on a review of recent work by organisations approaching the steel transition from different directions: multilateral institutions, national and regional research institutes, campaigning organisations and industry analysts. Their conclusions do not always agree, but there is broad consensus on the scale of support needed. We also draw on lessons learned developing the Green Iron Principles[15], launched at COP30.

9 Agora Industry (2023) Global Steel Transformation Tracker. https://www.agora-industry.org/data-tools/global-steel-transformation-tracker. A furnace level analysis gives a lower figure for Korea. On relining dates recorded by Global Energy Monitor, four of the eleven blast furnaces now operating were last relined before 2010 and so reach a twenty-year campaign life by 2030, with one more on a fifteen-year assumption.
10 Bachorz et al. (2026) op cit.
11 Mission Possible Partnership and RMI (2026) op cit
12 Agora Industry and Cambridge Econometrics (2026) Green iron, shared gains. The macroeconomic benefits of global green iron trade. https://www.agora-industry.org/publications/green-iron-shared-gains.
13 GH2 (2026) APAC Green Hydrogen Alliance Meeting: Unlocking Green Iron and Shipping Value Chains for a More Resilient and Competitive Asia Pacific https://gh2.org/event/apac-green-hydrogen-alliance-meeting-unlocking-green-iron-and-shipping-value-chains-more
14 IEA (2026) IEA Hydrogen Technology Collaboration Programme Task 52 "Hydrogen for Iron and Steelmaking" Oxford Workshop Agenda: Economic Competitiveness of Hydrogen-Based Iron and Steelmaking" https://ieahydrogentask52.org/workshops/#oxford
15 GH2 (2025) Green Iron Principles. https://gh2.org/green-iron-principles

2. Context: (mis)allocation of capital

Before the barriers: how steel (mis)allocates capital

Before considering the barriers to change and the way forward, a key feature of the steel sector needs to be understood. The steel sector does not allocate capital the way most companies and industries do. The analysis of the barriers that follow are easier to understand once that is established.

Steel has earned returns below its cost of capital for decades. BCG[16] finds that the industry's return on invested capital more often than not falls short of what that capital costs, blaming chronic overcapacity, the low utilisation and high fixed costs per tonne that follow from it.

The reason is state support. The OECD[17] MAGIC database measures grants, below-market borrowings and tax concessions at firm level. Relative to assets, the median Chinese steel firm now receives around fifteen times the subsidy of a typical firm elsewhere, up from roughly ten times, with China's subsidy rate almost doubling since 2019. Chinese support in 2025 was dominated by 59 new provincial and municipal subsidy programmes, and the OECD singles out as the most distortive category those measures that tie public money directly to realised production volumes or sales, because they reduce marginal operating costs, encourage continued output and postpone the closure of marginal facilities.

This captures only part of the picture, since non-market equity injections, debt swaps and cheap land, energy and raw materials are tracked but not quantified. Subsidy is not a Chinese peculiarity. Europe, Japan, Korea, India, the United States and others all support steel through capital grants, transition funds, tax credits and trade protection.

The consequence is the OECD's most telling finding: **Capital follows state support rather than returns**. Less-subsidised firms are losing market share to more-subsidised rivals despite having stronger finances. Governments value employment, security of supply and industrial standing above returns. High exit costs keep loss-making plants running. According to the OECD[18], global steelmaking capacity reached a record 2 445 million tonnes in 2025 and excess capacity climbed to 640 million tonnes, exceeding total OECD steel production by more than 200 million tonnes. It is projected to reach as much as 745 million tonnes by 2028, with capacity utilisation down to 76 per cent in 2025 and forecast to stay near 74 per cent until 2028.

16 BCG (2018) Solving Steel's Value-Added Riddle. https://www.bcg.com/publications/2018/solving-steel-value-added-riddle
17 OECD, Steel Outlook 2026. https://www.oecd.org/en/publications/2026/06/oecd-steel-outlook-2026_a79fb861.html
18 ibid

Two implications follow. First, support that keeps inefficient producers alive delays the closure of high-emission plants. Some 46.7 million tonnes of gross capacity additions are already underway worldwide for commissioning between 2026 and 2028, with a further 92.1 million tonnes planned. The OECD is explicit that these projections count gross additions only: closures are not netted off, and whether they will match new capacity remains unclear.[19]. The asset window clock described above is being held open by public money. Second, and more usefully, the question facing governments across this region is not whether to spend public money on steel. They already do, at considerable scale, and a great deal of it on facilities unlikely to be viable in a carbon-constrained market. The question is whether that support reaches assets with a future.

The recommendations in this report are an argument for reallocation rather than a request for new money.

19 Ibid. p. 37 and Table 3.2. The Outlook states that its capacity projections reflect gross additions only and do not account for closures.

3. Barriers to the first investment decision

Barrier 1 - Emissions are not priced

The gap between hydrogen-based and coal-based iron is not a technology failure: it primarily stems from an unpriced externality. Illustrative analysis presented at GH2's APAC workshop put the carbon price required for hydrogen-based direct reduction running fully on hydrogen to reach parity with gas at between USD 210 and 325 per tonne of CO2, assuming USD 3.50 per kilogram of delivered hydrogen, against a European benchmark near USD 100 and gas prices between USD 5 and 12 per MMBtu. Most steel-producing markets in the region price carbon far lower, or not at all.

Barrier 2 - There is not enough bankable demand

Voluntary commitments from downstream buyers across automotive, construction and machinery total roughly 6 million tonnes of green steel demand by 2030 - about 0.3 per cent of global steel demand.

Bankable demand is also not the only currency available in this sector. As noted above, incumbents with political support can raise capital without it. Demand-side measures need to be strong enough to compete.

There is also a question about what kind of demand is being created. Mission Possible Partnership and RMI find that the lower-emission offtake now emerging across the region will not necessarily translate into demand for clean iron at all, because much of it could be met through scrap-based electric arc furnaces or more efficient blast furnaces instead[20]. The Rhodium Group[21] presents an alternate perspective: scrap-based steel is lower quality, sufficient for construction but not for the higher-purity grades that automotive buyers require.

Barrier 3 - The cost gap

New clean assets must climb a mountain to get to the starting line to compete with incumbents. Modelled levelised production costs for green hydrogen-based direct reduction run around 43 per cent above the blast furnace baseline in the OECD's greenfield case[22], between 50 and 140 per cent above it in the IEA's regional estimates[23], and close to double in an archetype export project modelled by the Oxford Institute for Energy Studies[24]. The three figures are measured against different baselines and are not directly comparable. What they agree on is the order of magnitude, and that no buyer has yet volunteered to absorb it at scale.

