Green iron trade

Unlocking opportunities for South Korea

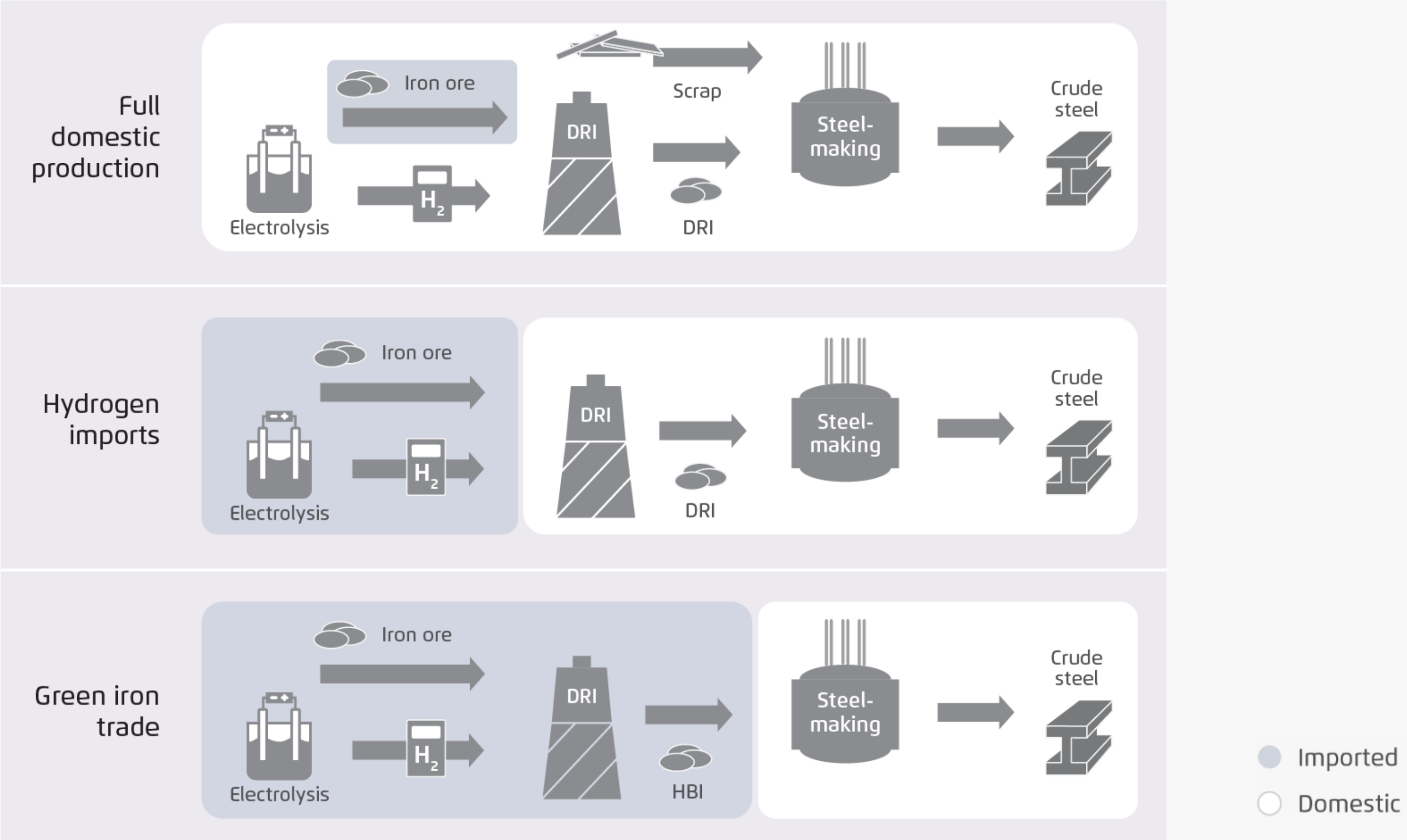
February 2026

Key findings

1. **South Korea's steel industry is central to its economic and industrial base, but it remains one of the country's most carbon-intensive sectors.** Investing in green steelmaking is both a necessity and a strategic opportunity for South Korea to secure jobs, enhance technological leadership and maintain competitiveness in global markets. Smart policy and international cooperation can unlock this potential and help build a global market for green iron.
2. **By importing green iron from regions rich in iron ore and renewables potential, South Korea could cut steelmaking costs by 12 to 15 percent by 2040.** The partial decoupling of energy-intensive ironmaking from steel and downstream processes could enable a cost-competitive transformation of South Korea's steel sector while contributing to the global transition through the development of international green iron supply chains.
3. **Policy momentum for low-carbon steel is picking up globally, including in South Korea, despite a challenging geopolitical context and recent trade policy shifts in the European Union and the United States.** The approval of the Korean K-Steel Act in 2025 signals government readiness to support this transition. This momentum can be leveraged through targeted measures along the value chain to unlock investment and scale the hydrogen ramp-up, including financial de-risking, green use of the Export-Import Bank of Korea's (KEXIM) Supply Chain Stabilisation Fund, lead markets for green products and the phase-out of free allowances under the K-ETS.
4. **Looking ahead, collaboration with key green iron-exporting countries can help South Korea align its climate, industrial and trade objectives.** This can be achieved through mutually beneficial international partnerships that de-risk investments and provide concessional finance, as well as through long-term offtake agreements. Such partnerships can help the country to position itself as a leader in Asia's green industrial transformation and in the global clean materials market.

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.

