Green iron trade

Unlocking opportunities for China

January 2026

Agora Industry

Agora Energy 博众智合

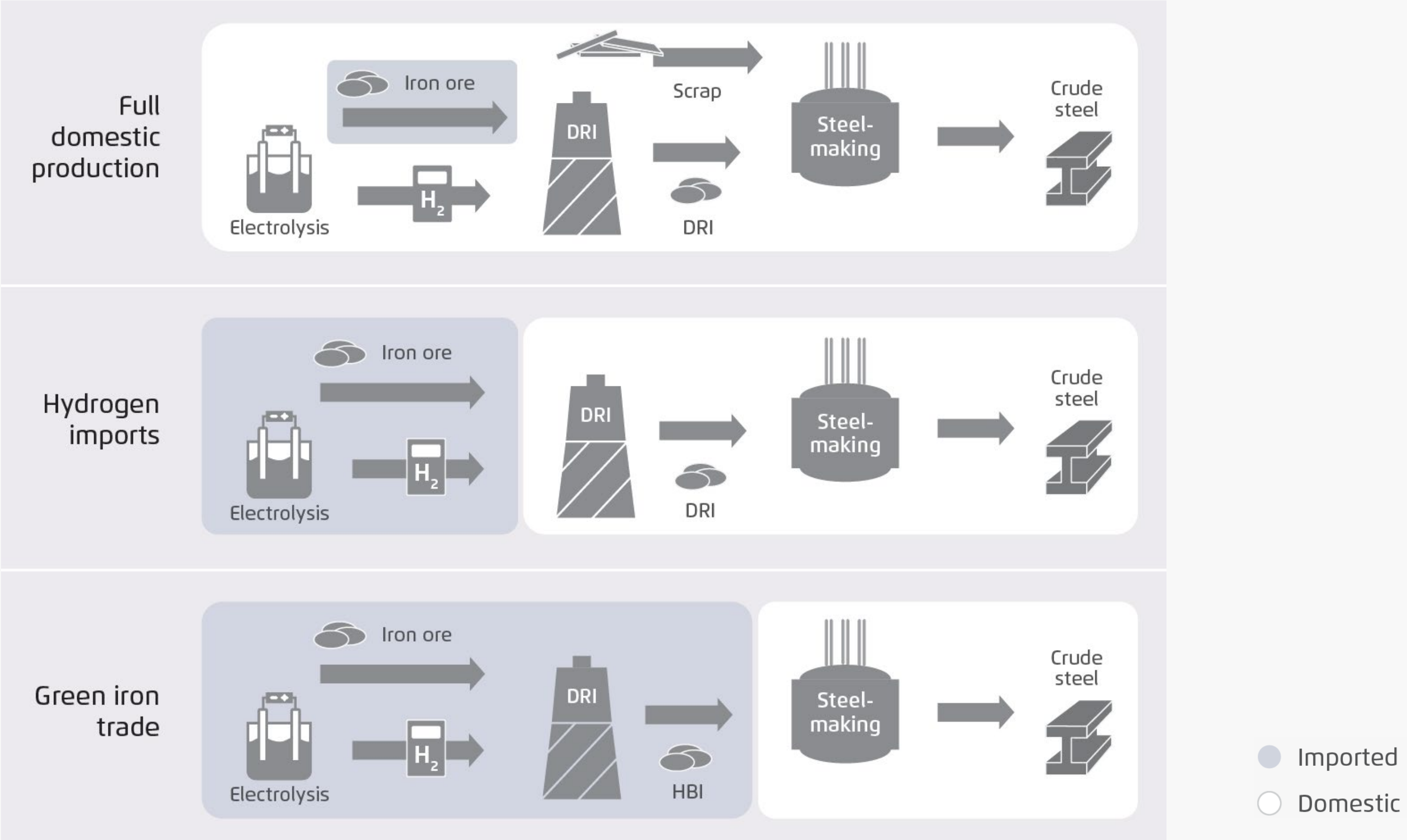
Key findings

1. **China's steel industry is pivotal to global decarbonisation efforts. Accounting for 17 percent of national carbon emissions as well as over half of global steel production, the sector remains central to China's economic and industrial competitiveness.** Investing in low-carbon steelmaking is both a climate necessity and a strategic opportunity to enhance technological leadership and safeguard jobs.
2. **China is beginning to phase down conventional steel capacity while scaling up low-carbon technologies and circular practices.** Strong policy signals, pilot projects and rapid renewable energy expansion are shaping a domestic pathway for industrial transformation. With nearly 90 percent of production still based on the blast furnace-blast oxygen furnace route, advancing breakthrough technologies such as hydrogen-based direct reduced iron (DRI) will be key to accelerating deep decarbonisation.
3. **China could evolve as both an importer and exporter of green iron.** Northern regions with abundant renewable resources and competitive power prices could supply green iron domestically or abroad, while southern coastal areas may increasingly rely on imported green iron to meet local steel demand. Such diversification can enable a cost-effective and regionally balanced transformation of China's steel sector.
4. **Policy measures across the value chain will be essential to unlock investment, scale hydrogen infrastructure and ensure international alignment.** Expanding green finance tools, strengthening certification and carbon accounting frameworks can reduce financing risks and support China's dual role as an importer and exporter in the emerging global market for green iron and steel.