20 Mission Possible Partnership and RMI (2026) note that there are 81 existing offtake transactions for lower-emission products in Asia Pacific, 33 of them between Chinese companies, and this demand "will not necessarily translate into direct demand for clean iron or seaborne clean iron imports, as it could be largely met through scrap EAF or efficient BF-BOF".
21 Rutkowski et al (2026) Furnaces, Fossils, and the Future of Chinese Green Steel. Rhodium Group. https://rhg.com/research/future-of-chinese-green-steel/
22 OECD (2026) Climate Club Financial Toolkit. https://www.oecd.org/en/publications/climate-club-financial-toolkit-2026-update_df71ab89-en.html
23 IEA (2025) Breakthrough Agenda Report 2025. Op cit
24 Muslemani, Hasan; Craen, Stephen; Butterworth, Paul; Duma, Daniel; Lambert, Martin (2024): Ironing out the way for green steel financing a green hydrogen-based: Ironmaking plant in an emerging market. The Oxford Institute for Energy Studies. https://www.oxfordenergy.org/publications/ironing-out-the-way-for-green-steel-financing-a-green-hydrogen-based-ironmaking-plant-in-an-emerging-market/

Most published premiums measure new clean capacity against incumbent assets that are already built and partly depreciated, which is the wrong counterfactual for a greenfield investment decision. Where the comparison is new-build against new-build, the gap narrows sharply. Transition Asia and TERI[25], pricing a real 9.6 Mtpa decision in Andhra Pradesh, put fully hydrogen-based direct reduction at USD 571 - 606 a tonne of crude steel against USD 536 for a greenfield blast furnace, a premium of six to thirteen per cent, falling to within five dollars of the incumbent route on the rotary kiln configuration with hub-supplied hydrogen. Quoting the larger figures alone, without stating what they are measured against, overstates the gap facing a new project.

Barrier 4 - The cost of capital is too high.

The OECD's illustrative case applies a weighted average cost of capital of 12.7 per cent to a greenfield hydrogen DRI plant, against 8 per cent for a blast furnace revamp[26]. Analysis presented at the most recent APAC Green Hydrogen Alliance Meeting[27] showed that in the accelerated transition scenario modelled for India by Bachorz et al., raising the weighted average cost of capital from 5 to 12 per cent nearly doubles peak annual financing costs, which reach around USD 35 billion a year by about 2050. The magnitude is specific to that scenario and country rather than a general property of green iron projects. In emerging markets, the gearing is worse: clean hydrogen projects carry debt-to-equity ratios closer to 60:40, whereas power projects manage 80:20[28].

Lenders assess the entire chain, from renewables through electrolysis to offtake, not an isolated shaft furnace. The asymmetry matters: a first mover pays a novelty premium for capital while subsidised incumbents borrow below market rates on the strength of implicit state guarantees.

Barrier 5 - Sustainability attributes that do not cross borders

Currently, there is no globally recognised definition of “green iron.” A range of overlapping standards describe “low-carbon” or “green” steel but stop short of setting clear emission thresholds or wider sustainability requirements. This creates confusion, inconsistent claims, and greenwashing risks. Clear definitions and thresholds are essential for scaling investment and trade in low-emission materials. They enable governments to design incentives and standards, financiers to set eligibility criteria, and producers to plan projects with confidence. They also help downstream buyers identify credible “green” products.

25 Transition Asia and TERI (2026) Is Green Steel Within Reach in India? Green DRI Economics, Policy Drivers and Site Feasibility in Andhra Pradesh. https://www.teriin.org/press-release/green-steel-within-reach-teri-transition-asia-study-charts-course-indias-first
26 OECD (2026) Climate Club Financial Toolkit.
27 GH2 (2026) ibid
28 ESMAP (2024) Scaling Hydrogen Financing for Development. https://www.esmap.org/publications/scaling-hydrogen-financing-development

While there has been some important progress on standards and certification[29], measurement methodologies diverge, hydrogen standards and steel standards are not interoperable, and the chain of custody question remains unsettled, with mass balance and book-and-claim advanced as rival candidates for the same role rather than as instruments suited to different circumstances[30]. For a physically decoupled value chain (i.e., iron made where renewable electricity is cheap and steel made where the customers are) this is a crucial barrier. It is the mechanism by which the environmental value is either monetised or lost.

The consequence is visible in what actually gets built. Of the clean ironmaking projects that have reached a final investment decision, around three-quarters by number and four-fifths by capacity are integrated plants making iron and steel on one site[31]. Decoupled production is the cheaper configuration in theory, but it is not the configuration firms are choosing while demand for green steel is thin and sustainability attributes are not recognised across borders.

Barrier 6 - Gas now, hydrogen later?

Of the roughly 80 million tonnes of announced capacity classified as near-zero capable, only about 25 million tonnes has a stated plan to operate as near-zero by 2030. The remainder intends to start on natural gas with no clear timeline for transition. GH2's MENA analysis[32] found the same pattern: projects labelled green that are gas-based or "hydrogen-ready" in name, with no commitment that fixes when hydrogen actually arrives. A staged transition is legitimate and may be the only financeable route in the short term is some markets. But hydrogen utilization should be planned, permitted and financed from the outset, not merely intended.

Barrier 7 - Everyone has to move at once.

Renewable generation, electrolysis, direct reduction, furnaces, ports, vessels and bunkering all have to be committed at roughly the same time for any of them to earn a return. No single party can move first without exposure to the others' hesitation, and individually rational caution produces collective inaction. As Deloitte and WWF have noted: "currently, individually rational decisions not to invest by value chain participants are leading to collective inaction and consequently a lost economic opportunity for all"[33].

The shipping leg makes this concrete: a green corridor needs vessels, fuel supply at both ends, port acceptance, trained crews and assurance arrangements in place. The trade environment is moving against co-ordination at the same time: close to 400 antidumping and countervailing duty measures initiated since 2016 were still in force in 2025, with 75 new investigations opened in that year alone, and 42 economies now apply some form of export restriction on ferrous scrap[34].

29 GH2 (2025) Review of Green Iron and Steel Standards. Working Paper. v2 July 2025. https://gh2.org/sites/default/files/2025-07/GH2%20_%20Review%20of%20Green%20Iron%20Standards%20_%20v2%20July%202025.pdf
30 GH2 (2026) Green Iron Certification: which chain of custody models should be prioritised to support steel decarbonisation in Asia? https://gh2.org/event/green-iron-certification-which-chain-custody-models-should-be-prioritised-support-steel
31 Mission Possible Partnership and RMI (2026) op. cit.
32 GH2 (2026) MENA's green iron opportunity: Decarbonising the global steel industry. https://gh2.org/publication/menas-green-iron-opportunity-decarbonising-global-steel-industry
33 Deloitte and WWF (2026) Creating the pull: Demand-side levers for green iron and steel. https://assets.wwf.org.au/image/upload/f_pdf/20260529_Creating_The_Pull_Green_Iron_and_Steel_Final_Report
34 OECD (2026) Steel Outlook 2026. op. cit.

4. The policy toolbox

The policy instruments needed to unlock the first commercial green iron projects in Asia Pacific already exist. The OECD alone catalogues 32 of them across economic, risk mitigation and financing families, each with case studies[35]. But countries throughout the region are applying these tools weakly, inconsistently, and often at cross purposes.