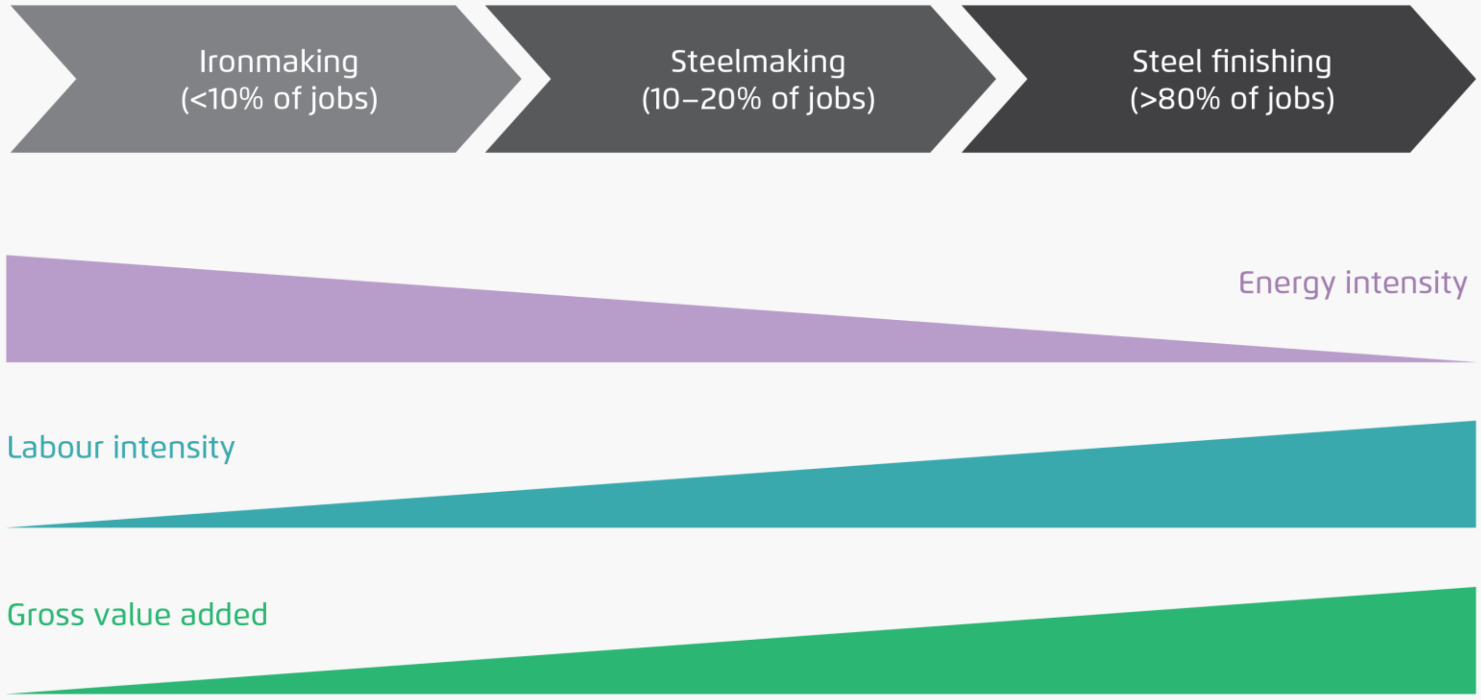
→ Green iron can be shipped as HBI, complementing domestically sourced metallic inputs (iron and steel scrap) and thereby providing steelmakers some flexibility in their raw material inputs compared to the integrated BF-BOF route.

→ 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

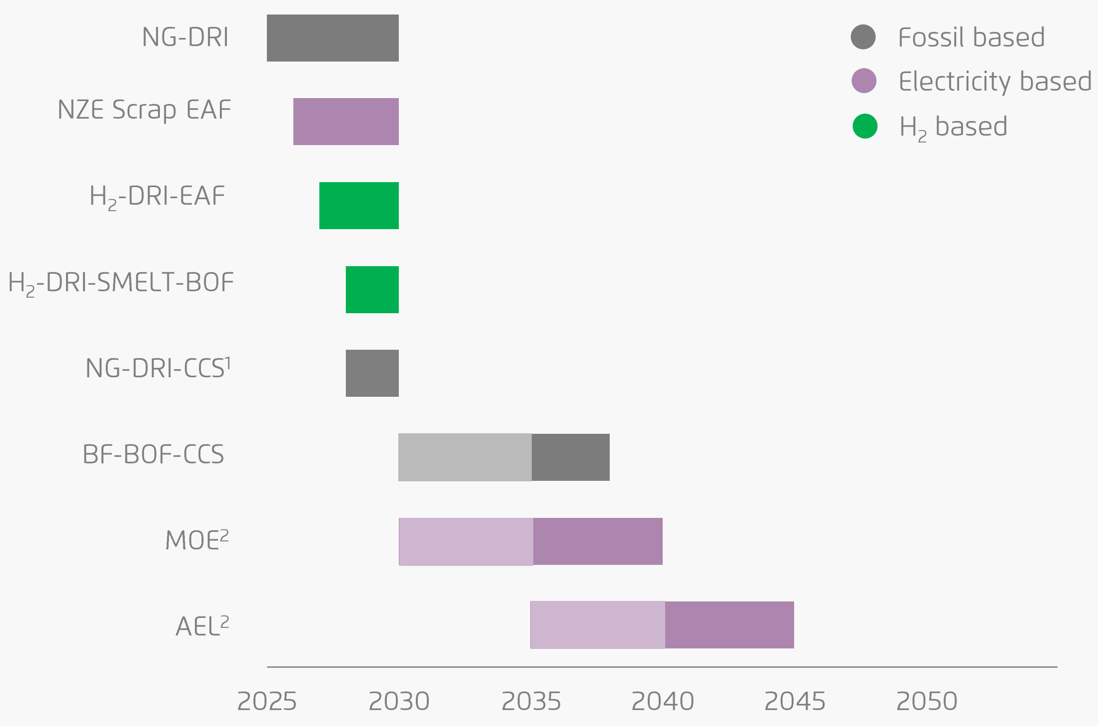


[1] Steel sector and downstream steel finishing share of employment calculated based on WV Stahl (2025), Statistisches Jahrbuch der Stahlindustrie (2024/2025).

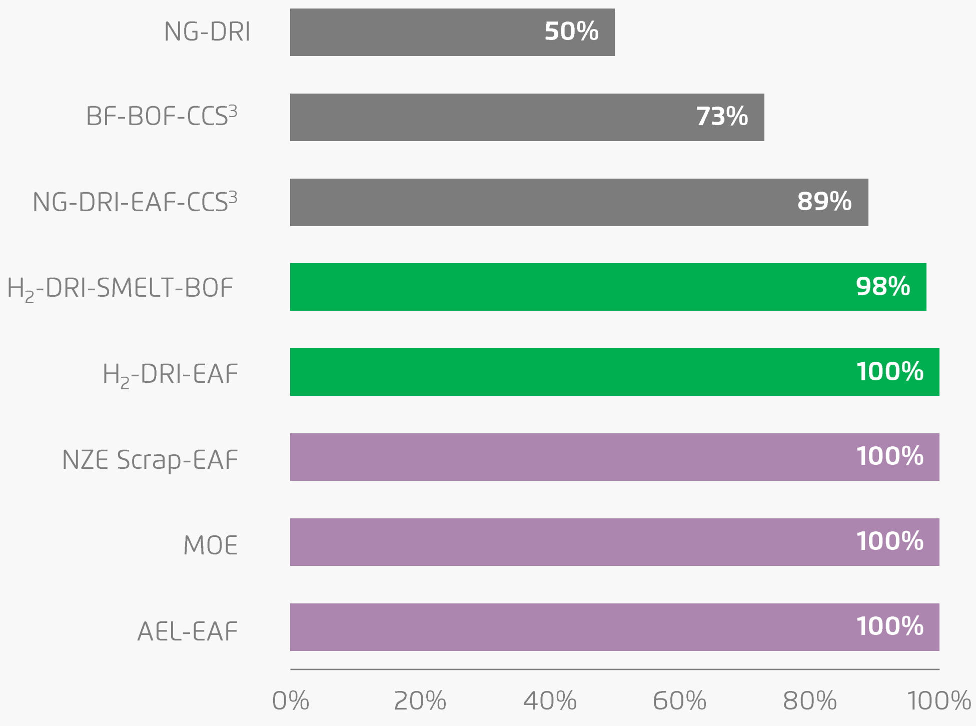
Next-generation steelmaking

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.

