

Closing the gap on 1.5°C aligned hydrogen economy, responsibly

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Green (Renewables-Based) Hydrogen - Overview

Renewables-based hydrogen is produced through the electrolysis of water with 100% or near 100% renewable energy with close to zero greenhouse gas emissions across the lifecycle

Green H2 Use Cases (Examples):

Fertilizers, Methanol, E-Fuels, Steel, Cement, & Chemical are all considered relatively “no regrets” end use sectors for hydrogen as well as some cases of seasonal storage...

// Potential in Aviation: Sustainable aviation fuels (SAFs), including low-emission hydrogen-based fuels such as synthetic kerosene are at the highest levels of technology readiness compared with other potential solutions for aviation decarbonization.

// Potential in Shipping: In March 2023, the first liquid hydrogen ferry, the MF Hydra, began operation in Norway, using zero-emission hydrogen, and PowerCell signed an agreement to provide their fuel cell system to two additional ferries in Norway set to be delivered in late 2024.

Tailwinds for the green hydrogen market:

- First movers (e.g., Ammonia powered shipping)
- Subsidies and government programs
- Regional and intergovernmental partnerships
- Influx of private financing

Barriers to scale:

- Lack of efficient, targeted, holistic policy
- High capital costs (CapEx)
- Technical barriers across the hydrogen value chain
- Midstream / connective infrastructure requirements
- High capital cost and low investment
- GHG leakage
- Safety (Flammability when mixed with Oxygen)
- “Green Premium”

Hydrogen to 2030/50, in numbers

Today



~1% is "low carbon"

Hydrogen is entirely supplied from fossil fuels, with 6% of global natural gas and 2% of global coal going into hydrogen production.

830 MtCO₂/yr

Hydrogen production is responsible for carbon dioxide emissions of around 830 million tons of carbon dioxide per year (MtCO₂/yr)

2030

~430 GW capacity

The 2030 Breakthroughs project a need for at least ~430GW of operational electrolyzer capacity (cumulative) to align with a 1.5°C pathway...[corresponding] to at least ~50Mt of renewables-based hydrogen deployed and operational by 2030

\$120B annually

Investments in green hydrogen will have to triple to \$120 billion annually by 2030 to accelerate these technology advancements, and halve the cost of green hydrogen by 2030.

430Mt H₂

global hydrogen demand in 2050 is projected to reach 430 million tonnes (Mt), with renewables (green) hydrogen accounting for 70%

2050

4116 GW capacity

To meet the IEA's projected demand of 301 Mt of green hydrogen in 2050, an electrolyzer capacity of 4116 GW would be required (based on an electrolyzer capacity factor of 0.8)

Going beyond deployment to deliver impact

Green hydrogen has enormous potential to support the achievement of the SDGs

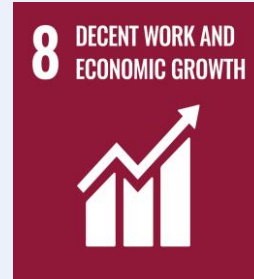
Contribution to SDGs:



Seasonal Storage: Providing firm dispatchable energy sources to electricity markets to reduce reliance on fossil fuels during low RE production



Hard-to-Abate Industry: Reducing reliance on fossil fuels for "no regrets" use cases



Job creation: Within developing markets, it could support up to 1.5 million jobs per year worldwide between 2030 and 2050. At global scale it can support 2 million jobs per year between 2030 and 2050.

Re-writing Global Power Dynamics: Supporting local offtake and innovative shared ownership models - especially in exporting countries

Contribution to other SDGs:



Closing the gap on 1.5°C, responsibly

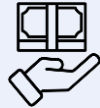
Green hydrogen is the only hydrogen production option strictly aligned with a 1.5-degree pathway.

What's needed?



A multi-faceted industrial policy

- Blacklisting certain technologies
- Mandated phase-out of fossil technologies
- Whitelist of decarbonized technologies
- Binding GH₂ quotas in the industrial sector
- Procurement of GH₂ via bilateral actions
- Measure to ramp up and guarantee sufficient renewable energy supply



Low Interest / Subsidized Financing

- Financial and fiscal support
- Grants and loans for each phase of project development
- Tax rebates to promote carbon emission reductions
- Carbon contracts for difference



Targeted Global Trade

- Cross-country regulations and standards
- Carbon-based import taxes
- Emission trading systems (ETS) or carbon pricing
- Bilateral auctions for GH₂
- Quota of green products



Quality TRLs & GHG Standards

- Focused public funding
- Pilots and demonstration projects
- Skilling and reskilling programs
- Knowledge brokerage

Setting critical guardrails *Non-exhaustive list of interventions*

- Effective global carbon pricing
- Incentivizing systems approach to decarbonisation

- Investment incentives rather than production incentives
- Hourly matching / certificate of origin standards

- Local content & offtake requirements
- Shared ownership models

- Increased / standardised approach to Technology Readiness Levels
- CI threshold of 1kg of CO₂e per kg of H₂; methane/hydrogen leakage accounting

An aerial photograph of a glacier, showing a dark blue meltwater stream flowing through a large, white, textured ice mass. The stream is bordered by smaller, lighter blue channels and patches of ice. The overall scene is set against a dark background, possibly the sky or a dark surface.

Thank you

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