For example, Japan has a mandatory emissions trading scheme, large capital subsidies, state debt guarantees, a production tax credit for green steel, green public procurement criteria, a demand-side subsidy add-on for low-carbon steel in vehicles, and a transition finance roadmap. It is still not producing or utilising green iron. The Renewable Energy Institute's diagnosis (see Box 1) is that the package is undone by its design: the emissions trading scheme carries no sector-wide aggregate cap, blast furnace benchmarks improve by about one per cent between 2026 and 2030, the non-fossil conversion target for blast furnaces is a two per cent cut in coal use per tonne against 2013, and the definition of eligible steel differs from one instrument to the next[36].

Box 1 – Japan's Steel Transition: the right tools but the wrong direction.

Japan has assembled more instruments than any other economy in the region[37]. Emissions trading became mandatory for large emitters in FY2026. Capital subsidies for hard-to-abate conversion have gone to JFE's Kurashiki and Nippon Steel's Yawata projects, with steel taking 89 per cent of the maximum grant amounts awarded under the programme. The GX Acceleration Agency holds JPY1.95 trillion (approximately USD 12.3 billion) of guarantee capacity and approved around JPY8 billion (approximately 50 million USD) of guarantees for a 2 million tonne electric arc furnace in March 2026. A tax credit pays JPY20,000 (approximately 125 USD) for every tonne of green steel produced. The Green Purchasing Act now sets criteria for steel-containing goods, and a clean-vehicle subsidy add-on rewards carmakers using lower-emission steel. And yet the direction is set elsewhere.

The emissions trading scheme carries no sector-wide aggregate cap. In practice it limits carbon dioxide per tonne of product rather than carbon dioxide in total: steel's main processes receive free allowances equal to a benchmark intensity multiplied by the firm's own output, so a producer that makes more receives more.

35 OECD (2026) Climate Club Financial Toolkit. op. cit.
36 Renewable Energy Institute (2026) Policies for Decarbonizing Japan's Steel Industry: Current Status and Future Outlook. https://www.renewable-ei.org/en/activities/reports/20260916.php
37 All figures in this box are sourced from Renewable Energy Institute (2026) op cit. The budget shares quoted are approximate allocations of the fund's maximum budgets rather than disbursed expenditure.

Blast furnace benchmarks sit within a very narrow range of current emissions intensities and tighten by only about one per cent between FY2026 and FY2030, so a blast furnace operating at today's intensity faces little compliance pressure. Benchmarks are also set per process rather than per tonne of steel, and the applicable benchmark changes with the technology, so a company that replaces a blast furnace with direct reduction loses the blast furnace benchmark rather than being rewarded against it. In the EU, by contrast, the hot metal benchmark continues to apply from 2026 when a plant switches from a blast furnace to direct reduction, so the reduction generates surplus allowances.

Within the Green Innovation Fund's steel-hydrogen programme, 64 per cent of the budget is allocated to injecting hydrogen into blast furnaces — 10 per cent for on-site hydrogen and a further 54 per cent for externally supplied hydrogen under Super COURSE50 — against 26 per cent for hydrogen direct reduction; and of 27 applications for hydrogen price-gap support, the single approved steel project accounts for 0.5 per cent of the supported volume.

1. Carbon pricing and border adjustment

Emissions trading, carbon taxes and border adjustment mechanisms are the only instruments that address the cause rather than the symptom. Their strength is that they are economy-wide, technology-neutral, cheap for governments and create a durable signal; their weakness is political difficulty and the length of time they take to bite. The EU's Carbon Border Adjustment Mechanism (CBAM) is already shaping investment decisions outside Europe, including in this region, and proposals for an equivalent Asian mechanism are in circulation. For an asset with a 20 - 40 year life, the expected trajectory of the carbon price matters more than its current level.

2. Demand creation

Public procurement, mandates and quotas, contracts for difference, double-sided auction mechanisms of the H2Global type, and buyers' clubs all create or guarantee demand. Procurement and mandates are strong domestic anchors but reach only the sectors a government controls. Offtake support of the contract-for-difference type gives the strongest possible signal to a lender and is the instrument most directly aimed at final investment decisions, at correspondingly high fiscal cost. Buyer coalitions aggregate willingness to pay that is otherwise too fragmented to bank. Japan's GX contracts for difference, Korea's emerging framework, the Industrial Deep Decarbonisation Initiative's Green Public Procurement Pledge[38] procurement pledge and SteelZero[39] are the live examples in or adjacent to the region.

38 https://decarbonization.unido.org/projects/iddi/
39 https://www.theclimategroup.org/about-steelzero-

One design in this family deserves separate mention, because it answers a common objection. A subsidy-and-recharge mechanism[40] funds support for clean primary production from a flat levy on all steel sold into the domestic market (imports included) and waives it on exports. It is revenue-neutral for the government in each year it operates. Because the levy falls equally on domestic and imported steel and not at all on exports it creates none of the competitiveness exposure that leads finance ministries to refuse demand-side support. It is also easier to extend downstream than a production-specific border adjustment because it requires measuring only the steel content of a traded product rather than the emissions embodied in it. Designs have been worked through for China and India among others.

In the China example[41], a dedicated Clean Steel Transition Fund would pay a unit subsidy for eligible clean primary steel. It would be financed through a uniform recharge on steel consumed in China, with imports paying it and exports exempt, topped up by auction revenue from the national emissions trading scheme. On the authors' costings, hydrogen-based direct reduction runs at USD 731 a tonne of crude steel against USD 523 for the blast furnace route, so supporting clean output equal to a tenth of current primary production costs about USD 19.4 billion a year, a recharge of USD 22.60 a tonne of steel consumed (or around USD 20 dollars on the price of a car). The authors are explicit that support should be delivered through multi-year contracts with emissions thresholds and verification rather than discretionary grants, and that it should avoid concentrating on a few large state-owned enterprises.

3. Risk mitigation and guarantees

Partial and full credit guarantees, buyer credit guarantees, first and second loss facilities, performance guarantees, political risk insurance and foreign exchange cover all work by reallocating downside risk rather than by paying down cost. Their effect is on the terms of finance: a guaranteed project borrows more cheaply, from a wider pool, at higher gearing. For emerging market projects this class of instrument does more than a capital grant of equivalent value, and multilateral development banks and export credit agencies are the providers that matter. Europe's first mover reached financial close on exactly this basis.

4. Concessional and blended finance

Concessional loans, subordinated debt, public equity, results-based and pull financing, offtake finance and transition bonds absorb the risks commercial lenders will not take on a first-of-a-kind asset. The OECD's own conclusion from thirty case studies is that concessional and risk-tolerant capital is what allows first-of-a-kind industrial projects to proceed at all, particularly when disbursed against milestones[42]. Notably, in the OECD's hydrogen DRI illustration, concessional debt closes the smallest share of the modelled cost gap while remaining decisive for whether the project is bankable.