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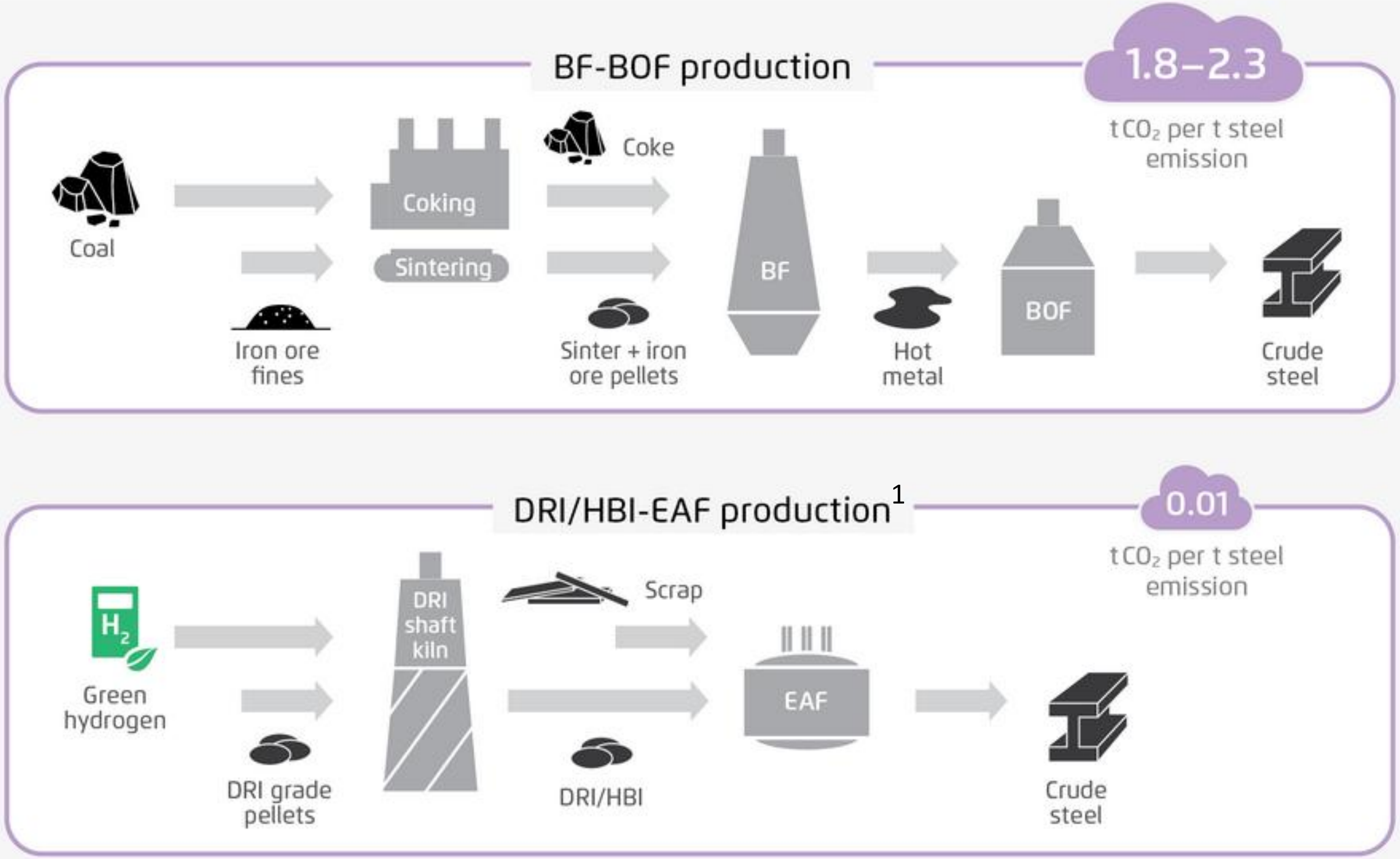
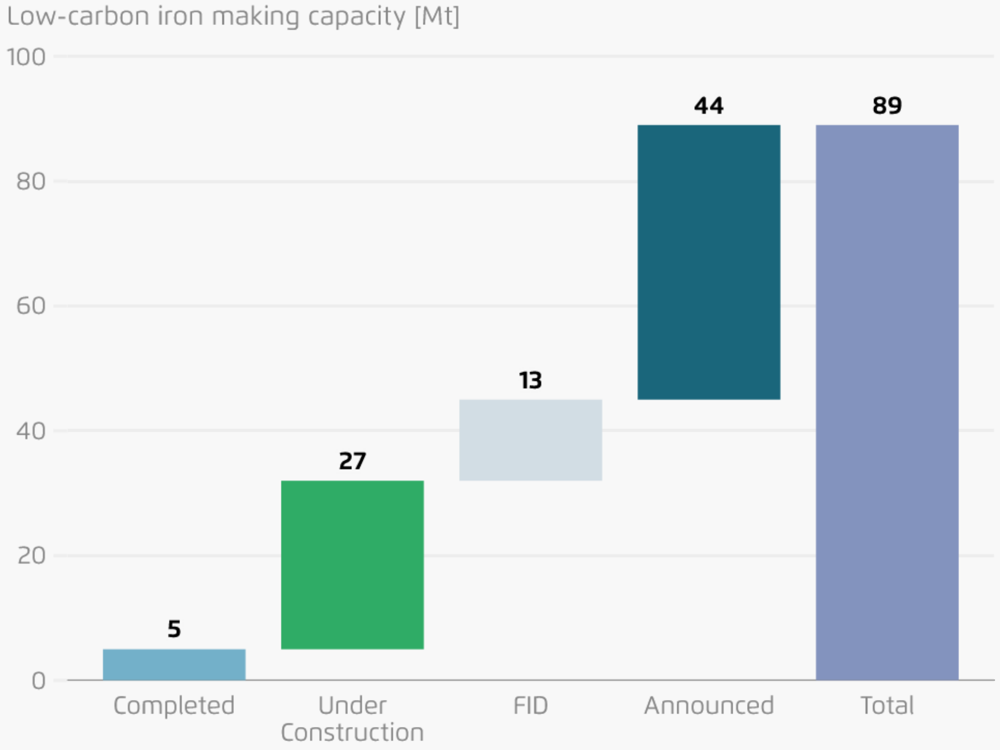
Steelmaking via the hydrogen-based DRI/HBI-EAF route can eliminate the vast majority of carbon emissions compared to the BF-BOF route