Agora Industry
Agora Energy 博众智合

Green steel supply chains: a diversified approach

The value chain shifts for exporters and importers from iron ore to green iron

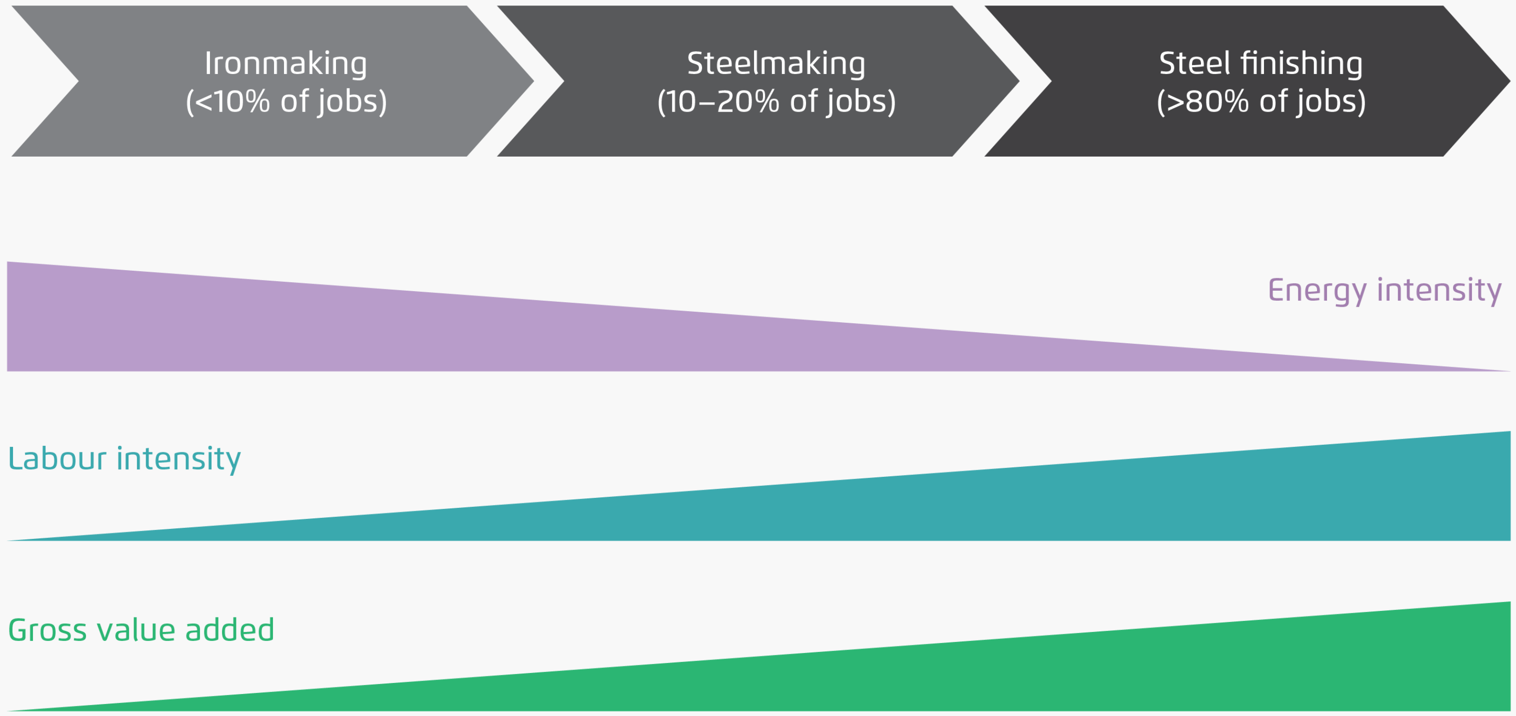


- → Producing green steel via DRI shifts the energy inputs from coal to clean electricity and H_2.
- → Green iron can be shipped as HBI, complementing domestically sourced metallic inputs (iron and steel scrap) and thereby providing steelmakers some flexibility in their raw material inputs compared to the integrated coal-based BF-BOF route.
- → This reduces the demand for domestic or imported H_2 and associated renewable energy and infrastructure.

Adapted from Verpoort et al. (2023).
Steelmaking refers to either the EAF process when DRI uses DRI-grade (high-grade) iron ore, or to the Smelt-BOF process if lower-grade iron ore is used for DRI production.
For more information on low-carbon iron production, refer to Agora Industry (2024).

Around 90 percent of jobs in the steel sector are in the more labour-intensive steelmaking and steel finishing sectors

Downstream steelmaking is also less energy-intensive and delivers higher gross value added



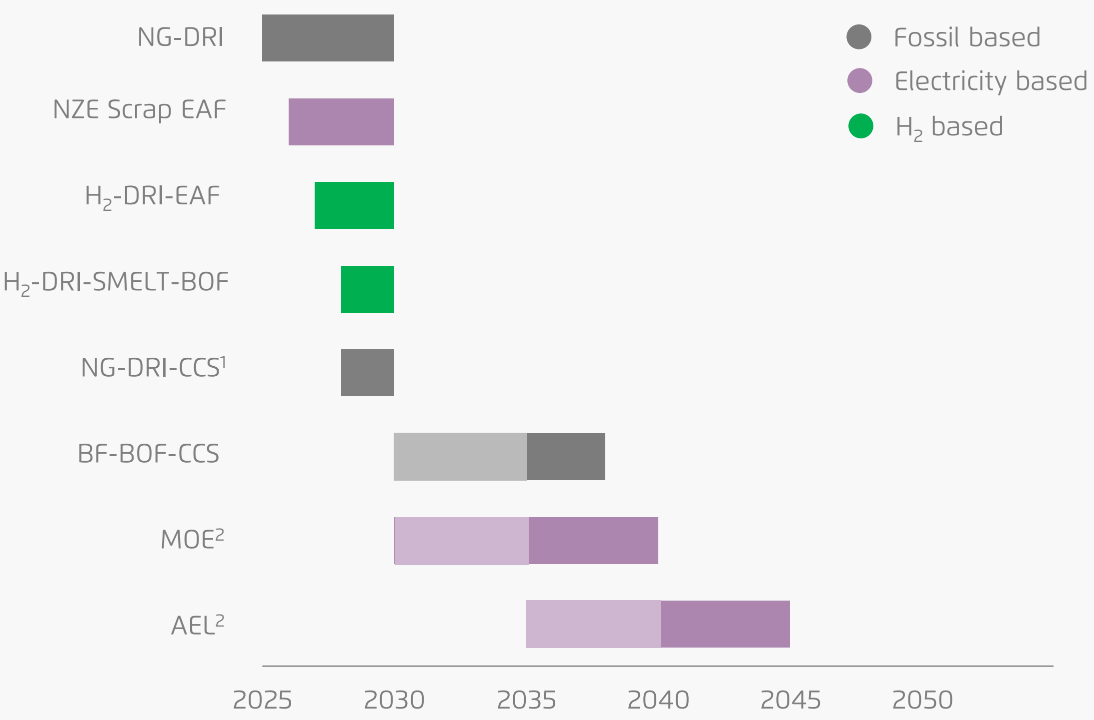
 [1] Steel sector and downstream steel finishing share of employment calculated based on WV Stahl (2025), Statistisches Jahrbuch der Stahlindustrie 2024/2025.

Agora Industry Agora Energy 博众智合

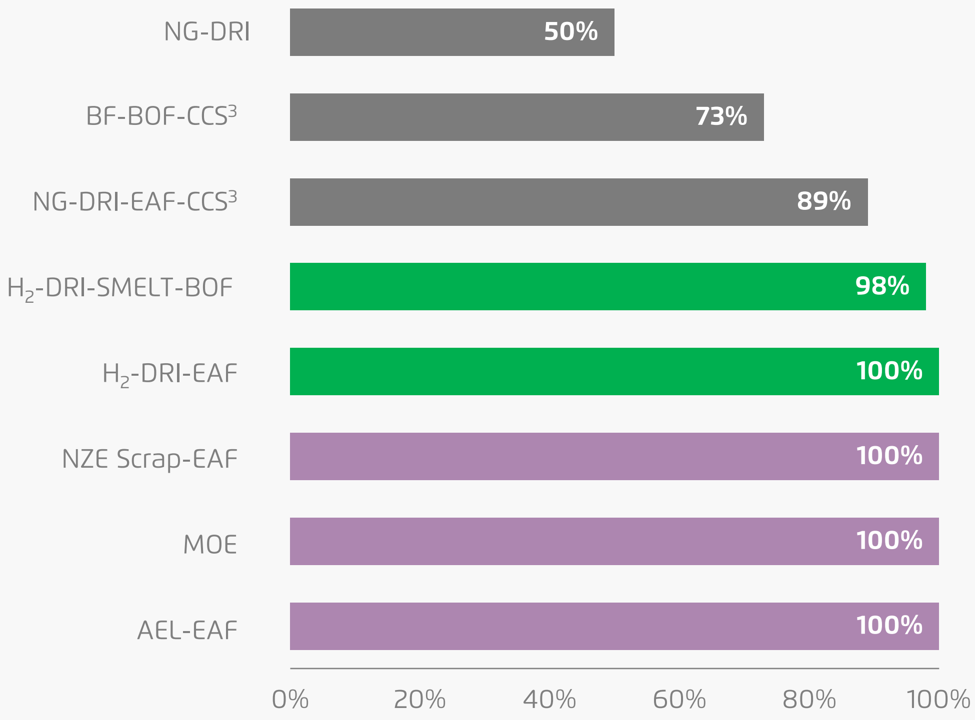
Next-generation steelmaking

By 2030, mature technologies like scrap-based electric arc furnace and hydrogen-based DRI routes will drive the decarbonisation of the steel sector

Expected market readiness[4] of different breakthrough technologies for steelmaking