40 Breakthrough Agenda Policy Network (2026) Enabling Investment in Clean Primary Steel: The Case for Subsidy-and-Recharge Policies. https://www.scurveeconomics.org/publications/enabling-investment-in-clean-primary-steel/
41 Prof. Wang Pu & Lin Ziyue (2026) "A subsidy-and-recharge policy for China". Chinese Academy of Sciences in Breakthrough Agenda Policy Network (2026) op. cit
42 OECD (2026) Climate Club Financial Toolkit. op. cit.

5. Standards, measurement and chain of custody

Common definitions and thresholds, interoperable measurement methodologies, guarantees of origin and chain-of-custody systems are what turn a low-carbon product into a tradable claim. They cost governments little and are the precondition for almost everything else: procurement cannot specify what it cannot define, a border adjustment cannot assess what it cannot verify, and a premium cannot be paid for an attribute that does not survive the voyage.

6. Transition-linked instruments

The tools include milestone-linked support that lapse if milestones are missed, contracted hydrogen tranches, indexation, reopeners and reset clauses in long-term supply agreements, binding emissions-intensity trajectories, and independent verification of conversion readiness. They exist in fragments - in private contract design, in certification rules that carry transition-alignment requirements, and in the recent literature on hydrogen-ready infrastructure[43] - but no government has assembled them into a condition of public support.

Korea provides an important test case. The government's K-GX strategy of October 2026[44] commits 1,000 trillion won (approximately USD 750 billion) between 2026 and 2035, of which 200 trillion won is fiscal spending and more than 790 trillion won is climate finance channelled through five state policy banks. Steel is one of five priority sectors, alongside petrochemicals, cement, semiconductors and displays, and refining. It includes within its K-GX industrial programme a POSCO hydrogen-based ironmaking demonstration plant of 300,000 tonnes a year at Pohang, in which fine iron ore is reduced in fluidised bed reactors and the reduced iron is melted in an electric smelting furnace to produce hot metal, with commissioning targeted for 2028[45]. It is the first project of its kind in the region to sit inside a government programme with committed private capital alongside it. Whether the support requires contracted hydrogen volumes, an intensity trajectory and independent verification, or simply funds a plant that is hydrogen-capable, is yet to be clarified.

A briefing by Solutions for Our Climate[46] reaches a similar conclusion. The steel pathway runs from the 300,000 tonne demonstration through scale-up towards 2.5 million tonnes by the mid-2030s and gradual conversion thereafter, but it carries no phase-out schedule for the eleven blast furnaces now operating, no quantified hydrogen and electricity demand to set against supply, and no statement of how support is tied to conversion speed, scale or emissions reduction. Its recommendation is that the sector roadmaps due in December should carry conversion schedules and performance conditions on support, with regular public reporting, and that the low-carbon steel certification standard due in 2027 should be paired with procurement.

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43 Lu et al. (2025) Hydrogen-ready infrastructure, PNAS. https://www.pnas.org/doi/full/10.1073/pnas.2601685123 sets out third-party verification, enforceable conversion milestones tied to permitting and cost recovery, and transparent reporting as the test for a credible conversion claim.

44 Ministry of Trade, Industry and Energy, Republic of Korea (2026) 「탄소 감소를 넘어 신성장동력으로, 정부 1,000조원 투자로 K-GX 본경 가동」, 7 October 2026. Won figures are converted at approximately 1,339 won to the dollar. See also Polly Martin, 'South Korea sets with role for hydrogen in steelmaking and transport', Hydrogen Insight, 7 October 2026.

45 POSCO's HyREX route reduces fine iron ore in fluidised bed reactors and melts the reduced iron in an electric smelting furnace to produce hot metal, rather than feeding an electric arc furnace. Because it takes fines directly, without pelletising, it is relevant to ore types that shaft-based direct reduction cannot use without beneficiation. BHP (2025) 'BHP and POSCO partner to advance hydrogen-based ironmaking technology', 30 October 2025. https://www.bhp.com/news/media-centre/releases/2025/10/bhp-and-posco-partner-to-advance-hydrogen-based-ironmaking-technology The 300,000 tonne a year integrated plant is under construction at Pohang with commissioning targeted for 2028; the reduction stage has been developed at laboratory scale and the smelting stage at pilot scale.

46 Solutions for Our Climate (2026) 「K-GX 발표, 1,000조 투자보다 중요한 것은 구치적인 전환 계획이다」 (Position statement: what matters more than the 1,000 trillion won investment is a concrete transition plan), 8 October 2026. https://forourclimate.org/ko/newsroo only.

Europe supplies a cautionary case study. German federal and state support for thyssenkrupp's direct reduction plant at Duisburg, approved by the European Commission in July 2023, carried a phased withdrawal of natural gas, renewable hydrogen only from 2037, annual independent verification of the volumes and prices actually paid, a competitive supply tender monitored by the authorities, and a clawback[47]. The company's February 2024 tender sought around 143,000 tonnes of hydrogen a year, with first use in 2028 and full hydrogen operation by 2029[48]. It suspended the tender in March 2025 on cost grounds, and in August 2026 the funding conditions were reported to have been amended, with the Commission's approval, so that support continues even if the plant does not initially run on hydrogen[49]. Put simply: A hydrogen condition attached to public money was renegotiated once the capital was committed. This sends the wrong signal and sets a bad precedent.

7. Large scale cross-border coordination instruments

Bilateral and plurilateral trade arrangements, joint standards work, shared infrastructure and hub models, corridor and bunkering readiness programmes, and technology licensing cooperation address the simultaneity problem. The foundations for this already exist. Agora and Cambridge Econometrics[50] highlight Australia–China memorandum of understanding on steel decarbonisation, Australia–Korea green economy arrangements, and in the Regional Comprehensive Economic Partnership alongside bilateral partnerships between Australia, Japan and Korea.

What is absent is any mechanism that binds an importer's demand to an exporter's supply at a scale that finances a plant.

8. Capacity governance and managed exit

China's capacity replacement mechanism is the significant instrument family absent from the OECD's catalogue. Under rules revised in May 2026, the most substantial overhaul since 2021, new capacity may be approved only against retirement of existing capacity, now at a ratio of 1.5 tonnes retired for every tonne added, with long-idled plants excluded from the calculation and the trading of retirement quotas between regions and companies restricted[51]. The record is a warning as much as a model. Between 2017 and 2024 the mechanism approved roughly 400 million tonnes of new blast furnace capacity against 128 million tonnes of electric arc furnace capacity: it modernised the fleet without decarbonising it, and every replacement reset the twenty-year clock[52]. Electric arc furnace output remains near ten per cent of Chinese production against a fifteen per cent target for 2025, and analysts estimate that some 350 million tonnes of blast furnace capacity may need to retire by 2030. Capacity policy is a powerful lever on exit, but only where eligibility turns on the production route rather than on efficiency.