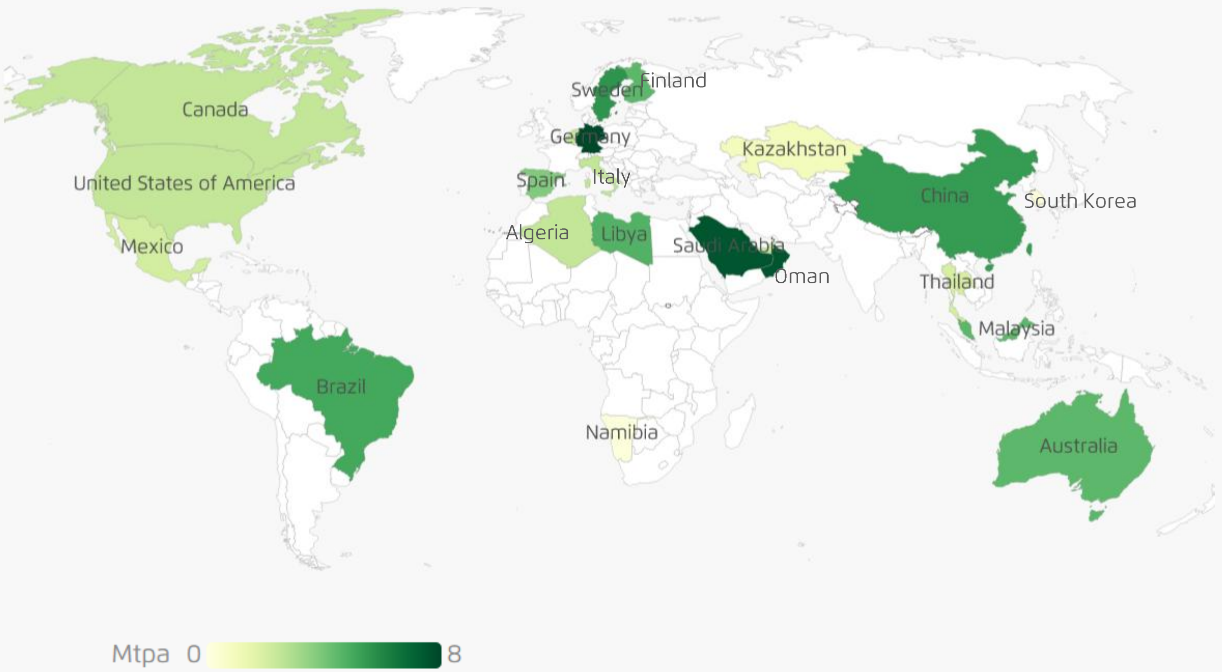
[1] The DRI-SMELT-BOF route (not pictured here) is another viable route for green iron trade, which is described further in Agora Industry and Wuppertal Institute (2023). HyREX technology (also not pictured) is another hydrogen-based ironmaking route that produces green iron and is a strategic focus in South Korea. For more information, see https://www.posco.co.kr/homepage/docs/eng7/jsp/hyrex/.

The transition to green steel is gaining momentum, with the EU and MENA region emerging as front-runners in the shift to H_2-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 hydrogen in the future but many have unspecified timelines on when that switch to hydrogen will occur.

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Opportunities of green iron trade: the case of South Korea

South Korea could lead steel decarbonisation in Asia, but needs to prioritise low-carbon alternatives over BF-BOF relining

South Korean steelmaking sector:

→ Produced 64 million tonnes of crude steel in 2024 (6th in the world)

→ Ranks 8th in carbon emissions globally

→ South Korea's steel industry is highly concentrated, with a few major producers accounting for a significant share of national crude steel production

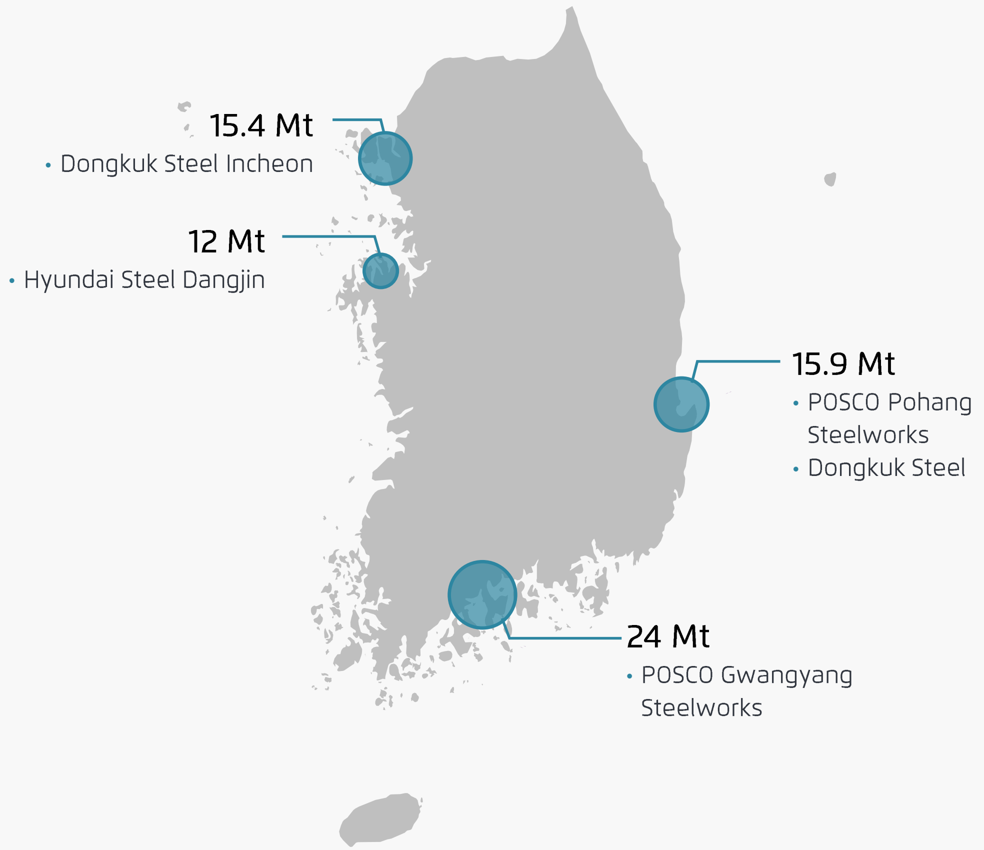
→ Steel production capacity by technology:
- BF-BOF: 68%
- EAF: 32%

