Green Iron Corridors: Building the Business Case for Green Iron as a Vector for Hydrogen Trade

H4D Webinar

GREEN HYDROGEN CATAPULT

ACWA POWER

ArcelorMittal

CWP GLOBAL

Fortescue

HYSTOR ENERGY

H2green steel

Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

POWER2X LEADING IN ENERGY

ReNew POWER

world energy

RACE TO ZERO BREAKTHROUGHS HYDROGEN

RMI ENERGY. TRANSFORMED.

GHC is a private sector coalition, convened with the **support of the UN High-Level Climate Champions,** and **coordinated by RMI**. It brings together the world's biggest green hydrogen project developers and other value chain participants to accelerate the emergence of a new green hydrogen economy and drive down the production cost of green hydrogen.

Catapult members have **already committed to work towards FID on deployment of 45 GW by 2027** to catalyze market growth, getting on a pathway to green hydrogen production at well below USD2 per kg.

Mission: Shape green hydrogen (and its derivatives) **flagship projects and markets** by providing thought leadership, promoting collaboration among green hydrogen champions and deep engagement with key stakeholders.

Taking action now is critical to meet our global climate targets. **Quickly scaling-up to multi-GW projects and capacity requires a "whole of system" approach:** engage all stakeholders, catalyze demand, build infrastructure, and de-risk and incentivise big finance.

Current areas of focus: (i) Enabling sectoral GW-scale flagship projects and infrastructure development in three key sectors – green shipping; green steel and green ammonia, (ii) Policy and International Trade, and (iii) Communications & Advocacy.

Why Steel? Why Now?

1

Climate & Community Imperative

- The global iron and steel industry is responsible for **3.1 $GtCO_2$** per year or **7% of global carbon emissions** — mostly from coal and coke use
- Steel mills **employ thousands** — but are among the **largest emitters of pollutants** which raise concerns about air and water pollution for fenceline communities.

2

Global Demand Growth

- Iron and steel production is a **$1.6T industry** and projections indicate it will be **$2.3T by 2032**
- Annual global steel demand is **1.8B metric tons** and could grow to **2.3B by 2050**
- Without clean technology adoption, iron and steel industry carbon emissions could grow 39% to **4.1 $GtCO_2$/year by 2050**

3

Green Steel Market Progress

- **Green steel** demand could be **200M metric tons in 2030**
- **Supportive policies**, including CAPEX grants and OPEX subsidies, are in place or in development around the world to incentivize green production
- **10 H_2-based steel projects in the EU** worth $26.6B are slated to be operational by 2030, with 40+ announced globally.

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Data sources: McKinsey, Mission Possible Partnership, Factview research, Public Citizen

RMI & The Green Hydrogen Catapult aim to accelerate global green iron corridors through insights, tools, and market development

Analysis and Insights

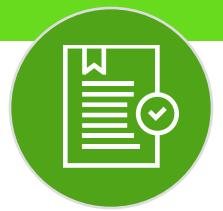
Analytics

Techno-economic and policy analysis identifying corridor opportunities and regional appetite.

Supply Insights

Deliver global outlook on IO capacity and domestic growth pathways for hydrogen based HBI corridors.

Market Development



Invest to Export Feasibility

Facilitate roundtables in key geographies, to understand and reduce trade barriers for supply needs.

Drive Demand

Public announcements of corridors to drive development of offtake agreements and secure revenue stream.

Modelling |Highlights from our analysis

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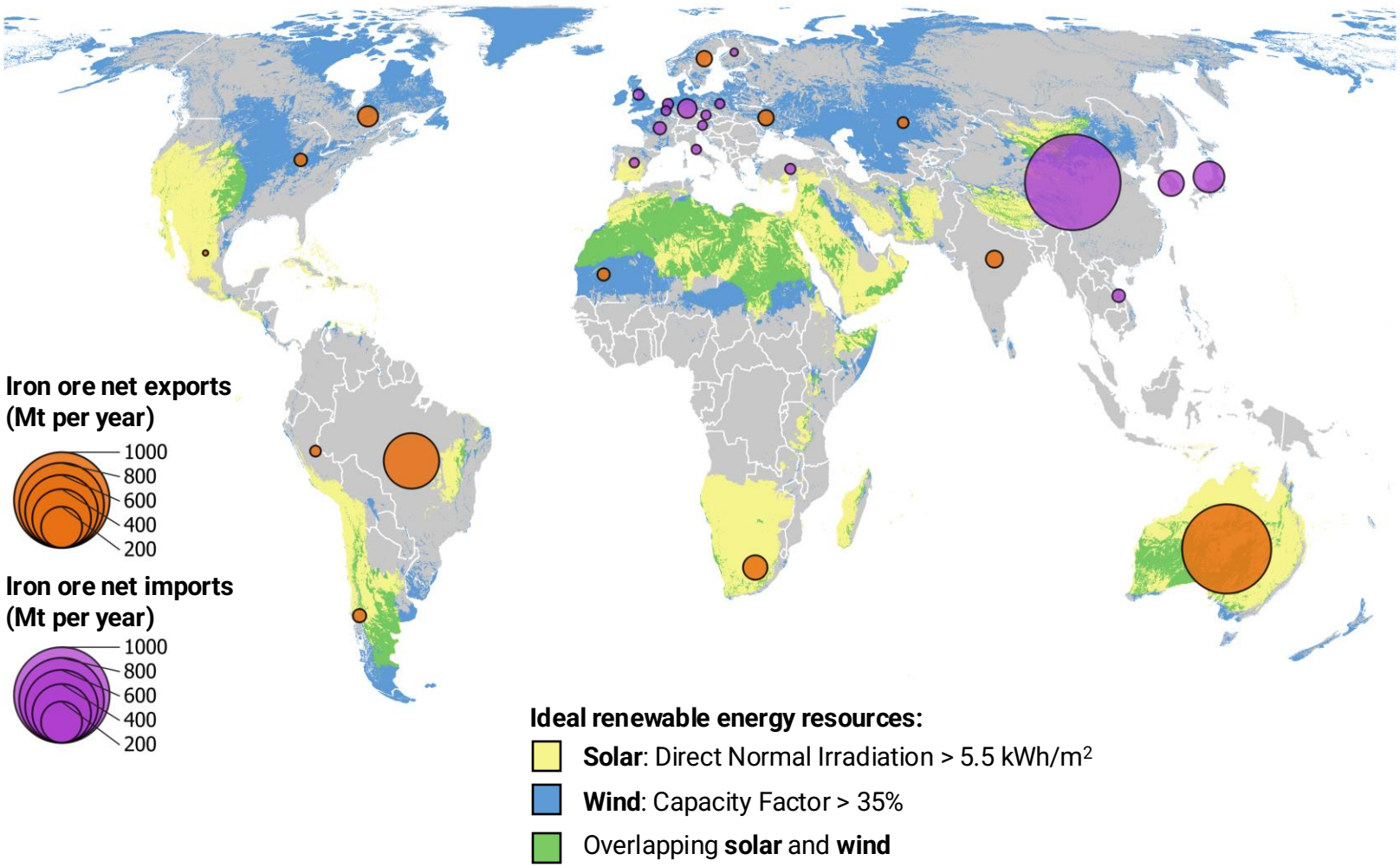
Establishing corridors with iron ore market and green iron potential requires consideration of existing and developing global dynamics