47 European Commission, State aid SA.105244, approved 20 July 2023: a direct grant of up to EUR 550 million alongside a conditional payment mechanism of up to EUR 1.45 billion. Natural gas "will be gradually phased out and, as of 2037, the plant will be operated using only renewable hydrogen"; the conditional payment covers the additional cost of renewable over low-carbon hydrogen during the first ten years of operation and is "subject to yearly verifications by an independent expert on the actual volumes and price paid", with a strict clawback mechanism.
48 thyssenkrupp Steel, "Call for tenders for supplying hydrogen to the first direct reduction plant at the Duisburg location", 16 February 2024. https://www.thyssenkrupp-steel.com/en/newsroom/press-releases/call-for-tenders-for-supplying-hydrogen-to-the-first-direct-reduction-plant-at-the-duisburg-location.html
49 https://eurometal.net/thyssenkrupps-duisburg-dri-plant-could-initially-operate-without-hydrogen/
50 Agora Industry and Cambridge Econometrics (2026) op cit.
51 Shen Xinyi (2026) Can China's New Steel Capacity Rules Accelerate its Green Transition? Dialogue Earth. https://dialogue.earth/en/business/can-chinas-new-steel-capacity-rules-accelerate-its-green-transition/
52 ibid

Box 2. China: the deployment leader's next decision

China has taken hydrogen metallurgy further than anywhere else. Four clean iron projects are under construction and seven more in development, together representing at least 8.6 million tonnes of capacity, with pure-hydrogen plants at Songyuan, Guyang and in Xinjiang and hydrogen-rich operations running at HBIS Zhangxuan, Baowu Zhanjiang and Jianlong Wuhai[53]. Australia and China between them account for more than half of the green iron projects under development globally[54]. Technological feasibility is largely established: the China Iron and Steel Research Institute's pure-hydrogen shaft furnace at Linyi in Shandong has demonstrated sustained operation of the process at pilot scale. What is not established is commercial bankability, which also requires competitively priced hydrogen and electricity, suitable iron ore feedstock, system integration and operational reliability, and financing on terms a lender will accept.

Demand is the largest of those constraints, but it is not the only one. Readiness is also specific to the ore. A process proven on one feed is not thereby proven on another: shaft-based direct reduction needs direct-reduction-grade pellets, while routes designed to take fine ores directly, such as fluidised bed reduction followed by electric smelting, sit at an earlier stage of development. Where that evidence is missing, demonstrated performance under continuous operation and qualification of the resulting product by the steelmakers who would buy it are investment barriers in their own right, and neither is resolved by demand policy.[55]

Between 2017 and 2024 the capacity replacement mechanism approved roughly 400 million tonnes of new blast furnace capacity against 128 million tonnes of electric arc furnace capacity. Newer plants replaced older ones, intensity improved, but coal dependence persists. Electric arc furnace output remains near ten per cent of production against a fifteen per cent target for 2025. Analysts estimate that some 350 million tonnes of blast furnace capacity may need to retire by 2030.

The May 2026 revision tightens the general replacement ratio to 1.5 to one, excludes long-idled assets and restricts quota trading. It also, for the first time, differentiates by route. New ironmaking capacity achieving at least a 60 per cent reduction in process emissions against the blast furnace route qualifies for equal-volume replacement, as do several electric arc furnace cases; capacity achieving at least 30 per cent qualifies for 1.25 to one if built within three years of the measures taking effect. Capacity replacement has therefore stopped being purely a cap on aggregate capacity and become an instrument of technology choice, relieving low-carbon investment of a constraint that coal-for-coal replacement still carries.[56]

Two further features are key to understanding the transition. China's steel transition is subnational, with renewable-rich interior provinces as potential exporters and coastal provinces as the plausible import market. In addition, Chinese hydrogen is projected to be the cheapest in the region at USD 2.6 per kilogram by 2030[57], which complicates any assumption that resource-rich exporters are automatically the low-cost producers[58].

53 Mission Possible Partnership and RMI (2026) op. cit.
54 ibid
55 Mission Possible Partnership, Build Clean Now project tracker, CISRI Linyi. https://buildcleannow.missionpossiblepartnership.org A 50,000 tonne a year pure-hydrogen shaft furnace in Linyi, Shandong, running on green electricity and operated as a research and demonstration platform rather than commercially.
56 Ministry of Industry and Information Technology of the People's Republic of China (2026) 《钢铁行业产能置换实施办法》(Measures for the Implementation of Capacity Replacement in the Steel Industry), MIIT Document No. 97, 18 May 2026, Article 10. The measures are published in Chinese only; the provisions summarised here are as reported by Chinese financial media at publication.
57 BloombergNEF, cited in Mission Possible Partnership and RMI (2026).
58 Three qualifications matter. First, capacity counts differ sharply with definition: against the figures above, Rhodium Group counts only 1.7 Mt of hydrogen DRI under construction with a secure hydrogen source, against 2.6 Mt in Europe, so on the stricter test Europe is ahead. Second, the design of China's emissions trading scheme rewards incremental efficiency at existing plants and allocates nothing to a zero-emission facility, so it offers no incentive to build one - a different design failure from Japan's, and the same lesson. Third, cheap hydrogen does not mean steel receives it: Chinese policy currently prioritises hydrogen for chemicals, and steel sits in the second tier for zero-carbon factory designation after 2030.

Table 1. Application of the policy toolkit in Asia Pacific.[59]