→ Newest blast furnace was built in 2013

→ 40% of production for export

→ 76% of blast furnaces' lifetime goes beyond 2035

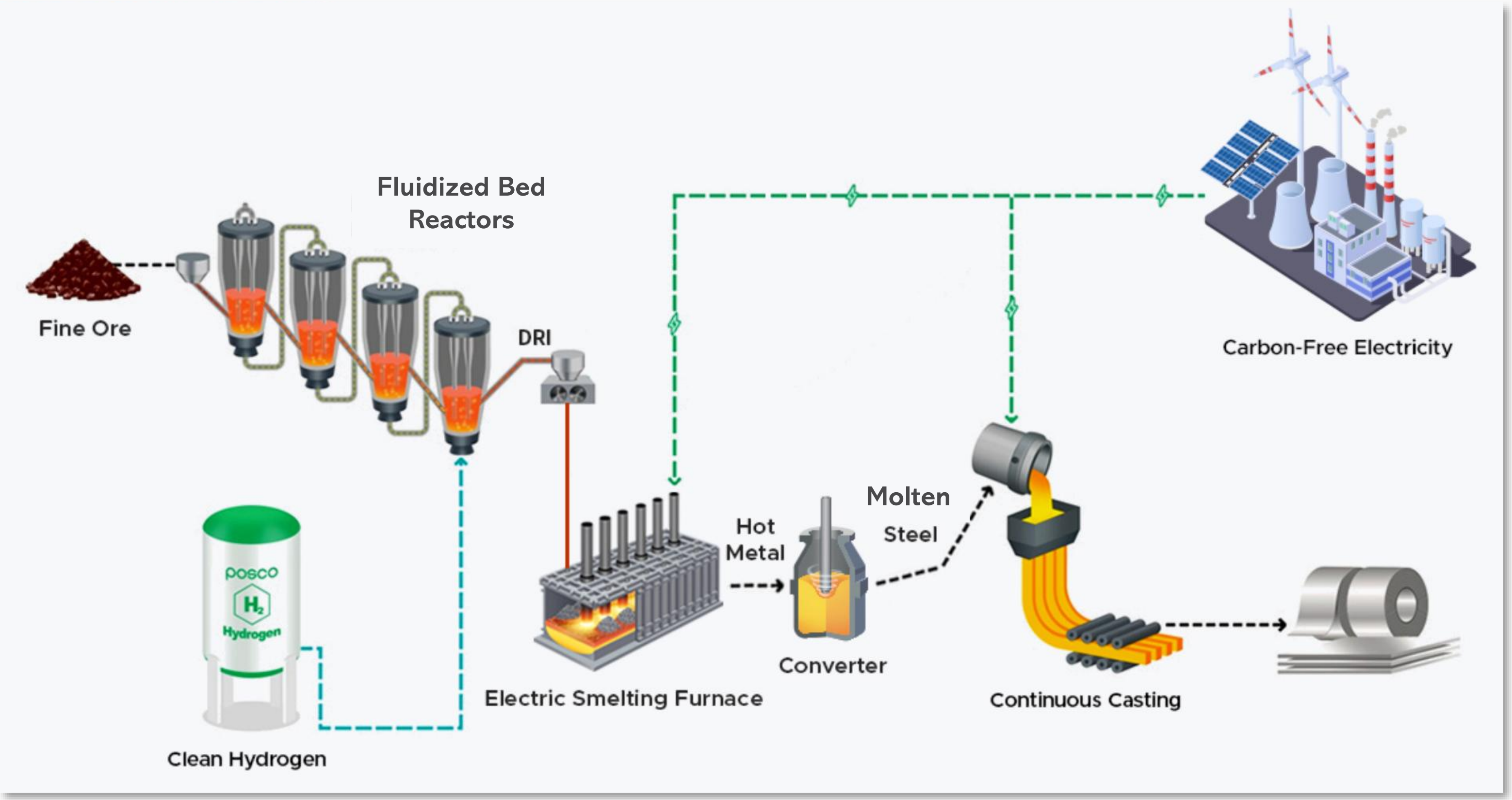
Major steel producers in South Korea:



 | Agora Industry and Wuppertal Institute (2022, 2023). Mt = million tonnes

South Korea is accelerating the green steel transition through overseas HBI investments, new EAF capacity and HyREX[1] development

Hydrogen reduction ironmaking based on HyREX technology



Overseas investment to produce HBI and renewable hydrogen

→ A major steel producer is investing in Australia to construct a HBI plant along with green hydrogen production

New EAFs planned, but small scale

→ A major steel producer is planning 2.5 Mt by 2026 (6% of total capacity) and 5 Mt by 2030 (22% of total capacity)

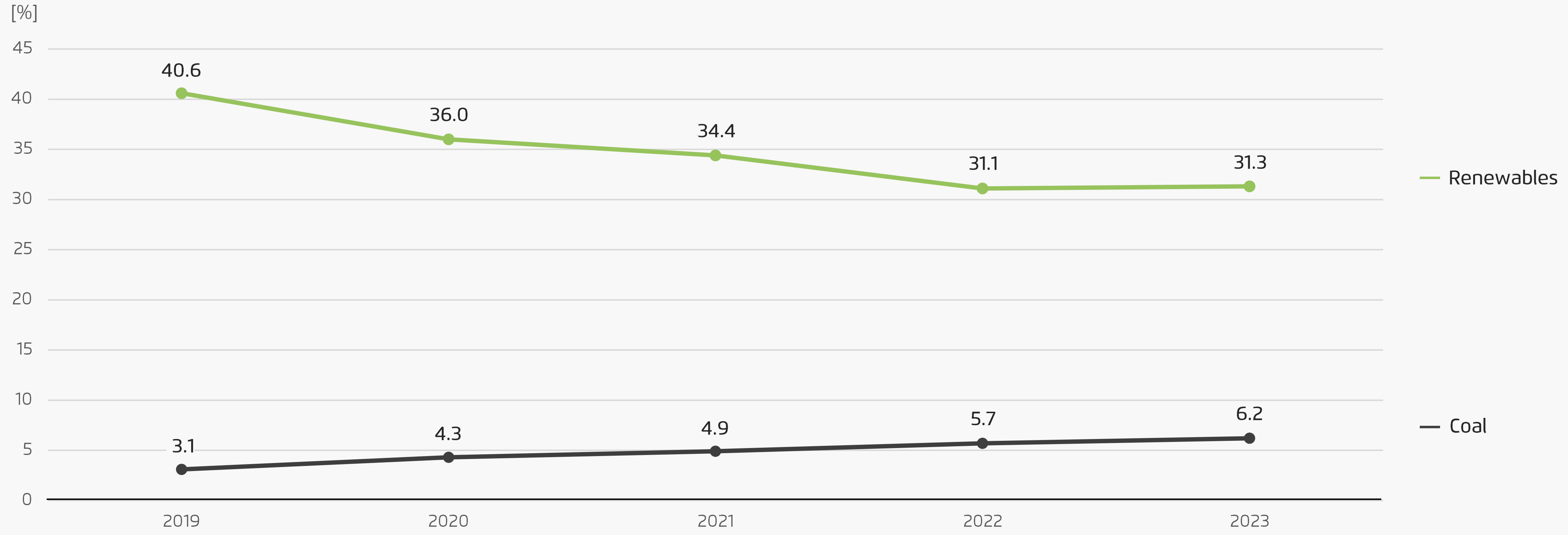
High hopes on HyREX technology

→ Government's focus on financial and regulatory supports HyREX technology with a demonstration plant being constructed (2027–2028) (0.3 Mt)

 Agora Industry and Wuppertal Institute (2022, 2023). [1] POSCO HyREX is a hydrogen-based fluidised-bed direct reduced iron process producing iron without coke or blast furnaces.

South Korea's power sector can meet the steel sector's growing demand for clean energy by expanding renewables and exploring additional supply routes