- Historically integrated iron and steel facilities have been located near cheap coal
- Shifting to H2-DRI based ironmaking will **favor locations with access to cheap renewable energy** to lower cost of H2 production
- Regions with optimal renewable energy resources overlapping with iron ore resources can ship a more finished **green iron product**
- Regions with steelmaking capacity that rely on iron ore imports can retain and expand advanced steelmaking supply chains by importing the more finished product of green iron

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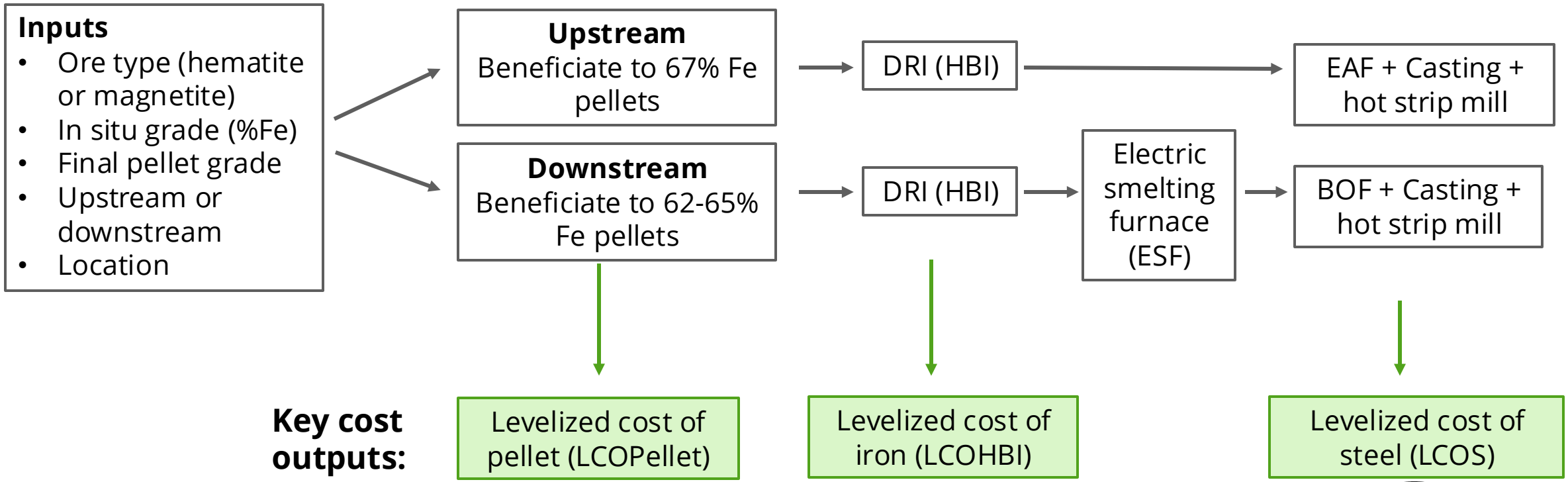
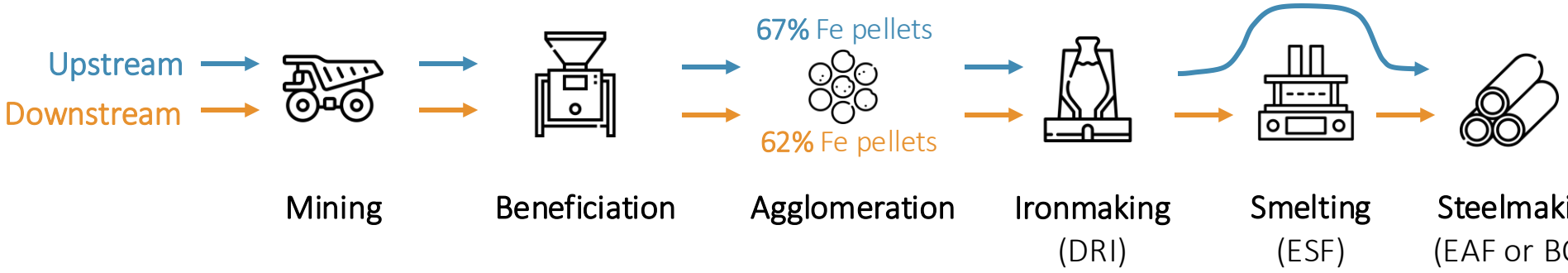
Techno-economic model developed to assess cost differences between different technology options, locations, and ore quality, with the goal of identifying cost-competitive export locations

Upgrades can occur upstream of the DRI with beneficiation or through downstream process additions (e.g., ESF). Comparing the cost and assessing regional adoption of these two routes can bring additional IO market clarity

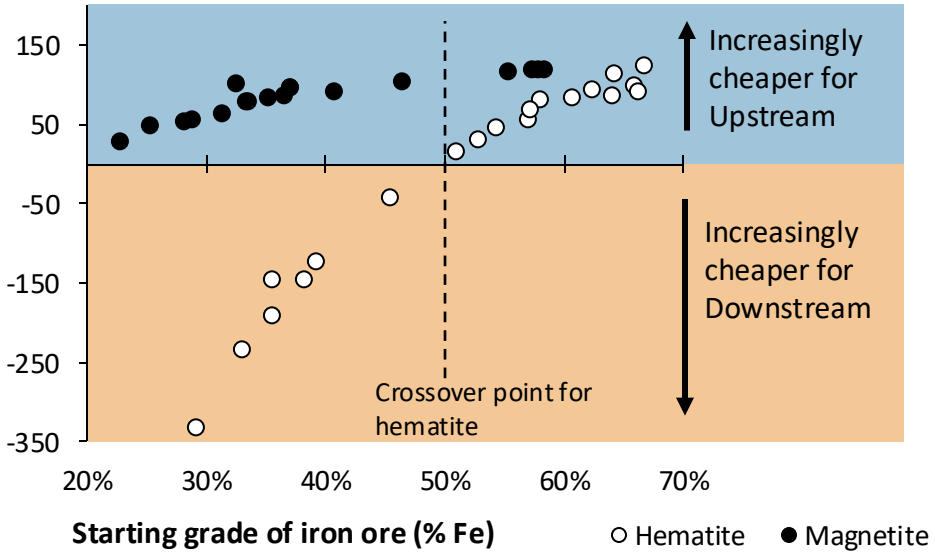


Cost competitive options exist for meeting Direct Reduction supply requirements through a combination of iron ore beneficiation and downstream process additions

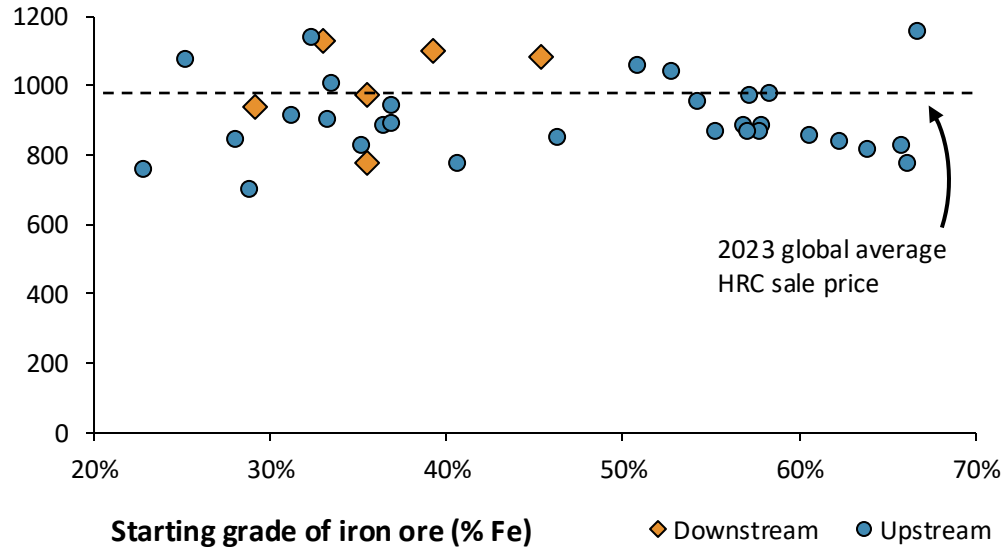
Magnetite ores should be prioritized for upgrading to DR-grade pellets while some hematite ores will see cost savings with less beneficiation combined with a smelter after the DRI.