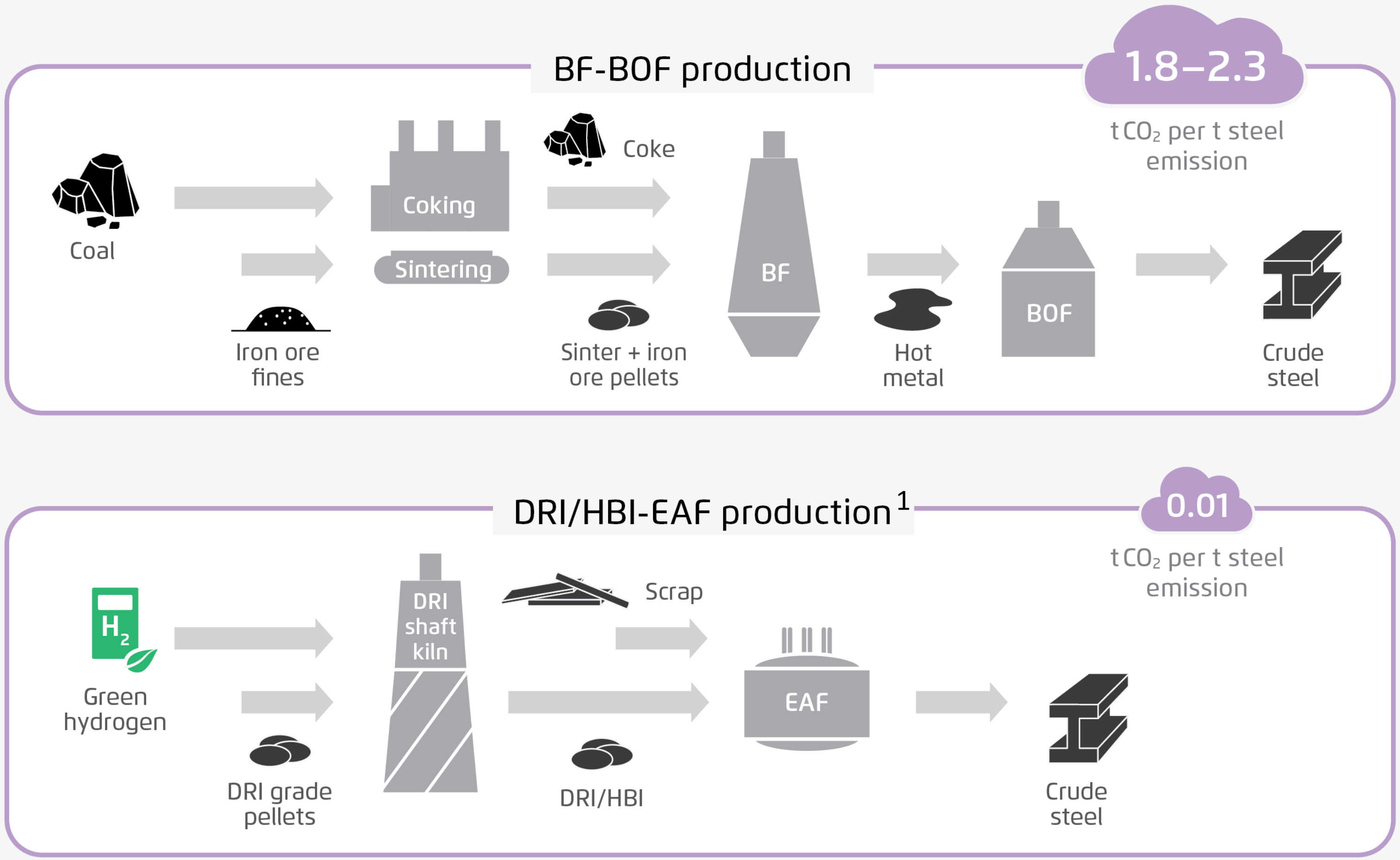


CO_2 abatement potential of different technologies compared to the integrated blast furnace route (BF-BOF)[3]



Agora Industry and Wuppertal Institute (2022, 2023). [1] Current commercial NG-DRI-CCS projects are not considered breakthrough technologies since they do not achieve large CO_2 emissions reduction rates.
[2] Due to their low TRL at the time of modelling, MOE was not foreseen to reach market readiness before 2035 and AEL before 2040. [3] CCS calculations are based on ambitious assumptions. Achieving high CO_2 capture rates at a BF-BOF plant is technically and economically challenging due to the many CO_2 point sources at the site. Note that upstream methane emissions (out of scope of this analysis) can substantially increase the full carbon footprint of steel, both for BF-BOF and NG-DRI with CCS. 4 Implies that TRL 9 is reached, and then you go from small commercial trials to full market deployment.

Steelmaking via the green hydrogen-DRI/HBI-EAF route can eliminate the vast majority of carbon emissions compared to the coal-based BF-BOF route

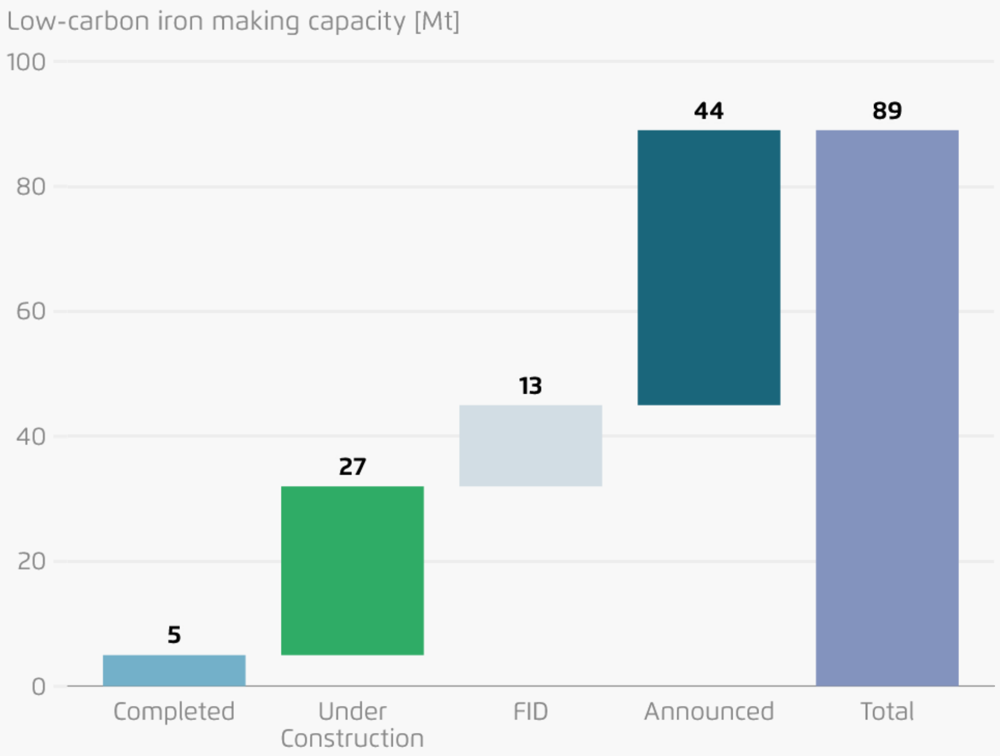


 [1] The DRI-SMELT-BOF route (not pictured here) is another viable route for green steel production, which is described further in Agora Industry and Wuppertal Institute (2023).