Coal and renewable shares of electricity generation, 2019-2023



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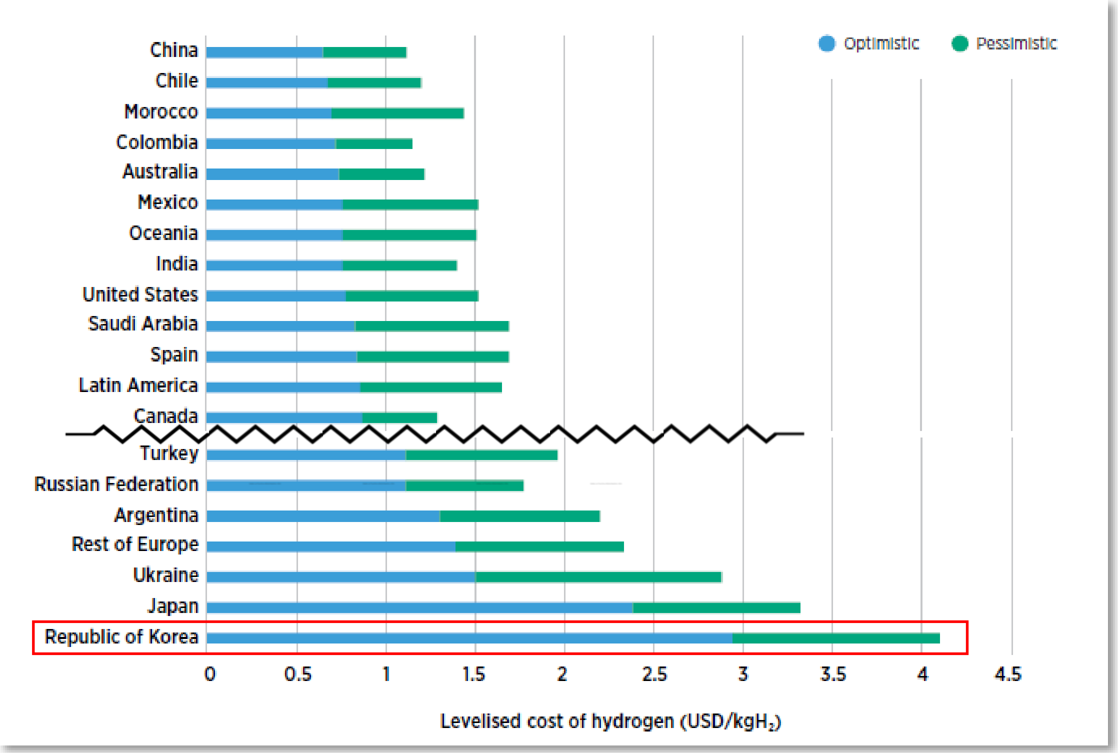
Due to higher renewable energy costs in South Korea, attention is turning to import options for renewable hydrogen to supply the steel sector

Hydrogen production potential below USD 4 per kg H_2 in the 2030-time horizon [EJ/yr]

Australia	520–598
Brazil	376–462
United States	213–385
Italy	1.1–1.3
Japan	0.1–1.2
South Korea	0.1–0.2

Levelised cost of hydrogen range in 2050 derived from supply-demand analysis



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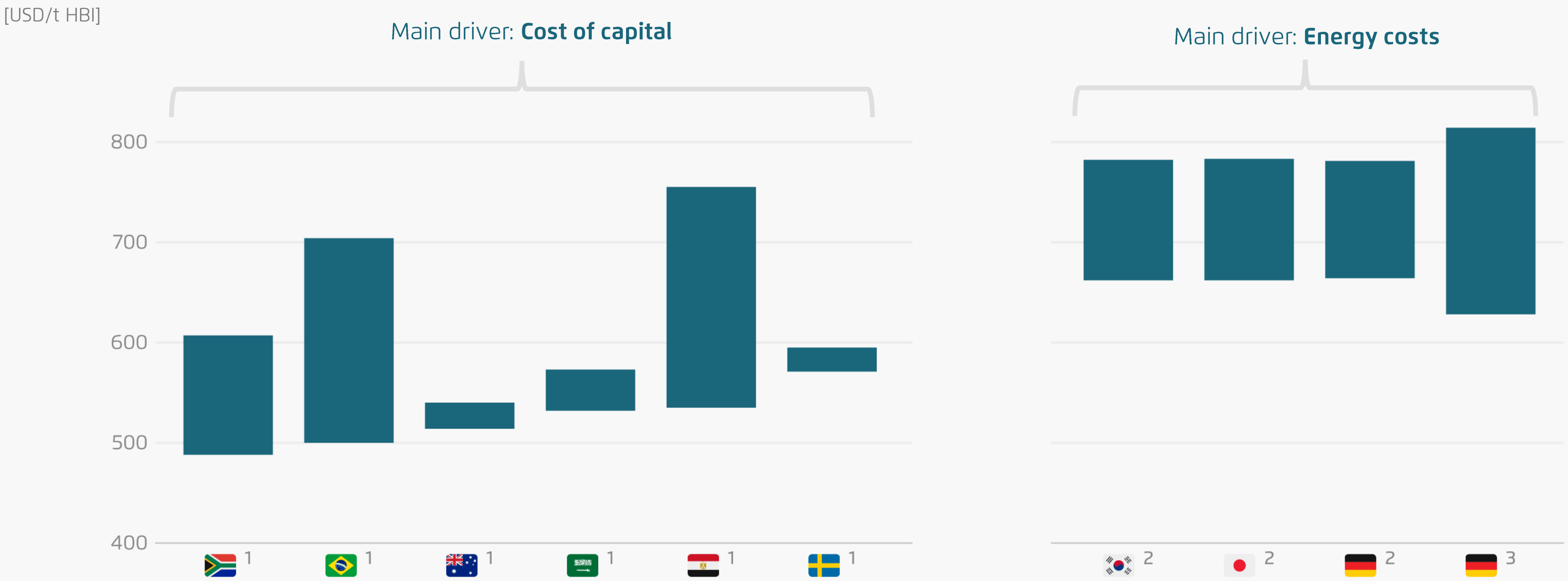
Green HBI production costs are mainly driven by cost of capital in potential exporting countries and by hydrogen costs from high energy costs in potential importing countries