Cost difference between Upstream and Downstream processes ($/t HRC)



Levelized cost of steel for lowest cost option ($/t HRC)



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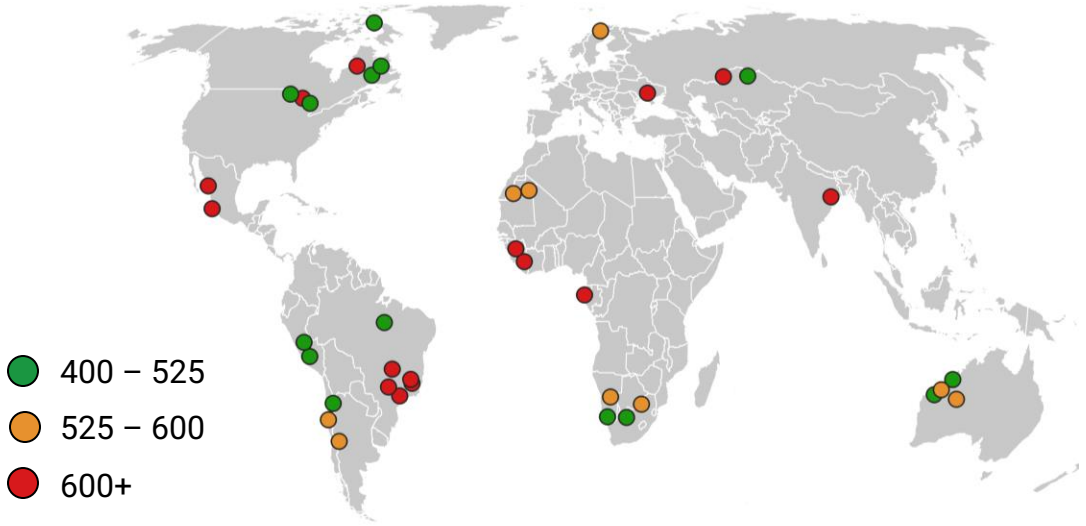
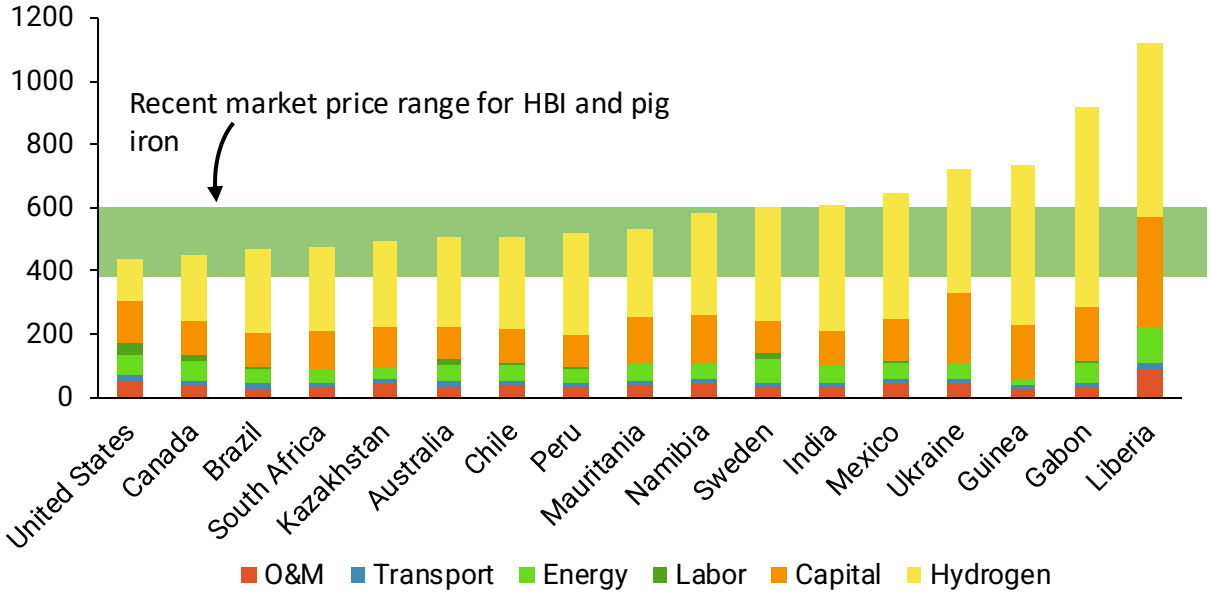
Green iron production is cheapest in regions with a combination of optimal renewable resources, high grade iron ore, and enabling policies.

Levelized cost of green iron at existing iron ore mine locations ($/t HBI)



Lowest cost option for each country: levelized cost of green iron at existing iron ore mine locations ($/t HBI)



Main factors affecting competitiveness of modeled HBI costs:

- Iron ore grade
- Solar and wind availability
- Enabling policies (e.g., tax credits for renewable energy and hydrogen production in U.S. and Canada)

Additional considerations for export candidates:

- Cost and distance of seaborne transport
- Available skilled workforce
- Water and land availability
- Government support
- Energy security and equity
- Geopolitical risk
- Hydrogen readiness
- Stakeholder engagement