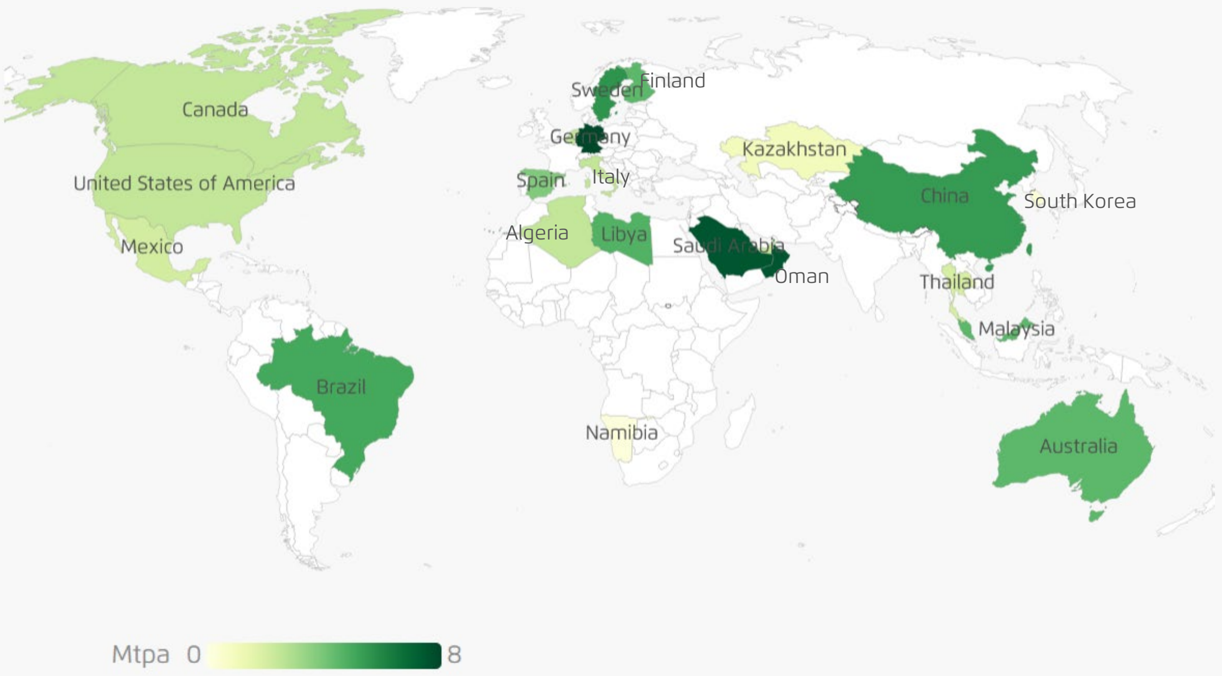
Agora Industry Agora Energy 博众智合

The transition to green steel is gaining momentum, with the EU and MENA region emerging as front-runners in the shift to hydrogen-DRI by 2030

2030 low-carbon steel announcement pipeline by project status



2030 low-carbon steel announcement pipeline by country



Agora Industry (2025) Low-Carbon also includes announced projects that are initially based on fossil gas. The large majority of the projects have plans to switch to renewables based H_2 in the future but many have unspecified timelines on when that switch to H_2 will occur.

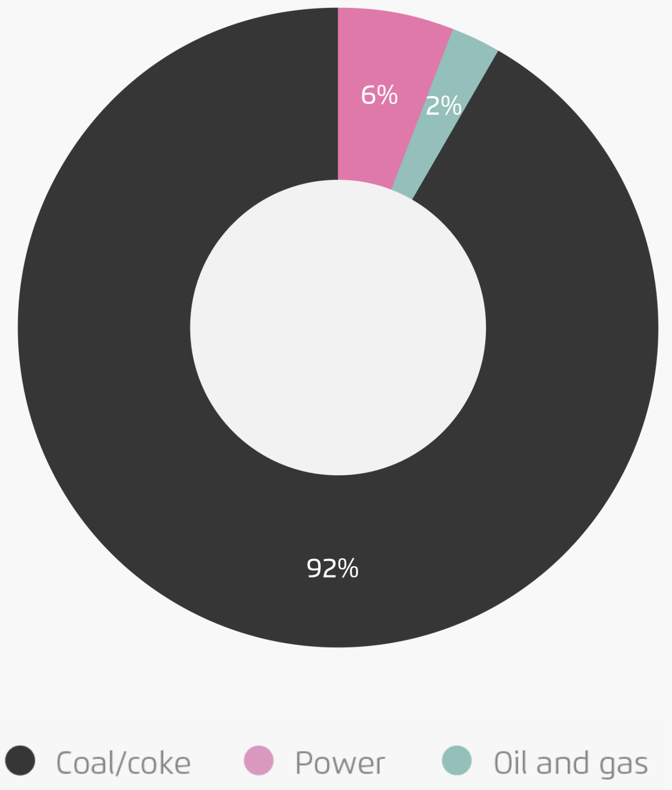
Opportunities of green iron trade: the case of China

As the world's largest steel producer, China's decarbonisation efforts are crucial for both its own climate goals and global emission reductions

China's steel sector:

- → 1 billion tonnes of crude steel production in 2024, accounting for 53.5% of global total
- → Accounted for around 17% of national carbon emissions
- → BF-BOF: 90%; EAF: 10%
- → BF's capacity utilisation rate at 85%,[1] exacerbating the industry's longstanding overcapacity issue
- → China has suspended the approval of new steel plants since August 2024, showing a realisation of stranded asset concerns, accompanied by state-owned enterprises' voluntary output cuts since March 2025
- → 111 million tonnes exports in 2024, reported 22% increase year-on-year, due to declining domestic demand

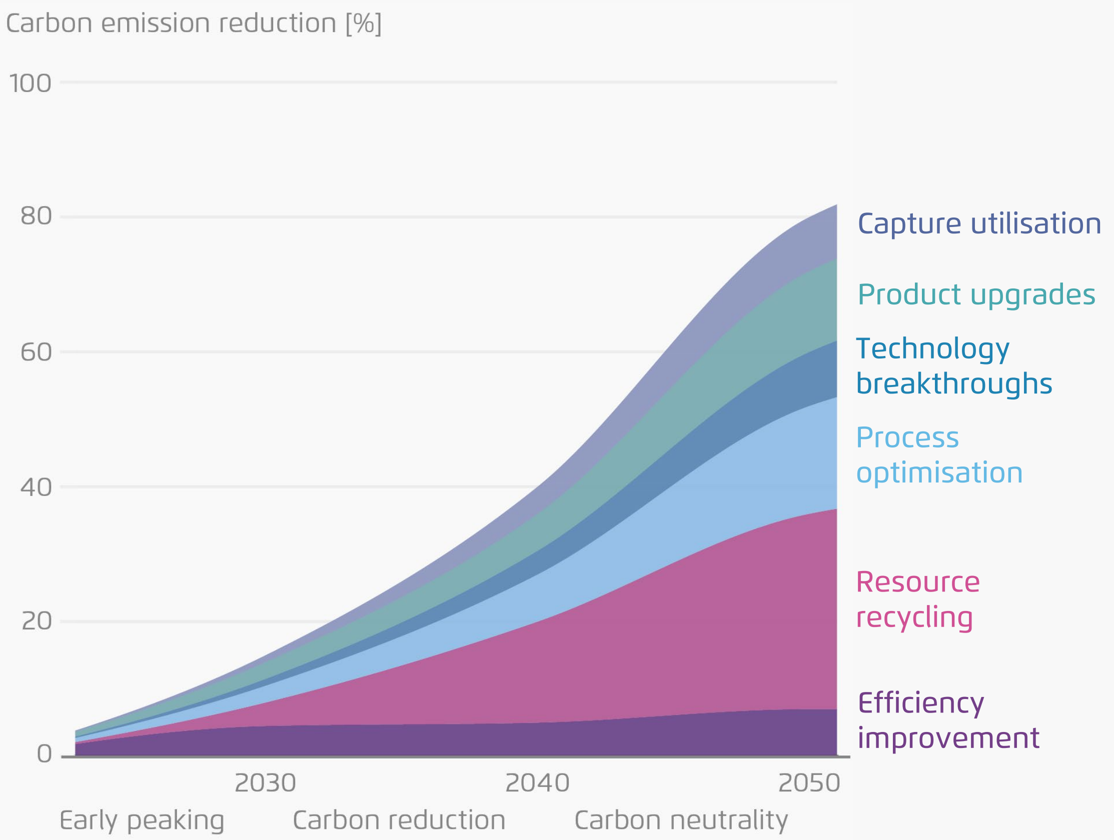
China steel sector energy source



 CSDRI. [1] https://www.reuters.com/markets/commodities/china-continue-crude-steel-output-cut-2025-2025-03-05/1

