The Hydrogen Economy:
Hot Air Or Future Reality?

We explore which sectors may see the greatest impact and when

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A Deep Dive By Sector

Here's a list of the articles published:

The Hydrogen Economy: Industrial Gas Companies Are In Pole Position	Oliver Kroemker and Florent Blot
The Hydrogen Economy: For Light Vehicles, Hydrogen Is Not For this Decade	Vittoria Ferraris
The Hydrogen Economy: Green Hydrogen May Transform The Fertilizer Industry	Paulina Grabowiec and Paul Kurias
The Hydrogen Economy: Steel Producers Have A Long Way To Go	Elad Jelasko
The Hydrogen Economy: Green H2 Offers Energy And Process Technology Majors A Long-Term Growth Opportunity	Tuomas E. Ekholm
The Hydrogen Economy: Can Natural Gas And H2 Have A Symbiotic Relationship?	Thomas Watters and Simon Redmond
The Hydrogen Economy: Storage Is Paramount For Utilities In The Long Term	Gabe Grosberg and Pierre Georges

Key Takeaways

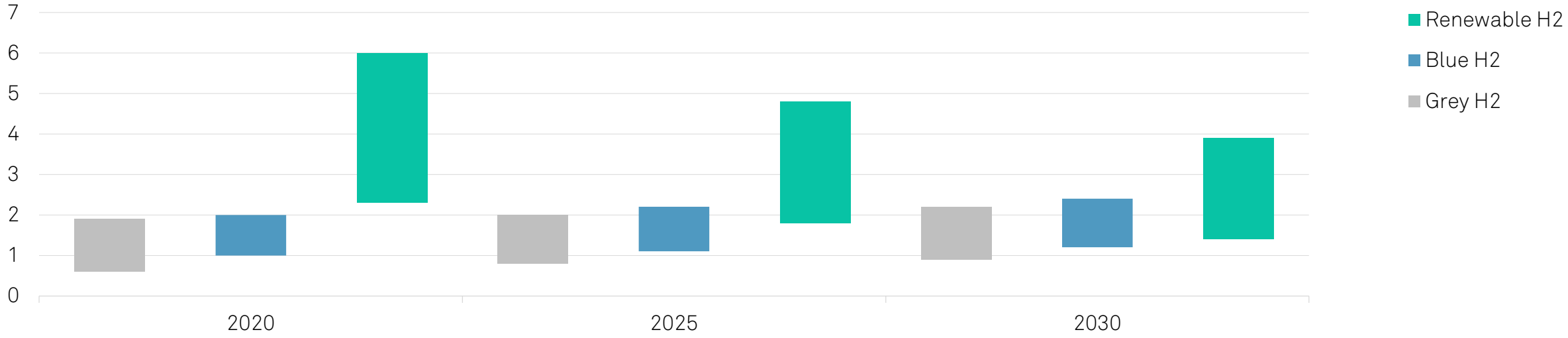
- Hydrogen (H2) is more expensive to produce than natural gas. Whether clean H2 will be widely adopted over the next two decades therefore hinges on supportive net zero policies, a steep decline in production costs from electrolysis, and ample renewables.
- Industrial gas players are likely to be among the earliest to benefit from increased outsourcing and demand for clean H2, given their established logistics capability along the hydrogen chain. Existing end markets, such as oil refining, chemicals, and later on possibly fertilizers, will likely also be among the early adopters of clean H2.
- Clean H2 to fuel buses and heavy trucks is a possibility for the second half of this decade, not least because manufacturers will have to adapt to more stringent emission targets in Europe. For autos, we do not see hydrogen as the preferred technology because batteries are significantly more energy efficient.
- Net zero commitments imply the full decarbonization of hard-to-abate sectors such as steel, but using hydrogen to do so would be extremely costly. We see steelmakers' credit quality as most at risk since the sector's profitability has been weak for years. A more likely route to reduce emissions is through process improvements and a shift to electric-arc furnaces.
- Although hydrogen cannot compete with gas-fired plants, it could play an important role beyond 2030 to provide storage and firm back-up power as the share of renewables increases, and if policies seek to decarbonize the power grid further.
- Using hydrogen for heating seems a more remote prospect, not only because of the complexity of coordinating the switch of distribution gas grids to hydrogen, but the concurrent need to adapt all end appliances and have access to huge amounts of low-cost hydrogen.