Problem	Instruments that address it	Already in play across APAC
Emissions are not priced	Emissions trading, carbon taxes, border adjustment	EU CBAM, but unevenly: worth USD 179–209/t of landed advantage for India on 3–5% of output, negligible for China (~EUR 50/t on 7% exported); Japan's GX-ETS mandatory from FY2026 but with no sector-wide cap; Korea's ETS; China's ETS rewards efficiency at existing plants and allocates nothing to zero-emission ones, so what incentive exists reaches a clean plant through the compliance costs borne by conventional production rather than through allocation; India's CCTS worth USD 25–45/t to a green plant by 2035
Not enough bankable demand	Public procurement, mandates and quotas, contracts for difference, double-auction offtake, buyers' clubs	Japan's Green Purchasing Act criteria for steel-containing goods and its clean-vehicle subsidy add-on; Korea's K-Steel Act framework and forthcoming certification; China's SASAC green procurement guidance for central state-owned enterprises; IDDI and SteelZero; 81 lower-emission offtake transactions across APAC, 33 of them between Chinese companies
The cost gap	Price-gap support, hydrogen supply-cost subsidy, production tax credits, capital grants	Japan's 15-year hydrogen price-gap support and its JPY20,000 per tonne green steel tax credit; Korea's hydrogen production cost targets of KRW 3,500 per kilogram by 2030 and KRW 2,500 by 2050, which are targets rather than funded instruments; Australia's A$2/kg hydrogen production tax incentive and A$1bn Green Iron Investment Fund.[60]
Cost of capital	Credit, buyer and political risk guarantees, first-loss facilities, concessional and subordinated debt, export credit cover	Japan's GX Acceleration Agency, with JPY1.95 trillion of guarantee capacity and a JPY8bn guarantee for a 2 Mt electric arc furnace; Australia's Net Zero Fund; Korea's K-GX strategy of October 2026: 1,000 trillion won (approximately USD 750 billion) over 2026–2035, of which 200 trillion won is fiscal and more than 790 trillion won (approximately USD 590 billion) is climate finance through five state policy banks, with the climate response fund expanded and a green sovereign bond framework due by mid-2027; MIGA and ADB instruments; RMB debt and blended finance proposed for the Australia–China corridor
Attributes do not cross borders	Common thresholds and definitions, measurement interoperability, chain of custody, guarantees of origin	ISO 19870-1 and the ISO steel standards; Japan's GX Steel guideline; Australia's Product Guarantee of Origin; China's C2F; RMI's book-and-claim framework; ResponsibleSteel and the EU low-emission steel standard
Gas now, hydrogen later	Milestone-linked support, contracted hydrogen tranches, indexation and resets, binding intensity trajectories, independent verification	Almost nothing. Private contract design; RMI's transition-alignment requirements; the IEA's near-zero versus near-zero capable distinction. Korea's October 2026 transition plan places a POSCO fluidised bed hydrogen reduction and electric smelting demonstration inside its K-GX programme. No government in the region, Korea included, yet conditions its support on a verified hydrogen trajectory.
Everyone must move at once	Bilateral trade arrangements, joint standards work, hubs and shared infrastructure, corridor and bunkering readiness, technology licensing	Australia–China steel decarbonisation MoU and policy dialogue, with A$650,000 committed to bilateral green iron co-operation in February 2026; Australia–Korea green economy arrangements.
Capacity and exit (cross-cutting)	Capacity replacement ratios, eligibility rules, exclusion of idle assets, restrictions on quota trading	China's revised capacity replacement rules from May 2026, at 1.5 tonnes retired for every tonne added, with idle assets excluded, and equal-volume replacement for ironmaking at least 60 per cent below the blast furnace route. Nothing comparable elsewhere in the region

59 Instrument families from OECD (2026) Climate Club Financial Toolkit. Entries in the third column are drawn from Renewable Energy Institute (2026) for Japan; Shen Xinyi (2026) and Rhodium Group (2026) for China; Transition Asia and TERI (2026) for India; and Mission Possible Partnership and RMI (2026) for the offtake transaction counts and the Australia–China corridor.

60 First Master Plan for the Implementation of the Hydrogen Economy (2021). These are policy targets for hydrogen production cost rather than funded instruments and are not currently on track to be met on the stated timetable.

5. Project case study

Meranti Green Steel: the anatomy of a staged transition

Meranti Green Steel is the clearest available test of the hydrogen trajectory test proposed in the recommendations. Its iron plant is at Duqm in Oman, which sits outside the region, but the value chain does not: a downstream steel plant is planned in Rayong, Thailand, the company is registered in Singapore, and its target markets include Asian steelmakers and traders alongside buyers with CBAM exposure. Iron made on the Arabian Sea and turned into steel in Thailand is an Asia Pacific supply chain, and the decoupled structure the region is being asked to consider is precisely what this project embodies. The account that follows examines that structure. It does not assess the project's commercial merits.

Meranti Green Steel is developing a green iron plant at Duqm in Oman and with plans for a green steel plant at Rayong, Thailand. The Oman project is in development rather than in operation, which is what makes it useful here. This report is concerned with what it takes to reach a final investment decision, and this is a project working through that question.

The first lesson is scale. A single 2.5 million tonne direct reduction module running fully on hydrogen would need around 175,000 tonnes of hydrogen a year, at roughly 70 kilograms per tonne of direct reduced iron. Direct reduction is a continuous process designed for high availability, and a bankable iron project converts that into offtake lasting twenty years or more. Green iron therefore offers hydrogen developers the demand profile that large-scale supply needs: scale, utilisation and duration. It is the strongest available answer to the question of what anchors a merchant hydrogen plant.

The second lesson is that today's hydrogen economics do not support that demand. On the project's own illustrative analysis, delivered hydrogen at USD 3.50 a kilogram would require a carbon price of between USD 210 and USD 325 a tonne to reach full parity with natural gas, depending on the gas price. The European benchmark is near USD 100 and most of this region prices nothing at all. A project that waits for that gap to close on its own does not get built. Full parity is not needed for a first step, however. At around USD 3 a kilogram, a low initial hydrogen share adds a modest cost per tonne that a first project can carry, and further tranches follow as hydrogen costs fall and carbon prices rise.

The response is a staged asset. A direct reduction shaft furnace can run on reformed natural gas, on hydrogen, or on blends of the two, so the plant can be financed today on the gas-based route and raise the hydrogen share as delivered cost falls and carbon value strengthens. On the project's own illustration, green hydrogen rises from around 12 per cent of the reducing gas in 2031 to about 85 per cent by 2050, taking the emissions intensity of hot briquetted iron from roughly 800 to under 200 kilograms of CO2 per tonne. Hydrogen substitution is not costless even where the shaft furnace is compatible, since balance-of-plant, safety and gas-system changes may be required.

The third lesson is the most consequential. Long-dated take-or-pay contracts are normal where a supplier must finance capacity ahead of delivery, but without a reset mechanism the earliest tranches outlive the cost environment that created them. The design approach Meranti Green Steel is working through is to contract hydrogen in tranches over time - an early tranche at first-of-a-kind prices, then further tranches in the middle and later 2030s and 2040s. First-mover contracts have to be built for falling costs. Meranti Green Steel is in discussions with hydrogen developers, with the aim of having a hydrogen supply and purchase agreement ready at financial close. A credible trajectory also has to be able to adjust its pace to delivered hydrogen costs and carbon prices.

This is what a credible staged pathway looks like from the inside, and it shapes the gas to hydrogen trajectory test set out in the recommendations below. The structure above is designed to provide most of what that test asks for: contracted volumes by date, a declining intensity trajectory, and a mechanism that stops early prices becoming permanent. What it cannot supply is enforceability. A private contract binds two counterparties. It does not bind a government that has granted support, and it does not tell a customs authority or a lender whether the trajectory is being met. Closing that gap is a public policy task, which is why the test belongs in the conditions attached to support rather than in the good intentions of developers.

6. Recommendations

These recommendations are primarily addressed to governments in the region. They are ordered by leverage. The first addresses the cause and the remaining four are second-best instruments that stand in for it. The cost gap is described as both a green premium and a grey discount, for the reasons given at the outset.

1 Price GHG emissions

Effective GHG emission pricing is the single most effective and efficient policy measure. Global steel markets are currently distorted by massive direct and indirect subsidies for fossil fuels and under-priced GHG emissions. These have regressive social outcomes and devastating environmental impacts. Every other recommendation here is a second-best instrument standing in for a carbon price.