Apart from policies to drive retrofitting for energy efficiency improvements and increase the use of scrap, low-carbon technologies are being tested out in China

Steel sector decarbonisation roadmap by China's iron and steel association[1]

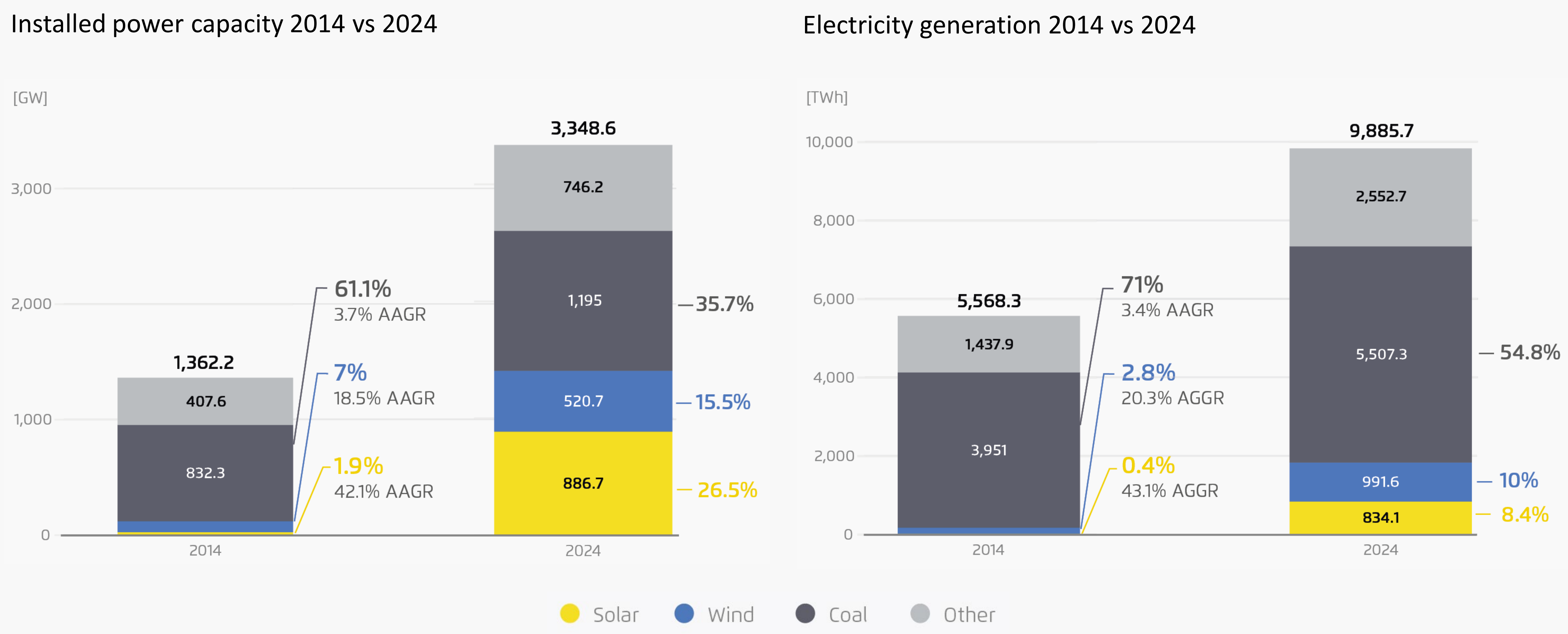


Low-carbon steel making technologies demonstrated in China

Technology	Enterprises	Status quo
Hydrogen-based DRI	Baowu, HBIS, ANSTEEL	Started operation (Baowu in 2024, HBIS in 2023); ANSTEEL finished construction in 2024
Hydrogen-rich carbon recycling BF	Baowu, HBIS, Jianlong Group	→ Baowu's project started construction in 2022, estimated operation starting date in 2023 → Jianlong's project is under construction phase until 2026/09
CCUS[2]	Bao Gang United Steel	Under construction since 2022
Hydrogen based DRI	Xinjiang Hydrogen Metallurgy Project	Announced. Construction due to start in April 2026. Operation due in 2029 after DRI completed. 1.2mtpa.

1. Carbon Neutral Vision and Low-Carbon Technology Roadmap for the Steel Industry, China Iron and Steel Association, 2022 2. CCUS carbon capture (utilization) and storage.

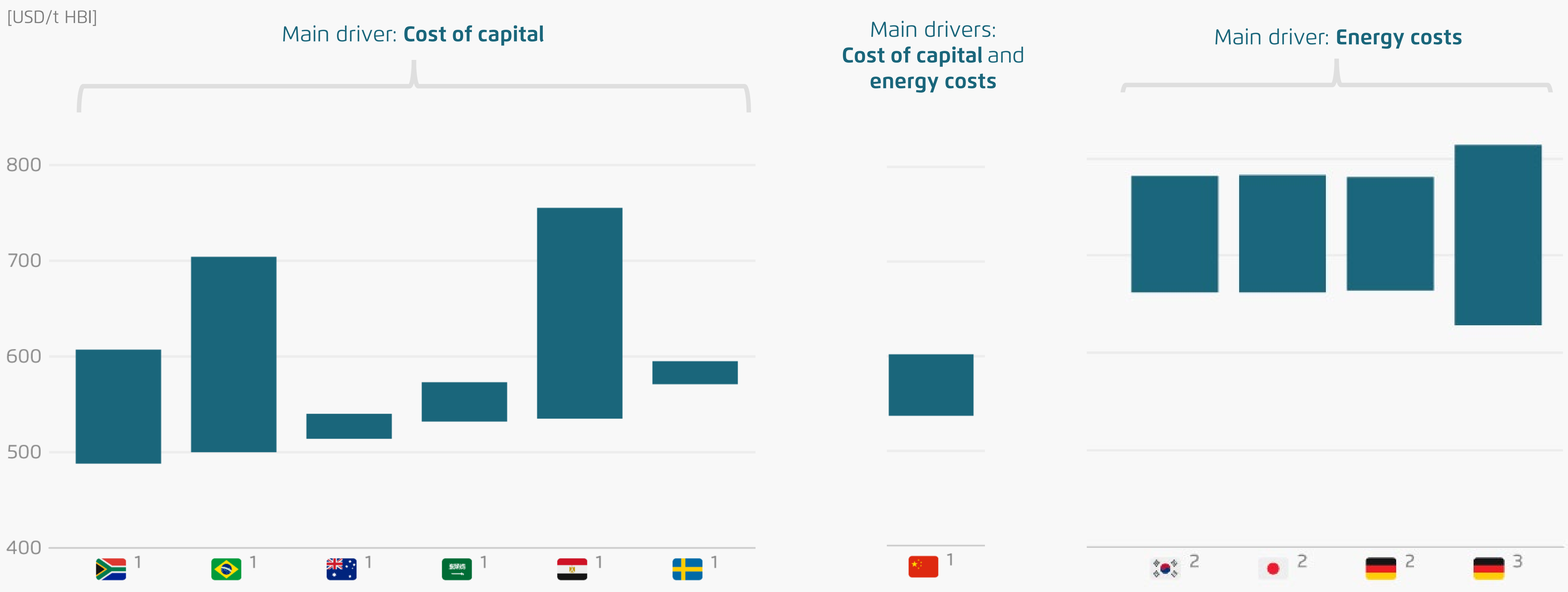
China's renewable power expansion is driving the cost-competitiveness of H_2-DRI



 | China Electricity Council (n.d.); AGGR = Annual average growth rate

Green HBI production costs are mainly driven by cost of capital in potential exporting countries and by hydrogen costs from high energy costs in potential importing countries