The Cost Of Clean H2 Is A Major Hurdle

- H2 adoption on a wider scale will require different technologies, for green (fueled by renewables) and blue (with CO2 capture and storage). Green H2 production costs are likely to drop, but not before 2030, rivalling grey hydrogen manufacturing costs over time.
- As a fuel source, however, hydrogen will remain substantially more expensive than natural gas, bearing in mind the production (methane reforming or hydrolysis) costs.
- Even if H2 production costs come down to grey hydrogen levels of $1/kg- $2/kg, this still implies an energy-equivalent natural gas price of $8.8-$17.6 per million British thermal unit.

Hydrogen Cost Development For Different H2 Technologies

Real €/kg H2



H2--Hydrogen. Sources: Hydrogen Council, HIS, IEA.

2020-2025: Oil And Gas, Industrial Gas Already Have H2 Business

Positive | Neutral to negative | Negative

Sector	Likelihood of hydrogen impact	Credit impact	Key opportunities (+) and challenges (-)
Oil and gas refineries	High		+ Hydrogen demand for refining will likely expand, given rising demand for low-sulphur products. + European oil and gas majors have already started various green hydrogen projects at refineries, also paving the way for expansion in renewables. – Investment costs will be quite high, even though likely passed on to end consumers. – New national regulations may stipulate minimum percentages of clean hydrogen for local refineries, but creating a level playing field with import tariffs on less clean oil products may be complex, as the H2 emission impact needs to be traced back to the refining stage.
Power generators/utilities	High		+ Green hydrogen demand will further support demand for renewables. + Utilities can leverage their renewables expertise in joint ventures to produce green hydrogen. Major European utilities have announced pilot projects and ambitious hydrogen targets for 2030. A few U.S. utilities are also considering projects.
Industrial gas	High		+ Demand for clean H2 will likely lead to increased outsourcing. Most of the (grey) hydrogen is currently produced onsite whereas green H2 investment is much larger, requiring partnerships. + Industrial gas players already have a sizeable hydrogen business providing them with technical, logistics and portfolio benefits. Air Product's $5 billion green ammonia project in Saudi Arabia will be a test-case since ammonia will act as a carrier to export the green H2 for final-use as a fuel for trucks or buses. – Utilities and oil and gas players' interest the space of hydrogen may increase the competitive landscape.
Gas networks	High		+ Blending of surplus hydrogen into grids (5%-20% of grid capacity) appears feasible without significant investments. – Opportunities may be limited though in our view, since the high cost of clean hydrogen may see the bulk being deployed for industrial uses rather than burnt as fuel.

2025-2030: H2 May Affect Fertilizers And Commercial vehicles

Positive | Neutral to negative | Negative

Sector	Likelihood of hydrogen impact	Credit impact	Key opportunities (+) and challenges (-)
Fertilizer producers	Medium		– The case for green or blue ammonia depends heavily on lowering costs and policy requirements, since fertilizers are a global commodity, highly sensitive to raw material costs and the sales price for farmers. – Policies aimed at reducing carbon could lead to shifts in competitiveness over the long-run as cheaper green ammonia imported from low-cost renewable producers in Saudi Arabia, North Africa, Australia or Northern Europe. U.S. producers may keep their competitive advantage of access to cheap natural gas if carbon storage solutions can be developed.
Commercial vehicles (buses and trucks)	Medium		+ Major heavy-duty vehicle manufacturers have started taking steps to explore the feasibility of hydrogen-based fuel cells. + That technology is a better alternative to batteries because of the combination of weight, range, and refuelling downtime. + Buses could see a first rollout, given public support and pollution considerations. – Regulatory standards for CO2 emissions for heavy vehicles tighten in Europe from 2025 (-15% vs base) and in 2030 (-30%). – Policy support to establish refuelling infrastructure remains key to enable long-distance truck routes.
Capital goods	High		+ Increased demand for green hydrogen will benefit technology manufacturers with electrolysis know-how or related renewable generation offerings. Energy and utilities already are among the most important end markets. – A key challenge will be achieving a rapid cost decrease from scale up effects.
Gas transmission networks	High		+ Gas transport companies should be well positioned to build an H2 backbone network next to existing natural gas lines to connect key industrial hubs. If regulated, H2 could support long-term RAB growth. + Transporting energy over long distances by pipeline is much more efficient than through high voltage electric wires. – Conversion of existing gas pipeline assets doesn't appear feasible, given the need to keep natural gas flowing to existing customers.