2 Focus on measures that can reduce the cost of capital for early movers

Multilateral development banks, export credit agencies and national development finance institutions should target guarantees, first-loss facilities and concessional debt at first commercial projects. Bringing a project's cost of capital from twelve per cent to eight does more for its viability than a subsidy of comparable fiscal cost. It does not, however, settle the comparison the incumbent is actually making. A producer weighing a new hydrogen direct reduction plant against relining a partly depreciated blast furnace is comparing the returns on the two, and cheaper capital for the first does not on its own overcome the low marginal cost of extending the second. That comparison turns on expected carbon costs, stranded asset risk and demand, which is why cost-of-capital instruments work only alongside a credible carbon price and capacity rules that price the coal option properly.

In China, where the transition is primarily a question of replacing a very large existing stock, this is the decision that matters most. Instruments should also be matched to how ready a project actually is, rather than applied uniformly. Where a route is commercially proven on the ore it will run on, the binding constraints are the cost of capital and the offtake. Where it is not, because performance has not been shown under continuous operation or because the product has not been qualified by its intended buyers, the useful intervention is support for generating that evidence: demonstration plants, extended trials and the qualification programmes that allow a steelmaker to accept a new feedstock into an existing process. This is a question of sequencing rather than of favouring any particular technology. Governments are not bystanders in this. They are the shareholders of the multilateral banks and the owners of the export credit agencies. The mandate letters, country strategies and capital allocations that decide whether green iron is an eligible use of those balance sheets are written in finance ministries. Korea has just shown what this looks like in practice: its October 2026 transition plan carries 790 trillion won (approximately USD 590 billion) of policy and climate finance, an expanded climate response fund and new green government bonds to be detailed by mid-2027, with the explicit aim of fully launching transition finance for high-emission industries. The ask to government is therefore specific: instruct the national development finance institution to treat first commercial green iron projects as a high priority.

3 Build demand across borders

Bankable demand is a key binding constraint, and no single market in the region can anchor it alone. A regional offtake mechanism is needed that pairs green iron importers (Japan, Korea, and in time China and India) with exporters (Australia, India, Southeast Asia and the Gulf) aggregating public and private demand to a volume that finances a plant rather than a pilot.

Modelling of ten economies by Agora Industry and Cambridge Econometrics[61] finds that green iron trade leaves importing and exporting economies alike larger than they would otherwise be. By 2050 Japan gains around USD 50 billion in GDP and 592,000 jobs (a little over one per cent of its workforce); Korea adds 336,000 jobs (or 1.49 per cent of its workforce, the largest proportional gain in the study); China adds 8.6 million jobs; and Australia adds USD 11 to 16 billion in GDP, with iron and steel output almost thirty per cent above the no-trade baseline by 2050. Existing models to build on include double-sided auctions, buyer coalitions[62], and the offtake agreements for low-emissions hydrogen and its derivatives that the IEA now tracks in its hydrogen projects database[63].

Two refinements follow from the Mission Possible Partnership and RMI analysis. First, the relevant demand is subnational rather than national. China's import-dependent coastal provinces, Guangdong among them, are the plausible market, while its renewable-rich interior provinces are competitors rather than customers. Aggregating demand at the country level is misleading. Second, reciprocity provides leverage. Australia buys around 3.1 million tonnes of Chinese steel a year, close to thirty per cent of China's announced clean steel capacity[64]. Australia's role as a customer for clean steel could play a crucial in catalysing the green iron trade. The target should also be explicit. Mission Possible Partnership and RMI argue that five to ten per cent of demand is what the market needs to become self-sustaining.

The same modelling by Agora Industry and Cambridge Econometrics suggests how much trade to aim for. The mutual gains cited above come from a scenario in which importers source around half their iron abroad, not from full substitution. Under full substitution the domestic supply chain that serves the other half closes, and the employment effect reverses. Partial substitution delivers the cost saving and the investment without dismantling the industry that remains, which is also a far easier proposition to put to an importing government.

61 Agora Industry and Cambridge Econometrics (2026) op cit. The figures are for the mid-trade scenario and are measured against a baseline with no green iron trade.
62 RMI (2026) Sustainable Steel Buyers Platform and Asia-Pacific's Green Steel Demand Opportunity https://rmi.org/resources/asia-pacifics-green-steel-demand-opportunity/
63 IEA (2025) Cumulative firm offtake agreements of low-emissions hydrogen by end product, 2021-2025. https://www.iea.org/data-and-statistics/charts/cumulative-firm-offtake-agreements-of-low-emissions-hydrogen-by-end-product-2021-2025
64 Mission Possible Partnership and RMI (2026) op. cit.

A regional mechanism should be sized against that goal, rather than against a general call for more demand. Demand policy also has to be specified so that it reaches the iron. As noted above, demand for lower-emission steel can be satisfied from scrap-based electric arc furnaces or more efficient blast furnaces, which means a procurement commitment written at the level of finished steel can be met without a tonne of new low-emissions primary iron being produced. Three design choices decide whether it pulls the investment this report is concerned with. First, place the requirement on the metallic input as well as on the finished product, so that a defined share of the iron entering the furnace must itself be near-zero. Second, draw the accounting boundary at the installation, so that the intensity of the ironmaking step is declared separately and travels with the iron into the steel instead of being averaged away downstream. Third, write the specification against the receiving process and the product grade, because what an electric arc furnace, an electric smelting furnace and a basic oxygen furnace can each accept differs.

While a regional mechanism would take years to negotiate, governments have one demand instrument they can use immediately: public procurement. Rail, grid infrastructure, defence and public buildings are bought by the state. Japan is an instructive case in the negative: green steel has not been designated for public works in part because of transparency concerns about mass-balance products, a reason stated explicitly in the procurement committee's records[65]. That part of the obstacle lies within government's own control. Procurement will not finance a plant by itself. However, it can help establish reference prices, published specifications and act as a first buyer. The rest of the demand stack is built on those elements.

65 Renewable Energy Institute (2026) op. cit.

4 Apply a gas to hydrogen trajectory test

Public support for staged gas-to-hydrogen projects should only proceed if they are conditional on a pathway that is contractual and verifiable, not merely intended. We suggest the following tests, based on the work on hydrogen-ready infrastructure by Lu et al (2025):

- Contracted renewable electricity and/or hydrogen volumes by date
- A binding emissions-intensity trajectory
- Independent third-party verification of conversion readiness
- Transparent reporting
- Support that lapses if milestones are missed.

The test should also cover the electricity used to produce the hydrogen. Transition Asia and TERI find that hydrogen-based direct reduction made on grid power in India would emit around 2.2 tonnes of CO2 per tonne of crude steel at the 2030 grid factor[66], which is no better than the blast furnace it replaces, and begins to cut emissions only once the grid falls below roughly 0.57 kgCO2 per kWh[67]. A project could satisfy every other element of this test and still be no cleaner than the incumbent.