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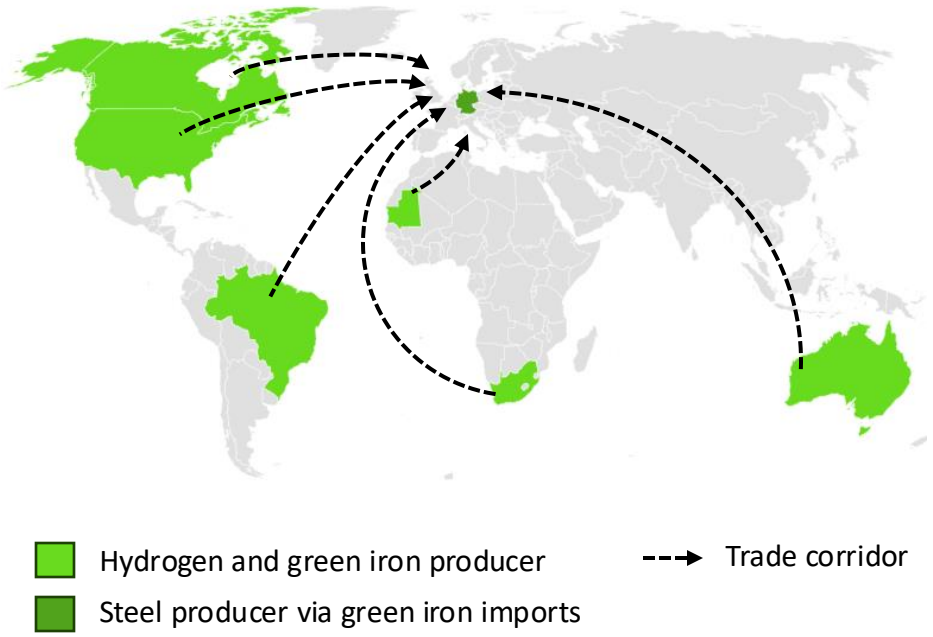
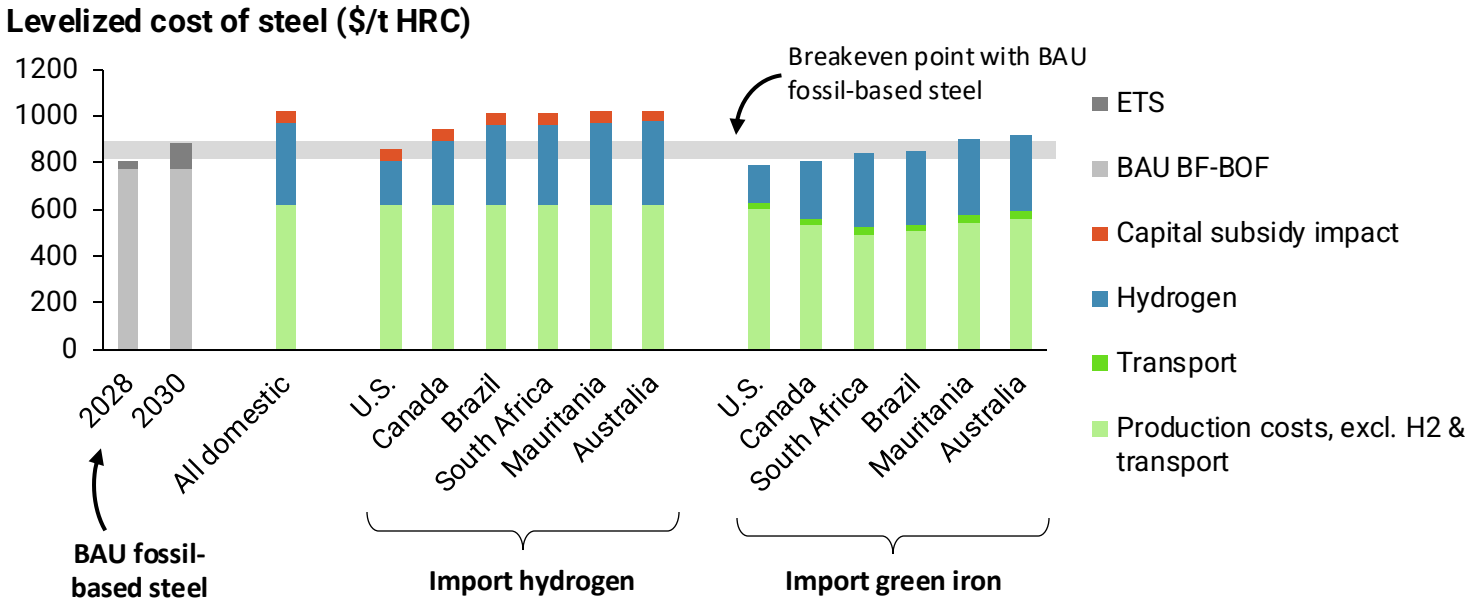
Green iron corridors lower costs and enable a faster transition of the steel sector for importers

Looking closer at options for one importer example: Germany





Policy | European Union Case Study

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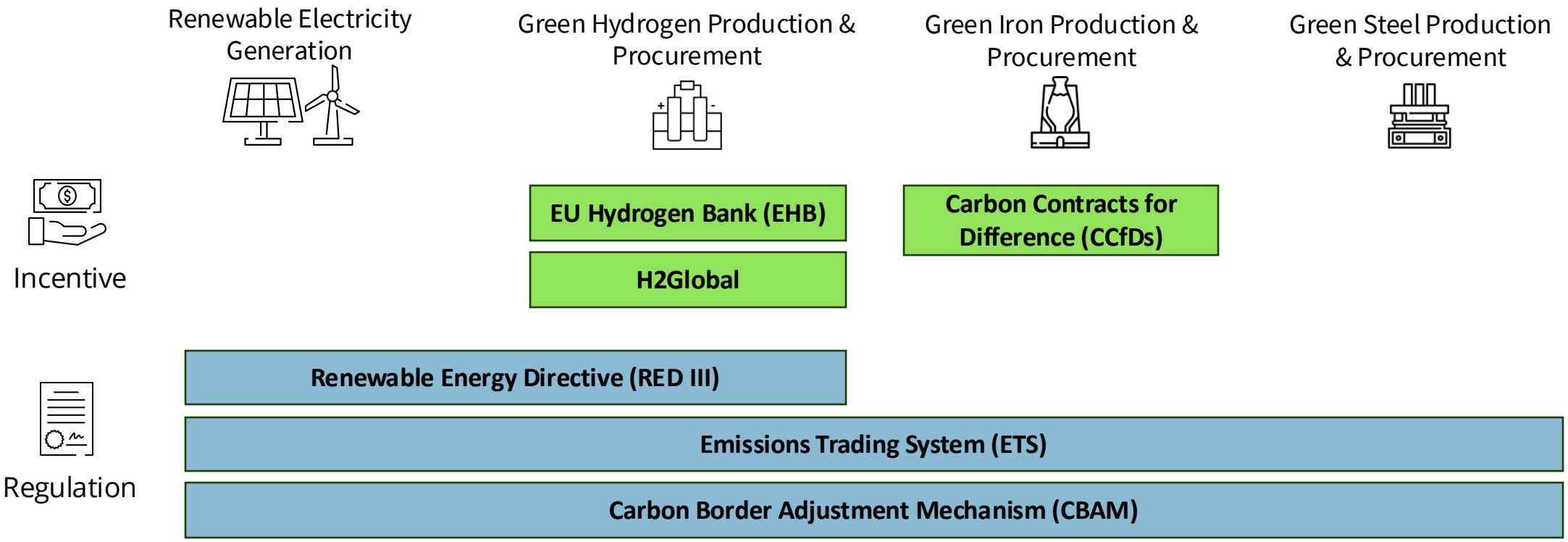
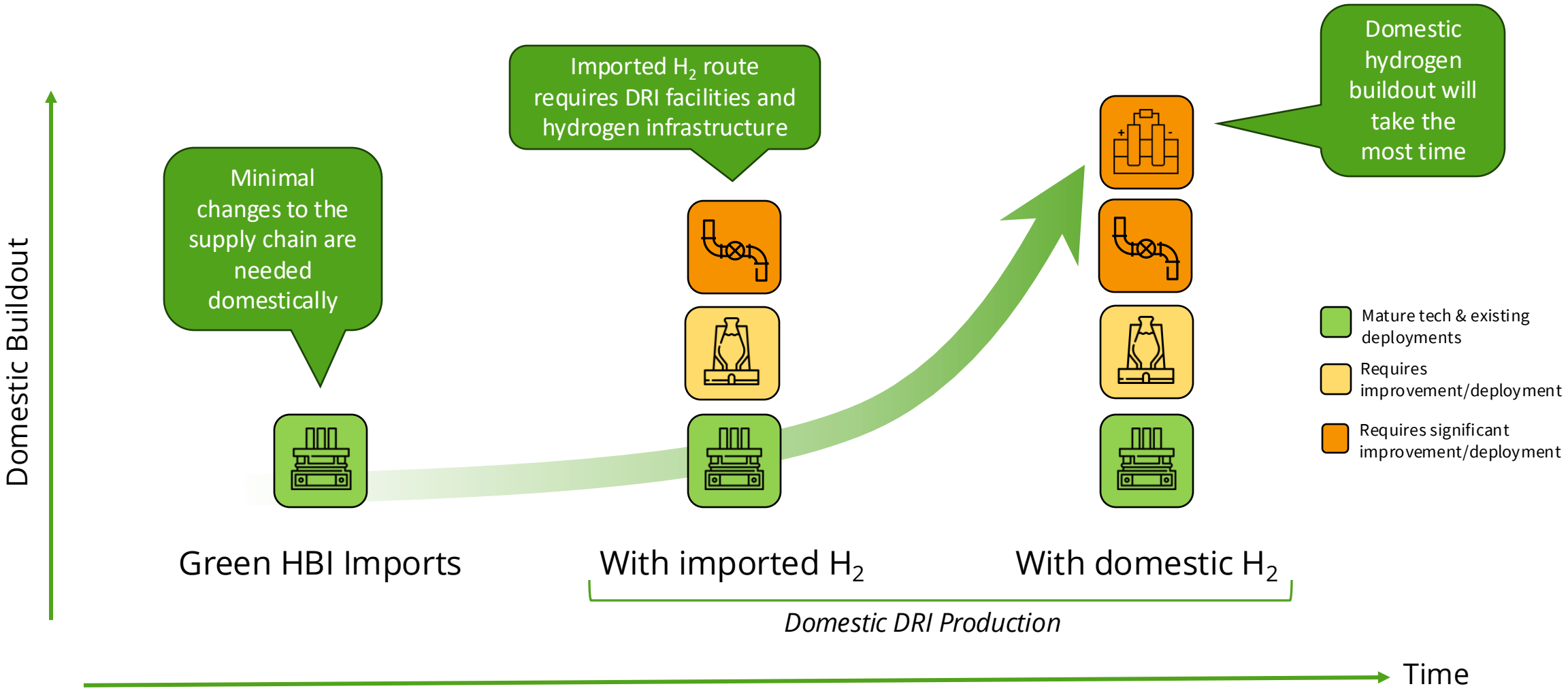
Policy landscape | The European Union is set to increase demand for both clean steel and hydrogen