Range of HBI production costs in 2040



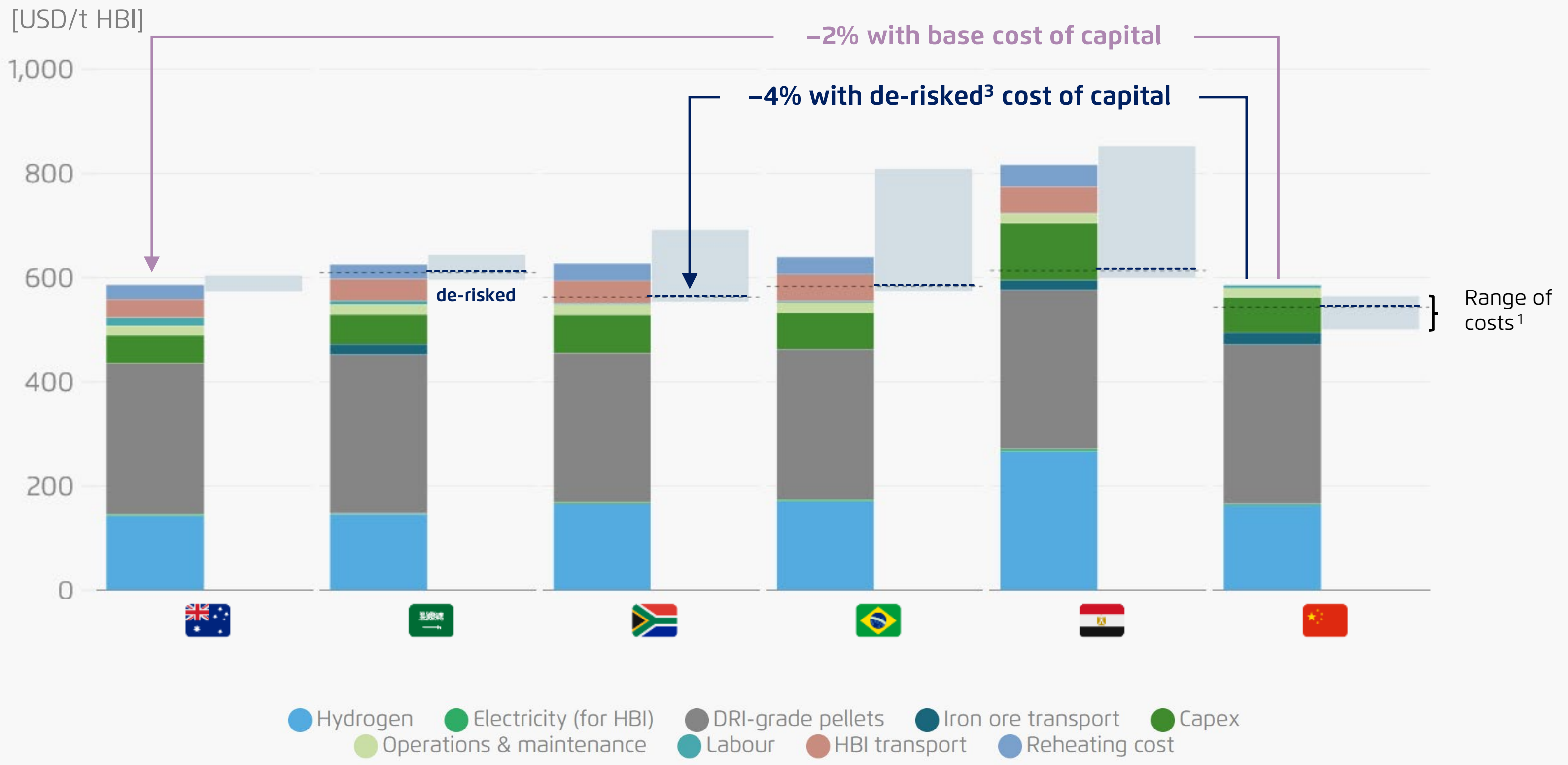
Agora Industry (2025). [1] driven by variable renewable energy; [2] grid-based electricity procurement; [3] hydrogen imports via pipeline from Tunisia (upper bound) and Denmark (lower bound). HBI production costs based on Oeko-Institut, Agora Energiewende and Agora Industry (2024): PtX Business Opportunity Analyser, version 2.0. For detailed information on the scenarios assessed, see slides in the Appendix.

Agora Industry

Agora Energy 博众智合

China is well positioned as a green iron exporter in the short term, supported by large-scale renewables, lower labour costs and competitive industrial production

HBI production and import[2] costs in 2040 based on medium cost scenario



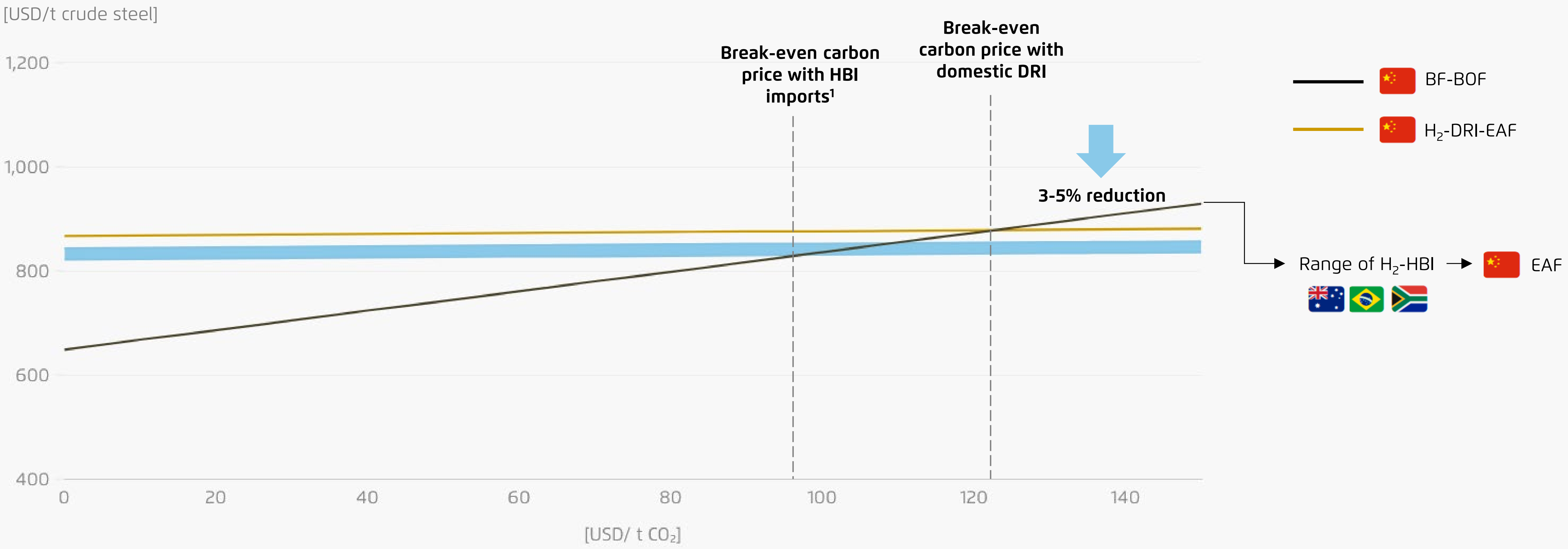
→ Projects in many exporting countries will need supporting de-risking[4] measures to be developed.

→ As a global green iron market develops, access to cost-competitive HBI imports would enable more cost-effective steel production.

Agora Industry (2025). * H_2 pipeline in Europe considering imports from Spain (medium cost scenario); **HBI production costs based on grid-based electricity procurement. [1] The light grey columns indicate the range of HBI production costs across low, medium, and high cost scenarios. [2] import costs include re-heating cold HBI; [3] de-risked cost of capital assumed to be 4.3%. [4] De-risking includes measures such as concessional finance and offtake contracts that result in lowering the cost of capital for investments in HBI production. For detailed information on the scenarios assessed, see slides in the Appendix.