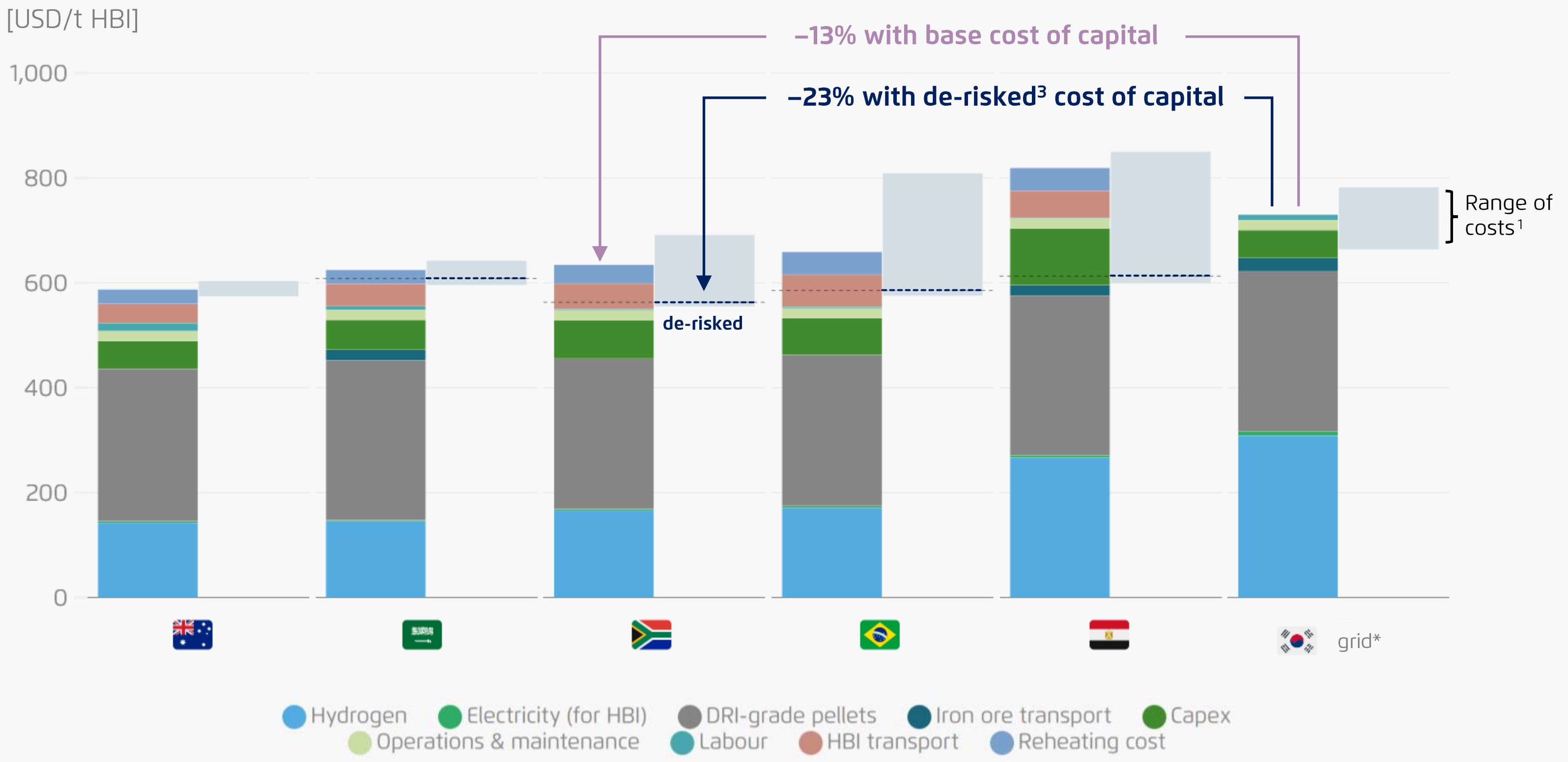
Range of HBI production costs in 2040



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.

Unlocking production in regions with high renewables potential could create significant cost reduction opportunities

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



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

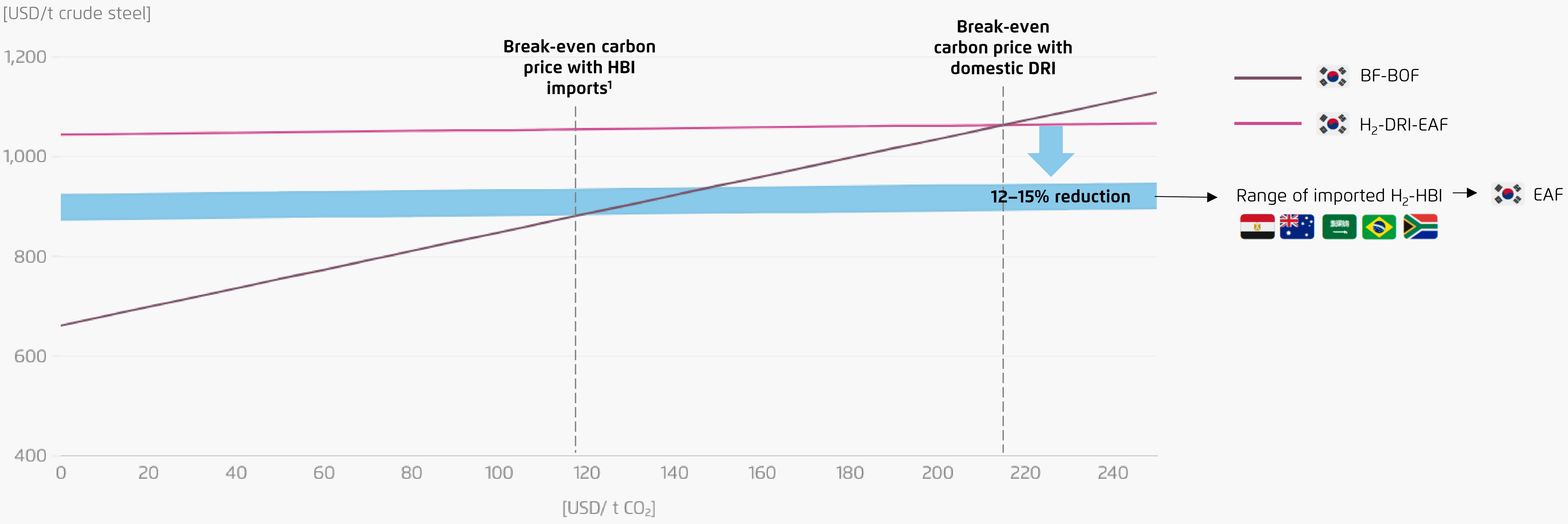
→ As a global green iron market develops, access to cost-competitive HBI imports would enable more cost-effective steel production.

→ Using imported green HBI with up to 23% lower production costs can lead to a cost reduction of 15% of overall steelmaking in South Korea, avoiding subsidy expenses of around USD 3.5 billion[5] by 2040.

Agora Industry (2025). *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 transportation and 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 cost of capital for investments in HBI production. For detailed information on the scenarios assessed, see slides in Appendix. [5] Assuming that 33% of the projected steel production of 64 Mt by 2040 will come from HBI.

Green HBI imports from regions rich in iron ore and renewables could nearly halve the break-even carbon price needed for green steel to compete with BF-BOF in South Korea

Crude steel production costs in 2040 using imported (de-risked*) and domestic HBI/DRI.
Importing HBI could cut 12 to 15% 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.

South Korea policy recommendations

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

- National government & regulators
- Multilaterals (World Bank, UN bodies etc.)
- Think tanks / researchers
- Certification bodies (standards, MRV)

- HBI producer (steelmaker)
- Renewables / hydrogen developers (solar, wind, PPAs)
- Technology provider (electrolyser, DRI, etc.)
- HBI off-taker / steelmaker (off-take agreement)
- Engineering firm (EPC, plant design)

- Local communities
- Labour / trade organisations
- Environmental & community NGOs

- Concessional finance (DFIs, MDBs, JETP, EU-SA Global Gateway)
- Equity investors (project consortium)
- Commercial debt provider (commercial banks)
- Export credit agencies

1) Domestic industrial policy: creating market confidence and support domestic H_2DRI commercialisation

1. **Create lead markets to drive business cases for green iron**
    - Use green public procurement and private-sector incentives on end-use sectors such as automotive, construction and machinery and set content requirements for green steel made in Korea
    - Develop a credible certification system moving beyond mass-balance, with transparent life cycle accounting and carbon metrics to support procurement and market alignment
    - Engage automotive, construction and manufacturing sectors in shaping standards to strengthen trust and market uptake

2. **Support domestic lighthouse projects**
    - Provide funding and tax incentives for first movers adopting EAF production using certified green DRI imports, using the K-Steel Act as the implementation framework (e.g., expanding KEXIM’s Supply Chain Stabilisation Fund to green industrial projects; CCfDs investment support)
    - Support DRI-specific logistics and storage infrastructure
    - Strengthen the Korean Emissions Trading Scheme (K-ETS), remove the free allowances for the steel sector, implementing an effective anti-carbon leakage system
    - Advance HyREX domestically to diversify steel decarbonisation technologies, reduce risks, and technological leadership.