Regulations will increase the cost of business-as-usual production and mandate deployments of renewable energy while incentives seek to reduce the cost of fuel switching.

EU policies along the green steel value chain



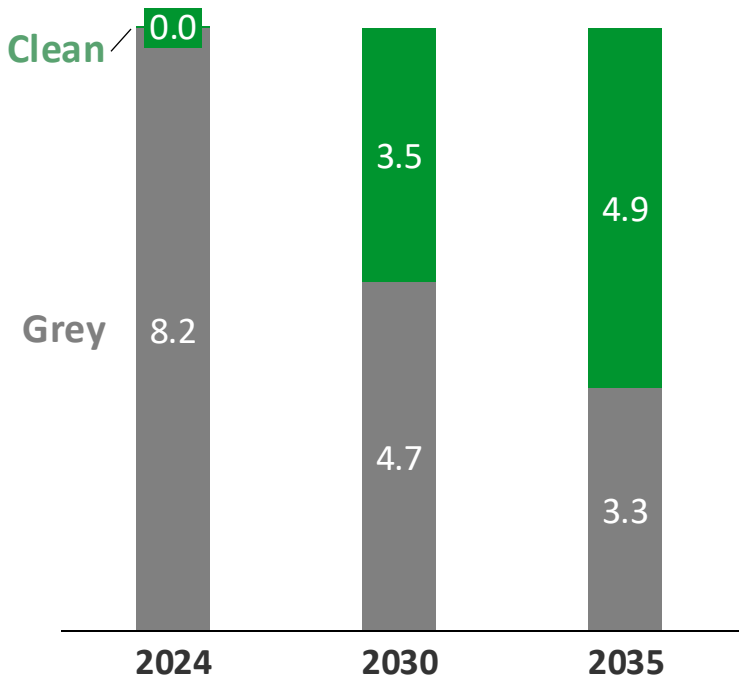
Green steel pathways | HBI imports can complement the buildout of domestic hydrogen and DRI capabilities while kickstarting EU green steel



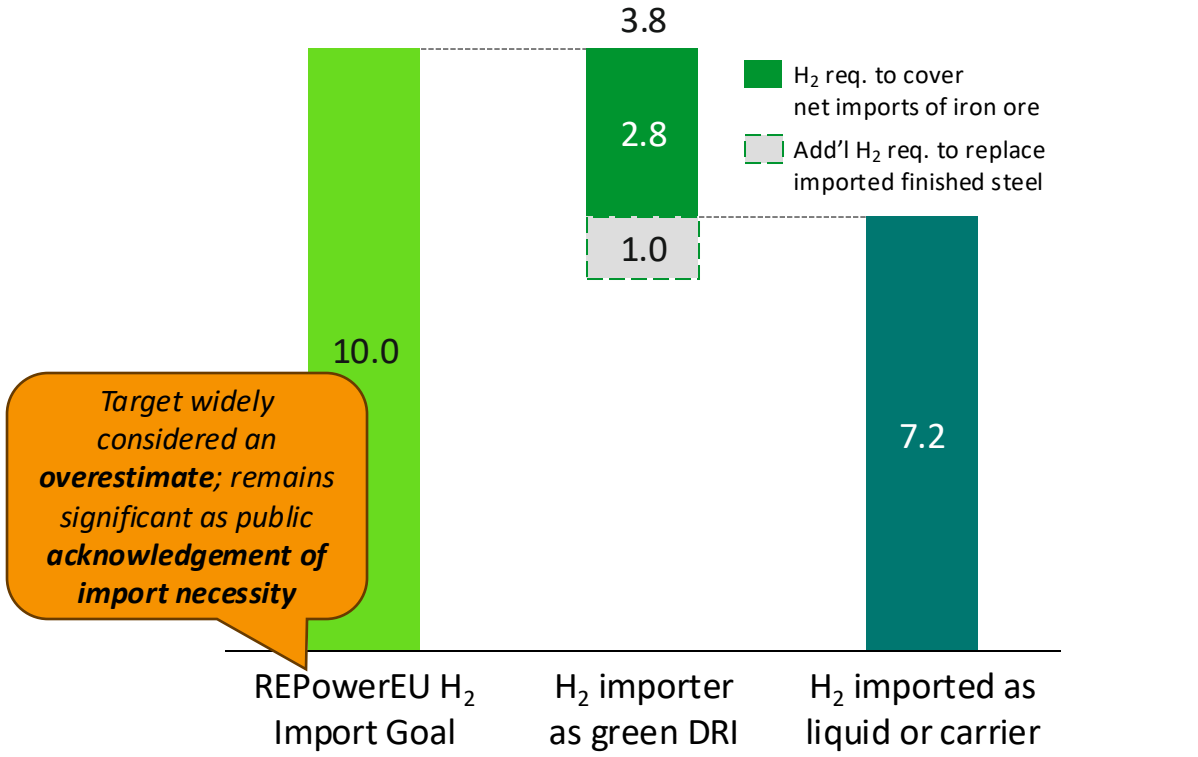
Efficiency case | HBI imports can contribute to hydrogen targets and ease the burden on an industry facing high domestic competition

The Commission publicly recognizes that domestic supply will be insufficient. RED III RFNBO targets will induce heavy competition for hydrogen from incumbent users.