GH2's Green Iron Principles Principle 4 provides guidance on sustainable sourcing of renewable electricity and the associated emissions accounting[68]. The Principles state that Green Iron producers may count electricity taken from the grid as fully renewable if they have concluded one or more power purchase agreements (PPAs) with operators producing renewable electricity in one or more installations, generating renewable electricity for an amount that is at least equivalent to the amount of electricity that is claimed as fully renewable. PPAs should make use of credible Energy Attribute Certificates (EACs), Renewable Energy Certificates (RECs) or other guarantee of origin certification schemes where available. Certification schemes for green iron production should include detailed information on renewable electricity utilisation, including data on temporal correlation, market matching, and the location and age of the renewable electricity sources in accordance with global best practice such as the Greenhouse Gas Protocol Scope 2 Guidance[69].

Two pieces of evidence strengthen the case for a hydrogen trajectory test. As noted above, sixty-four per cent of Japan's Green Innovation Fund's steel-hydrogen budget is allocated to injecting hydrogen into blast furnaces against twenty-six per cent for direct reduction[71]. China shows the same failure in a different instrument: a decade of capacity replacement approved roughly three times as much new blast furnace capacity as electric arc furnace capacity.

The hydrogen trajectory test should apply to any public support that impacts the reinvestment decision, including capacity approvals and transition finance eligibility. Transition Asia and TERI[70] reach the same conclusion from the project side: a later switch to hydrogen "is only real if the hydrogen system has been planned, permitted and financed from the outset". Hydrogen use should be planned, permitted and financed (not merely intended).

66 Transition Asia and TERI (2026) op. cit.
67 ibid
68 GH2 (2025) Green Iron Principles. Op cit.
69 https://ghgprotocol.org/scope-2-guidance. Currently under review. The review is expected to include changes to the location-based method (e.g., updated emission factor hierarchy, requirement to use the most precise emission factors accessible, a new definition of accessible data) and market-based method (e.g., hourly matching requirement, deliverability requirement, new emission factor requirements) to improve accuracy, transparency and comparability.
70 Renewable Energy Institute (2026) op. cit.
71 Transition Asia and TERI (2026) op. cit. p42

5 Support emissions accounting certification that is credible, transferable and interoperable

While there has been some important progress on standards and certification[72], measurement methodologies diverge, hydrogen standards and steel standards are not interoperable, and the chain of custody question remains unsettled, with mass balance and book-and-claim advanced as rival candidates for the same role rather than as instruments suited to different circumstances[73]. A priority is to ensure interoperability between hydrogen emissions accounting (e.g., under ISO 19870-1) and steel standards ISO 20915 and ISO 14404.

With respect to chain of custody, physical corridors and controlled attribute transfer are recommended for traded iron, with book-and-claim confined to where physical sourcing is genuinely infeasible and subject to transition-alignment guardrails. Japan provides a cautionary case: green steel has not been adopted as a designated procurement item for public works, explicitly because of transparency concerns about mass-balance products. The Science Based Targets Initiative's 2026 corporate standard permits commodity certificates but not models that reallocate attributes without proportionality to physical flows[74].

72 GH2 (2025) Review of Green Iron and Steel Standards. Working Paper. v2 July 2025. https://gh2.org/sites/default/files/2025-07/GH2%20_%20Review%20of%20Green%20Iron%20Standards%20_%20v2%20July%202025.pdf
73 GH2 (2026) Green Iron Certification: which chain of custody models should be prioritised to support steel decarbonisation in Asia? https://gh2.org/event/green-iron-certification-which-chain-custody-models-should-be-prioritised-support-steel
74 Science Based Targets initiative (2026) Corporate Net-Zero Standard. https://sciencebasedtargets.org/corporate-net-zero

Country Recommendations

As highlighted in Figure 1, in several countries there is a foundation for unlocking the first commercial green iron projects in Asia Pacific. We would highlight the following measures:



Japan's GX-ETS needs an aggregate cap on the sector and free allocation reformed so that it rewards switching, for example by letting the blast furnace benchmark continue to apply to plants converting to direct reduction, as the EU does from 2026, alongside a falling share of free allocation. Without these reforms (see Box 1 above), the scheme's own incentives favour extending the life of the incumbent assets.



Similarly, **Korea's** K-ETS should move the steel sector off free allocation benchmarked on the blast furnace. The benchmark is attached to the asset, so it rewards the installed base for operating as it already does and penalises the switch. A plant that replaces a blast furnace with direct reduction and an electric arc furnace loses the basis on which its permits were granted. A route-neutral benchmark per tonne of crude steel, declining towards near-zero, with a rising auctioned share, would do the opposite. The case is sharper now that public money is going into hydrogen ironmaking through the K-GX programme.



China has already made its capacity replacement ratio partly route-dependent and should go further. Between 2017 and 2024 the mechanism approved roughly three times as much new blast furnace capacity as electric arc furnace capacity, because eligibility turned on efficiency rather than on the production route. The May 2026 revision changed that, granting equal-volume replacement to new ironmaking at least 60 per cent below the blast furnace route and to several electric arc furnace cases. Two refinements would sharpen it: a steeper ratio where coal replaces coal, since the concession is permissive and coal-for-coal replacement remains available at 1.5 to one; and attention to the 30 per cent tier, which is within reach of hydrogen injection into a blast furnace and available only for three years, so that it does not end up rewarding the pathway this report argues against.



India's Carbon Credit Trading Scheme should set an emissions-intensity trajectory for ironmaking before the capacity decisions described in this report are taken, not after they are irreversible.

Country Recommendations



Australia should lead on standards and procurement. Completing the Product Guarantee of Origin for iron and steel, and securing its recognition by importing governments in Japan, Korea and the European Union, would help make Australian green iron bankable. Federal and state procurement, alongside the Green Iron Investment Fund, could help anchor the first commercial volumes.

Those measures would work better inside a settled view of what Australia is building. The prior step is a government and industry process that defines the intended industry (Australia's position in the value chain, the target markets and products, the scale sought, the priority regions, the timing, and the basis on which Australian iron would compete) and then works backwards from it, identifying the constraints that stand in the way and the measures that would clear each one, set out as a coordinated delivery plan with named owners and dates.

A further recommendation follows from Australia's position as a prospective exporter rather than a buyer. The gas to hydrogen trajectory test (above) applies to Australian projects, as many are planned as gas-based direct reduction first with a switch to hydrogen later. Gas-based pathways may not satisfy the emissions thresholds that importing markets are now setting. Conversion milestones should attach to the Green Iron Investment Fund. Also, because readiness is specific to the ore, support should be staged accordingly. Where performance on Australian ores has not yet been demonstrated under continuous operation, or where the product has not been qualified by the steelmakers who would buy it, support for generating that evidence should be prioritised.[75]

75 Yeongmin Kweon and Ayantu Teshome Mossisa (2026) Choosing a Green Steel Pathway: Implications for South Korea, Japan, and Australia, Solutions for Our Climate, 14 September 2026. https://forourclimate.org/research/693