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

1. **Develop strategic international partnerships**
   - In a context of increased trade tensions and international competition, there are key benefits to moving early towards green steel production to maintain access to tightening markets
   - Create strategic partnerships between governments (e.g., EU-South Africa Clean Trade and Investment Partnerships and memoranda of understanding between Korea and Australia) focusing on clean industrial supply chains and integrating green iron into trade agreements
   - Use harmonised green product criteria, trade agreements and CBAM to align energy, industrial and climate policies

2. **Establish offtake mechanisms and long-term security of supply**
   - Engage with demand side platforms for both public and private procurement to aggregate demand and create certainty for first movers.
   - Include green iron in international market maker mechanisms (e.g., H_2Global or similar auction-based instruments) to develop cross-border offtake agreements

3. **Enable financing for green iron projects and value chains**
   - Deploy de-risking instruments to reduce investment and project risks (e.g., guarantees on counterparty credit, foreign currency and political risk via export credit agencies, multilateral and bilateral development banks)
   - Reduce financing barriers for international joint ventures or project developers facing high costs of capital via blended finance (e.g., concessional capital, results-based climate funding, public-private partnerships)

4. **Set global standards and support technology transfer**
   - Engage bilaterally and within multilateral platforms (e.g., the Climate Club) to harmonise green steel and hydrogen standards
   - Support international actions towards technology cooperation, efficiency improvements and local capacity building

Appendix

List of abbreviations

AEL: Alkaline iron electrolysis

BF: Blast furnace

BOF: Basic oxygen furnace

Capex: Capital expenditures

CBAM: Carbon border adjustment mechanism

CCfD: Carbon contract for difference

CCS: Carbon capture and storage

DRI: Direct reduced iron

EAF: Electric arc furnace

Fe: Iron

GHG: Greenhouse gas

H_2: Hydrogen

HBI: Hot briquetted iron

HyREX: POSCO HyREX is a hydrogen-based fluidised-bed direct reduced iron process producing iron without coke or blast furnaces

K-ETS: Korea Emissions Trading Scheme

LCA: Life cycle accounting

MOE: Molten oxide electrolysis

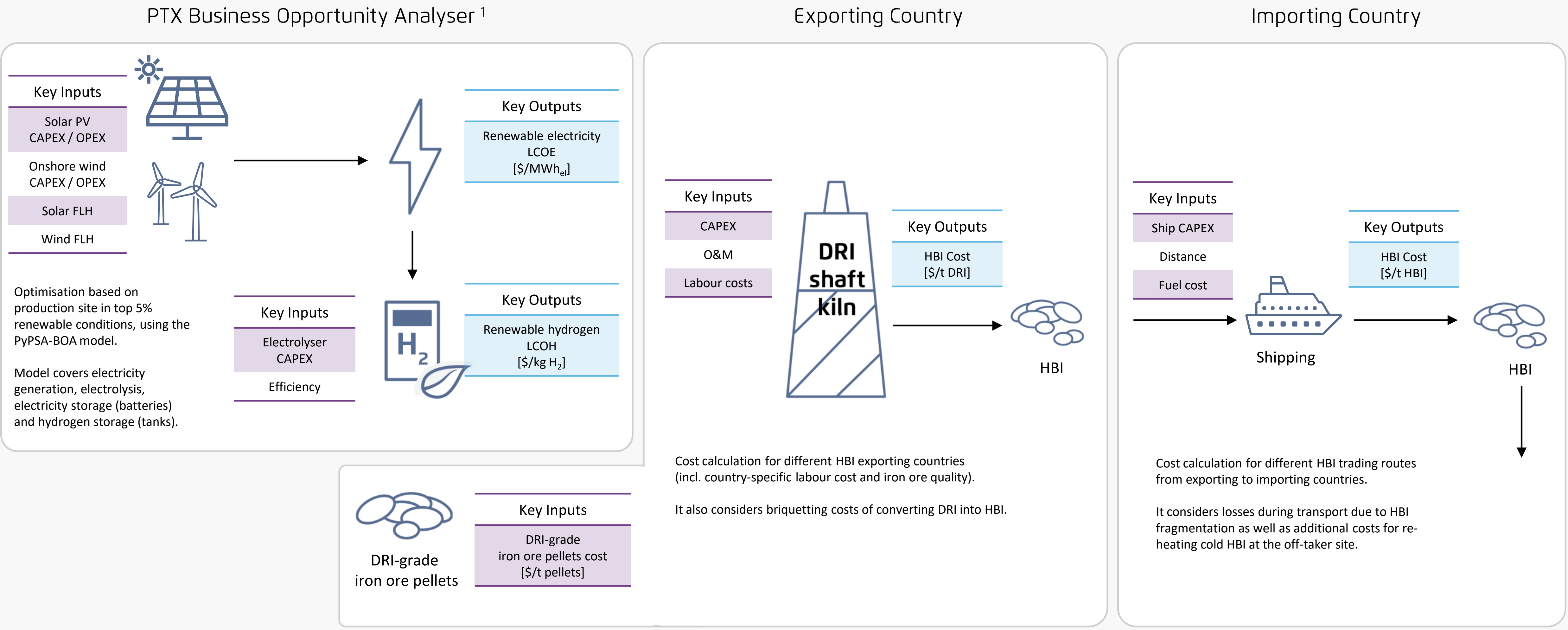
NG: Natural (fossil) gas

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

Opex: Operating expenditures

TRL: Technology readiness level

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	Egypt	South Africa	Saudi Arabia	Germany*	Germany**	Japan	South Korea	References
Discount rate*** (%)	High	4.3	14.6	14.3	10.8	5.1	4.3	4.3	5.3	4.9	6,7
	Medium (default)	4.3	7.7	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	6
CAPEX of wind onshore (USD_{2024} / kW)	High	1176	910	1269	868	1482	1456	-	-	-	8
	Medium (default)	1037	802	1119	765	1307	1624	-	-	-	8
	Low	977	756	792	721	1232	1531	-	-	-	8
CAPEX of solar PV (USD_{2024} / kW)	High	698	564	628	303	977	1042	-	-	-	8
	Medium (default)	528	426	475	389	357	434	-	-	-	8
	Low	411	332	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	Egypt	South Africa	Saudi Arabia	Germany*	Germany**	Japan	South Korea	References
Cost of renewable energy (USD_{2024} / MWh)	High	37	64	77.1	70	26	105	105	105	105	8,9
	Medium (default)	32	38	55.5	29	21	90	90	90	90	8,9
	Low	29	27	22.6	21	16	70	70	70	70	8,9
Cost of renewable hydrogen (USD_{2024} / kg)	High	2.3	4.0	4.3	4.5	2.4	4.6	5.2	5.2	5.2	8,9
	Medium (default)	2.1	2.5	3.9	2.5	2.1	2.9	4.5	4.5	4.5	8,9
	Low	1.9	1.9	2.0	2.0	1.8	2.8	3.5	3.5	3.5	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.

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