Projected demand for clean H_2 under REDIII
Million tons of hydrogen



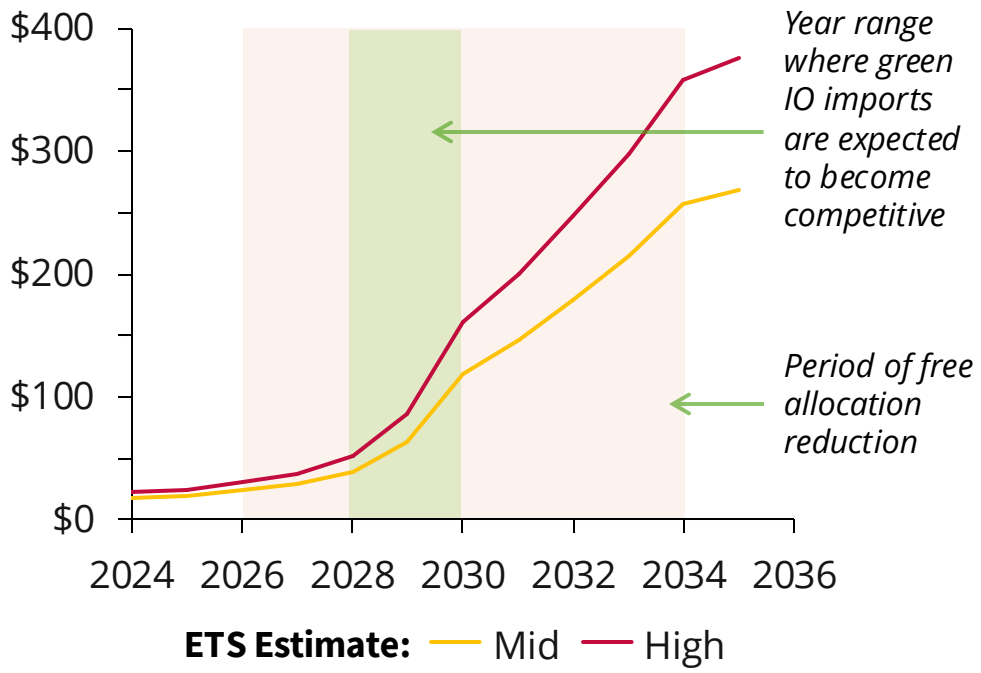
Potential of HBI imports to offset hydrogen import goals
Million tons of hydrogen



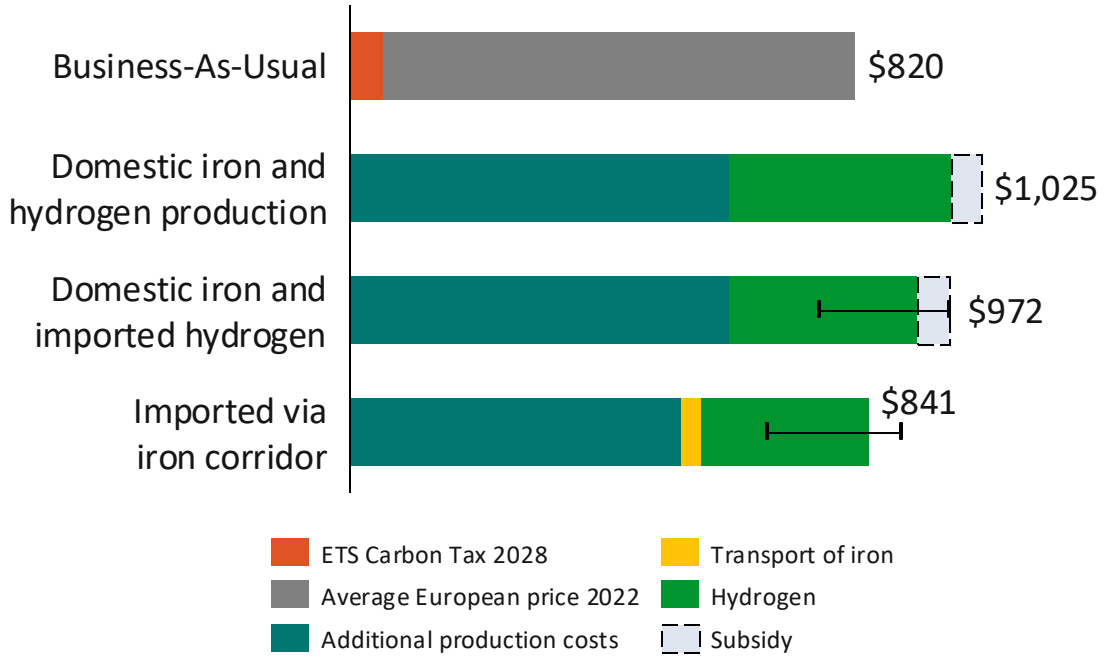
Business case | Current European policies are slated to make green iron imports cost-effective compared to both domestic green iron and conventional BF-BOF steel

Competitive prices abroad, combined with an expected increase in ETS allowance prices, will make steel produced with green iron imports a cost-effective solution for decarbonizing European steel as the bloc grows its hydrogen capacity.

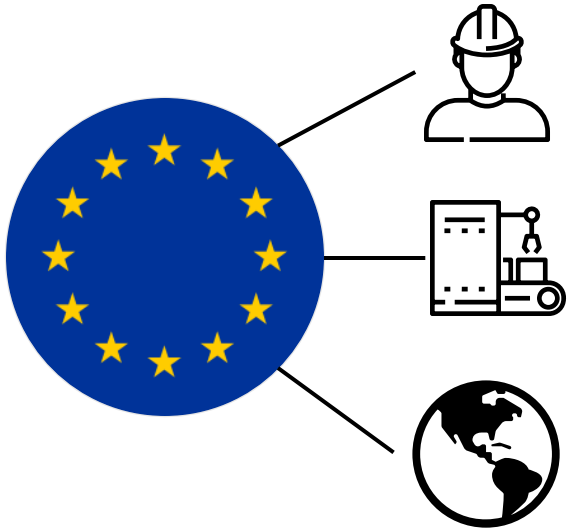
Additional steel cost due to ETS for BF-BOF route
$/ton HRC



German options for steel decarbonization
$/ton HRC



Policy considerations | Europe can safeguard its steel industry by incorporating green HBI imports into a broader industrial strategy that accounts for worker and industry transitions



Prioritization of an equitable worker transition within domestic ironmaking

Imports as a complement to EU industry

Partnerships that promote the adoption of green steel globally

Recommended policy actions:

Strengthen international green partnerships with candidate countries and **ease customs barriers** to importing green products

Develop binding targets for the usage of green iron within steelmaking

Increase **funding to reskilling and upskilling** programs within the **Net-Zero Industry Act** that focus on steel worker transitioning

Expand hydrogen-based policy instruments such as the EHB and H2Global to include green iron

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By choosing locations based on resources and needs, Green Iron Corridors can offer efficiency, cost, and growth opportunities across the steel value chain

Importer

- Existing steelmaking capacity
- Reliance on iron ore imports
- Demand for hydrogen to meet energy security and decarbonization targets

Green Iron Corridor

Exporter Candidates

- High-grade iron ore
- Optimal renewable resources
- Enabling policies to reduce hydrogen production cost