Limited high-grade iron ore could constrain domestic green iron production, making imports more competitive in southern Chinese regions by 2040

Crude steel production costs in 2040 using imported (de-risked*) and domestic HBI/DRI.
Importing HBI could cut 3-5% of steel production costs.



Agora Industry (2025). *de-risked cost of capital: 4.3%; production costs of green steel include: shipping costs of iron pellets and HBI, losses during transportation, cost of re-heating cold HBI as well as costs associated with higher tap to tap time by using cold HBI. For detailed information on the scenarios assessed, see slides in the Appendix.

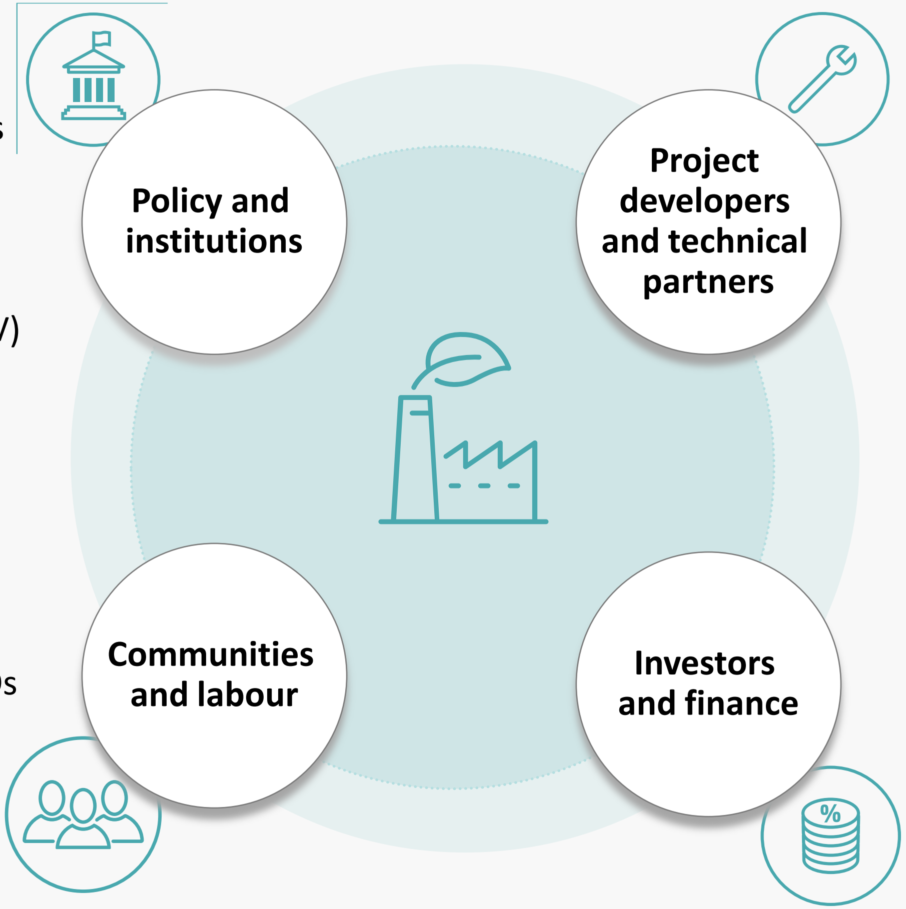
Agora Industry

Agora Energy 博众智合

China policy recommendations

Key players must come together to create the enabling environment required to enable H_2-DRI project implementation

- National government and regulators
- Multilateral organisations and platforms (World Bank, UN bodies, Climate Club, etc.)
- Think tanks and researchers
- Certification bodies (standards, MRV)



- Iron ore miners
- Green iron and steel producers
- Renewables and hydrogen developers
- Infrastructure developers (grids, pipelines, storage)
- Technology providers (electrolysers, DRI, EAF)
- Green iron & steel offtakers
- Project developers (EPC, plant design)

- Local communities
- Labour and trade organisations
- Environmental and community NGOs

- Equity investors (project consortium)
- Commercial debt providers (commercial banks)
- Concessional finance (PPPs, DFIs, MDBs, JETPs)
- Export credit agencies

1) Domestic industrial policy: creating market confidence and accelerating domestic readiness

1. **Create lead markets to drive business cases for green iron**
   - Use green public procurement and incentives for end-use sectors such as automotive, construction and machinery
   - Set clear green content requirements and align standards and certification with international practices
   - Support green private procurement to stimulate early demand and strengthen market trust

2. **Scale renewable energy and hydrogen production and infrastructure**
   - Co-ordinate and accelerate build-out of renewable electricity and hydrogen infrastructure (grids, pipelines, storage).
   - Increase steel sector's renewable power consumption obligation

3. **Support domestic lighthouse projects**
   - Provide funding and tax incentives for first movers and critical infrastructure such as DRI logistics and hydrogen storage
   - Establish national offtake schemes to de-risk early investment, similar to Hydrogen Bank or H_2Global models
   - Strengthen carbon pricing and phase out free allowances to create a level playing field for green steel
   - Support the Zero-carbon Industrial Valleys that aim to provide clean power, hydrogen, CO_2 infrastructure, and digital carbon management systems. This avoids each plant having to act alone.

2) International collaboration: leveraging trade to drive investments into green supply chains

1. **Stengthen cooperation with key suppliers to secure access to high-quality iron ore**
   - Accessing affordable green iron can support the competitiveness of China's green steel sector

2. **Establish offtake mechanisms and long-term security of supply**
   - Engage with international demand-side platforms and procurement coalitions to aggregate early demand
   - Include green iron in international market maker mechanisms (e.g. H_2Global) to develop cross-border offtake agreements
   - Grant market access and consider incentives for green iron imports to position China as a key global offtaker

3. **Enable financing for green iron projects and value chains**
   - Deploy de-risking instruments and blended-finance tools through public banks and multilateral institutions to lower capital costs
   - Amplify commercial mode of Simandou to accelerate green iron project financing

4. **Set global standards and support technology transfer**
   - Building off of the successful MoU signed between the LESS standard supported by European companies and the CISA standard on interoperability, global standards are now in sight.
   - Work through bilateral and multilateral platforms to harmonise standards for green steel, hydrogen and carbon accounting
   - Promote technology cooperation and local capacity building to accelerate the global diffusion of clean industrial solutions