Benefits for Europe include:

- Significant green steel production cost savings of 5-40% compared to all domestic production
- Maintain domestic steelmaking supply chains and 75% of sector jobs
- Avoid scaling full infrastructure buildout for steel decarbonization
- H_2 Help meet hydrogen import goals
- Few shipping infrastructure changes needed

Case | Mauritania

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CWP Global

An Introduction to CWP Global

Our green hydrogen portfolio

CWP Global is a leading independent renewable energy developer, with expertise across the full project lifecycle

180+ GW

Renewable generation under development for non-grid-connected green hydrogen derivatives

500+ MW

Corporate PPAs signed

A team of over 200 experts

Present in offices in 5 continents

6+ GW

Grid-connected wind & solar under development and operation

25mt CO2

Avoided through RE projects

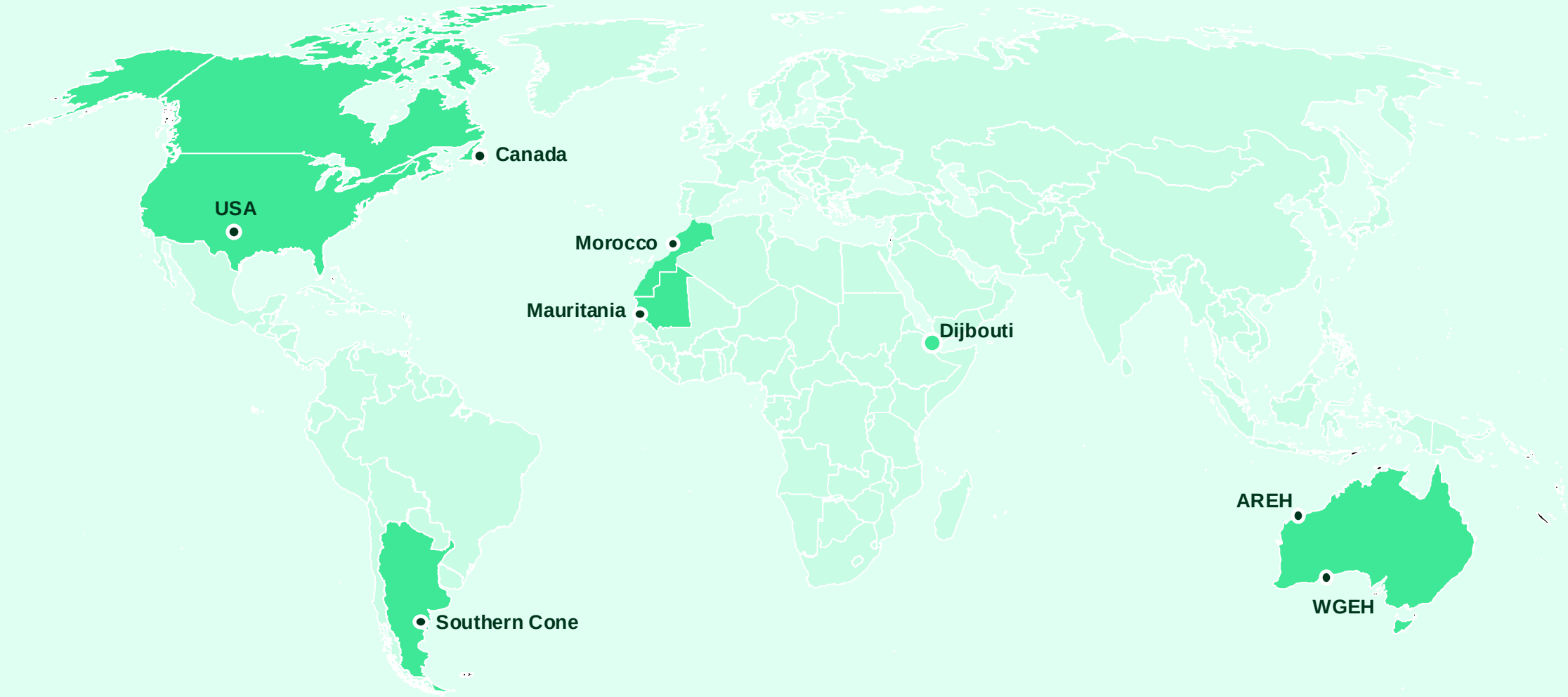
1,520 MW

Wind already built in Europe, Australia*

€3 bn

Financing raised

CWP’s Green Hydrogen & Derivatives pipeline



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Select Projects

A high-level view

AREH – Our Flagship H2 Project

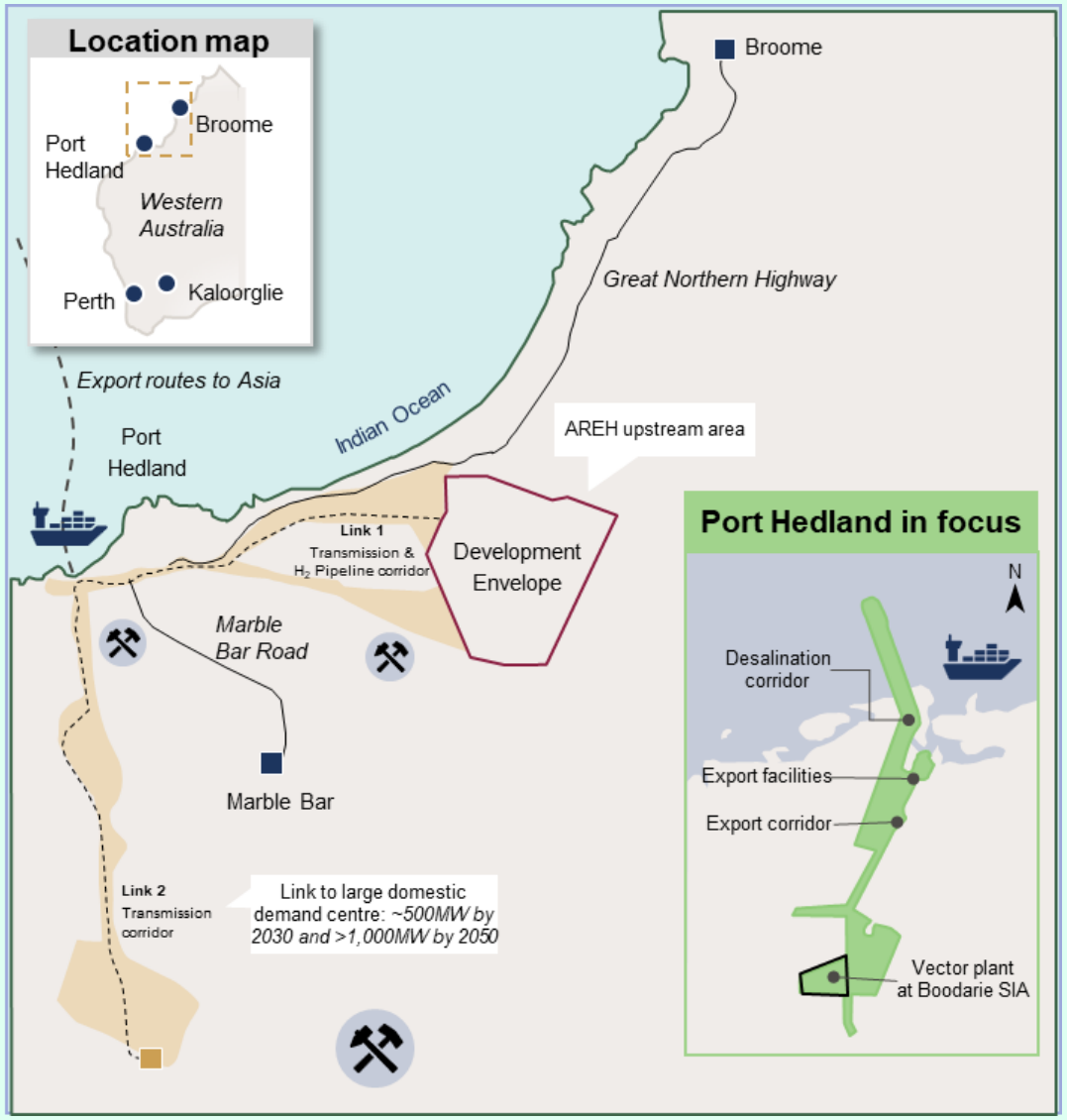
Australian Renewable Energy Hub
Nyangumarta Warrarn wangal pa janyja