Appendix

List of abbreviations

AEL: Alkaline iron electrolysis

BF: Blast furnace

BOF: Basic oxygen furnace

Capex: Capital expenditures

CBAM: Carbon Border Adjustment Mechanism

CCS: Carbon capture and storage

DRI: Direct reduced iron

EAF: Electric arc furnace

Fe: Iron

FLH: Full Load Hours

GHG: Greenhouse gase

H_2: Hydrogen

HBI: Hot briquetted iron

MOE: Molten oxide electrolysis

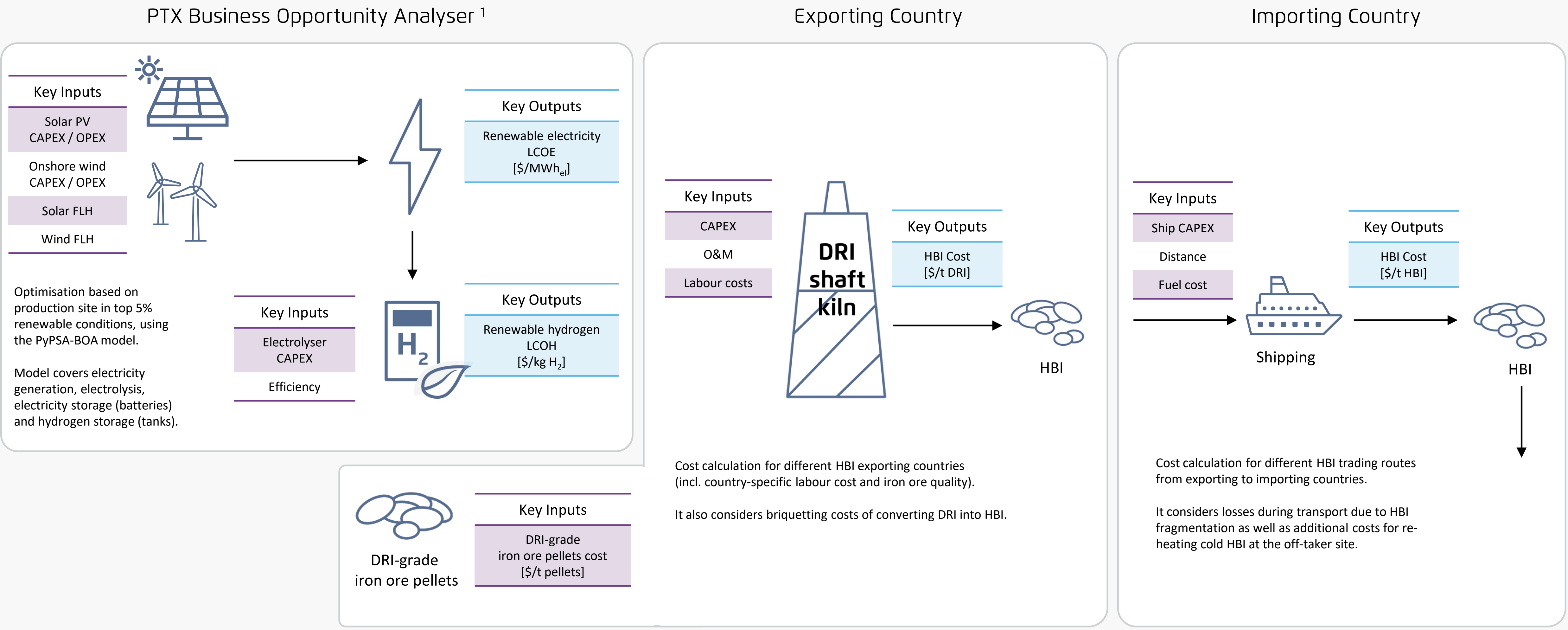
NZE-scrap-EAF: Near-zero emissions scrap electric arc furnace

Opex: Operating expenditures

TRL: Technology Readiness Level

WACC: Weighted average cost of capital

HBI production cost – calculation methodology



[1] Oeko-Institut, Agora Energiewende & Agora Industry (2024): PTX Business Opportunity Analyser, Version 2.0

Appendix – key assumptions

Overall values

Parameters		Value	Reference	Comment
Amortisation time (years)		20	Own assumption	-
Capacity utilisation (%)		90	Own assumption	72% for EAF charged with cold HBI[1]
DR grade iron pellets (USD_{2024} / tonne)		207	1, 2	Price for countries without DR grade iron ore. Countries with DR can produce pellets with lower costs.
DRI plant	CAPEX (USD_{2024} / tonne DRI per year)	633	2	Recent announcements values
	Fixed OPEX (% of CAPEX per year)	3	2, 4	-
	Electricity consumption (kWh / tonne DRI)	93	2, 3	Including DRI briquetting
	Hydrogen consumption (kg H_2 / tonne DRI)	69	2, 4	Including H_2 pre-heating
EAF plant	CAPEX (USD_{2024} / tonne CS per year)	468	2,	Recent announcements values
	Fixed OPEX (% of CAPEX per year)	3	2, 4	-
	Electricity consumption (kWh / tonne HBI)	651	2, 4, 5	Including re-heating of cold HBI (150 kWh / ton HBI)

Note: [1] The capacity factor of the EAF was adjusted to account for lower productivity when charged with cold HBI compared with hot HBI due to a higher tap-to-tap time.

Appendix – key assumptions

Overall values

Parameters		Value	Reference	Comment
BF-BOF plant	CAPEX (USD_{2024} / tonne CS per year)	326	10	-
	Fixed OPEX (% of CAPEX per year)	3	10	-
	Coking coal (USD_{2024} / tonne)	257	2	-
Alkaline electrolyser	CAPEX (USD_{2024} / kW_{el})	657	8	-
	Fixed OPEX (USD_{2024} / kW_{el}-year)	13	8	-
	Efficiency	71.5%	8	-

Appendix – key assumptions

Country-specific values

Parameters	Case	Australia	Brazil	China	Egypt	South Africa	Saudi Arabia	Germany*	Germany**	Japan	South Korea	References
Discount rate*** (%)	High	4.3	14.6	7.2	14.3	10.8	5.1	4.3	4.3	5.3	4.9	6,7
	Medium (default)	4.3	7.7	7.2	14.3	8.35	5.1	4.3	4.3	5.3	4.9	6
	Low	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	6
CAPEX of wind onshore (USD_{2024} / kW)	High	1176	910	941	1269	868	1482	1531	-	-	-	8
	Medium (default)	1037	802	829	1119	765	1307	1624	-	-	-	8
	Low	977	756	782	792	721	1232	1456	-	-	-	8
CAPEX of solar PV (USD_{2024} / kW)	High	698	564	483	628	303	977	1042	-	-	-	8
	Medium (default)	528	426	365	475	389	357	434	-	-	-	8
	Low	411	332	284	370	515	278	505	-	-	-	8

* H_2 pipeline for Germany is based on H_2 production in Tunisia (high case), Spain (medium case) and Denmark (low case). ** grid-based electricity for Germany; *** country-specific equity risk premiums (ERP) and government bond yields are used as simplified approach in levelised cost calculations, since a more detailed weighted average cost of capital (WACC) is intrinsic to each individual project; All costs refer to 2040 technological scenario.

Appendix – key assumptions

Country-specific values

Parameters	Case	Australia	Brazil	China	Egypt	South Africa	Saudi Arabia	Germany*	Germany**	Japan	South Korea	References
Cost of renewable energy (USD_{2024} / MWh)	High	37	64	31	77	70	26	105	105	105	105	8,9
	Medium (default)	32	38	31	56	29	21	90	90	90	90	8,9
	Low	29	27	21	23	21	16	70	70	70	70	8,9
Cost of renewable hydrogen (USD_{2024} / kg)	High	2.3	4.0	2.6	4.3	4.5	2.4	4.6	5.16	5.16	5.16	8,9
	Medium (default)	2.1	2.5	2.4	3.9	2.5	2.1	2.9	4.47	4.47	4.47	8,9
	Low	1.9	1.9	1.9	2.0	2.0	1.8	2.8	3.54	3.54	3.54	8,9

* H_2 pipeline for Germany is based on H_2 production in Tunisia (high case), Spain (medium case) and Denmark (low case); ** grid-based electricity for Germany; All costs refer to 2040 technological scenario.

Imprint

Agora Industry
Agora Think Tanks gGmbH
Anna-Louisa-Karsch-Straße 2, D-10178 Berlin
+49 (0) 30 7001435-000
www.agora-industrie.de
info@agora-industrie.de

Project Lead
Camilla Oliveira, camilla.oliveira@agora-industrie.de

Technical Coordination
Leandro Janke, Darlene D'Mello (both Agora Industry); Niklas Wagner (previously Agora Industry)

Policy Coordination
Ysanne Choksey, Julian Somers, Karina Marzano (all Agora Industry); Zaffar Hussain (previously Agora Industry)

Contributors
Julia Metz (Agora Industry); Wenbo Zhao (Agora Energy China); Isadora Wang (previously Agora Energy China); Kathy Reimann (previously Agora Industry)

Picture credits title: istock/peterschreiber.media