Hybrid Generation	16 GW 8.7 m/s	10 GW
Partners	bp CWP Global InterContinental Energy	

- Mature project, started in 2015, approaching Phase 1 concept select, then into FEED
- 6,600 sq km of developable land; potential **26 GW upstream**
- First 15GW RE permit received in Oct 2020.
- **Major Project Status** granted by Australian Government in late 2020, recently extended for further 3 years (to 2027)
- In mid-2022, bp acquired 40.5% of project and became project operator. Recently increased shareholding to approx 65%.
- At full scale, could produce ~10 mtpa of green NH3 (1.7 mtpa green H2), potentially produce **exports valued at US$5B p.a.**
- **Phase 1: 1-2 GW of carbon-free power to be made for local industry** – Pilbara miners, heavy transport. Massive decarb opportunity (3B litres diesel consumed annually)
- Early gH2 for potential DRI facilities at nearby Boodarie industrial area, then scale up gH2 for DRI; NH3 for shipping and Asian export markets

Australian Renewable Energy Hub (AREH)

Australian Renewable Energy Hub
Nyangumarta Warrarn wangal pa janya



Project highlights

1. High class wind and solar resources with complementary profiles optimally suited to green hydrogen production

2. Secured land for 26GW of upstream gen capacity

3. Strategically located in the Pilbara region with high concentration of large mining and industrial companies and existing infrastructure (Port Hedland)

4. Direct sea access via existing deep-water ports with advantageous location at “gateway to Asia”

5. BP-led consortium driving project to FID in 2026-7, positioning AREH as leading giga-scale green H_2 project capable of delivering Pilbara power, gH2, green iron / steel and derivatives to Asia by 2030.

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AMAN - Mauritania

8,500 sq kms

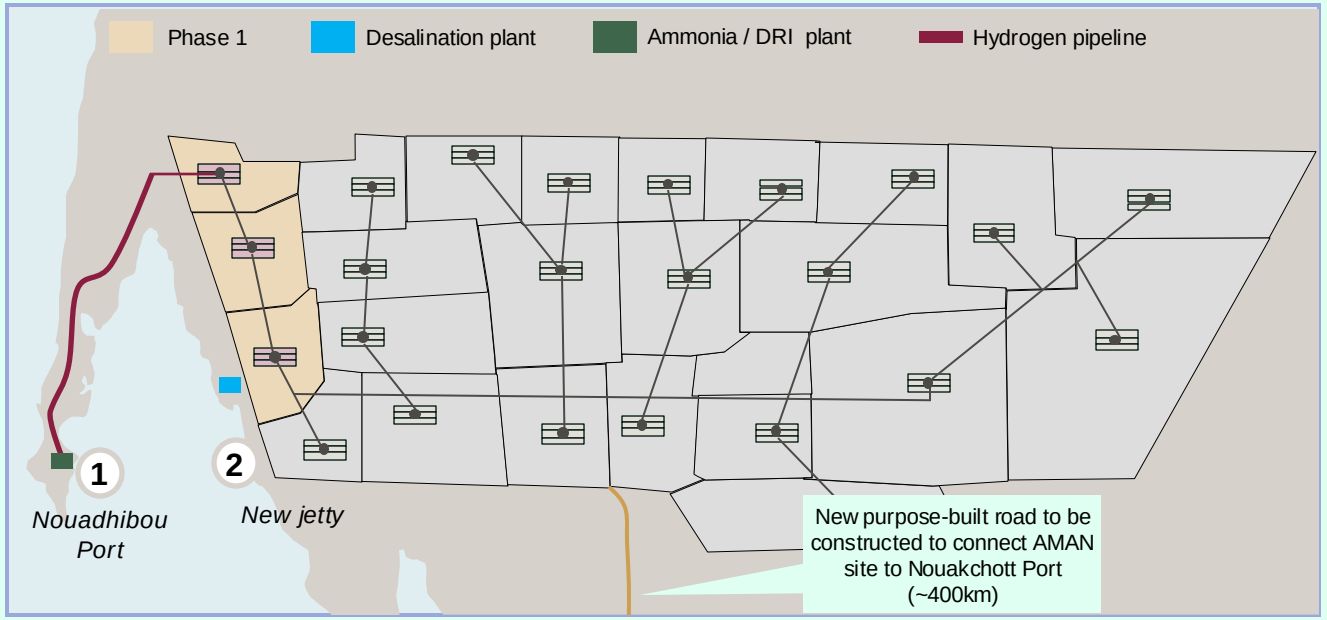
30 GW
power generation potential

~ 10mtpa NH3
nameplate ammonia capacity

~ 2,500 NM
AMAN to Port of Rotterdam

- Exceptional resource fundamentals driving lowest cost hydrogen production
- Extensive site investigation completed, well-defined Phase 1 and nodal concept facilitating efficient scalability
- Strategic location with proximity to European export markets and co-located iron ore deposits
- Established local team (10 pax) facilitating collaborative relationship with host government and local stakeholders
- Immediate critical milestones: WBG H2 Infrastructure Study & adoption of national Hydrogen Code

AMAN - Mauritania



- Launched in 2020, now in accelerated pre-FEED ⇨ FEED in H2 2025
- Two years resource measurement – 10.5–11 m/s wind; 1st class solar
- MOU (2021) & Framework Agreement (2022) in place, HGA negs to recommence in H2 2024 (after adoption of Hydrogen Code)
- **Initial 3 – 5 GW first stage**, multiple offtake vectors: e.g. 1 mtpa NH3; 2.5 mtpa DRI, can adjust proportions. DRI focus has higher CAPEX.

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The Green Iron Opportunity

- Mauritania currently exports more than **13 mtpa** (**$1.2 billion) of iron ore per annum**
- **Massive iron ore production expansion envisaged thru SNIM** (e.g. Sabic and Glencore JVs), could together add another **21 mtpa of iron ore**.
- Proven reserves in the range of **4 billion tons of high grade iron ore (69% Fe content).**
- CWP Global in discussions re a fully integrated HBI hub in country. **CWP x SNIM MOU in June 2024**. Capacity to build a **3.5mtpa green DRI plant.**
- AMAN full scale capable of producing **9-10 mtpa of Green NH3, or a combination of offtake products**.
- Target market: **EU-Mauritania cooperation**: Global Gateway partnership, Feb 24 visit by EC Pres von der Leyen – "**we want your green H2 / green iron**".

Thank You

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