2030-2040: H2 Can Meet Only A Fraction OF Future Energy Needs

Positive | Neutral to negative | Negative

Sector	Likelihood of hydrogen impact	Credit impact	Key opportunities (+) and challenges (-)
Oil and gas producers	High		- Conversion of methane into blue hydrogen through carbon capture and storage (CCS) in depleted oil and gas fields could extend the value of gas reserves. The U.S. appears to have the most potential: Exxon announced plans to construct a $100 billion CCS facility along the Houston Ship Channel to capture carbon emissions from refineries and petrochemical plants. Under a clean energy scenario, Total S.A. forecasts CCS could become as important as green H2, blue H2, and biomass combined. - Green H2 could displace gas-fired power if policies target complete decarbonization of power grids. Future H2 use in transport (including shipping and airlines) remains highly uncertain, but could weigh on long-term oil demand.
Gas-fired or base load power generation	Medium		– Hydrogen may gradually replace some gas-fired generation capacity in providing long-term storage and firm capacity, but only if policies seek to fully decarbonize the grid, as hydrogen will inevitably be more expensive than natural gas. Under a clean energy scenario, S&P Global Platts Analytics forecasts that hydrogen could represent 14% of the U.S. dependable capacity by 2040 (8% of dispatch). + Technologically speaking it requires limited investment to co-fire hydrogen in gas turbines. Enel SpA, for example, has a target of more than 8% of its power plants being hybridized with hydrogen by 2030. + Complete replacement of turbines to run 100% on H2 would require higher investment but could prevent assets from becoming stranded.
Gas distribution networks	Low		– Cost and availability of clean H2, as well as downstream equipment investment to convert heating applications to hydrogen (e.g. fuel cells, and H2 boilers) is likely to raise affordability questions for residential clients. – Concurrent switch from gas- to hydrogen-use by all end-consumers requires major planning and co-ordination. + Existing gas distribution grids could be converted to hydrogen at limited cost, but stranded cost risks remain given complexities.

2030-2040: Hard-To-Abate Sectors Face Increasing Pressure

Positive | Neutral to negative | Negative

Sector	Likelihood of hydrogen impact	Credit impact	Key opportunities (+) and challenges for hydrogen (-)
Steel	Low		– For steelmakers, the most feasible way to reduce emissions is through raw-material and process efficiencies, alongside switching to lower-emission electric arc furnaces (EAFs) from older blast furnaces. In Europe, SSAB and Thyssenkrupp are experimenting with small-scale green hydrogen steel pilots. – Increasing the share of EAFs is an obvious transition measure to reduce emissions but requires high investment that steelmakers, weakened by a decade of low returns, can ill afford. – The adoption of extremely costly hydrogen-fuelled directly reduced iron EAF technology appears currently out of reach, requiring significant cost reductions and policy support.
Autos (light vehicles)	Low/Medium		– Automakers' current preference is for battery-electric rather than fuel-cell vehicles. Despite concerns about their range and durability, battery electric vehicles currently offer far superior costs and energy efficiency. Concerns regarding safety and nitrogen oxide emissions associated with fuel cell vehicles are other hurdles. – Further technological progress in the field of solid-state batteries, if successful, would increase energy density by 50% over Li-ion batteries, with faster charging times, increased range, lower fire risk, and longer life. + Beyond 2030 the phase-out of combustion engines, potential scarcity of materials for battery manufacture, and government policies could support H2 as a supplemental decarbonization technology for light vehicles.
Other transport (shipping, airlines)	Low/Medium		– Green ammonia to fuel ships could become a long-term replacement for fuel oil but would be costly and preceded by the penetration of hydrogen in industrial applications. – Hydrogen-based fuel cells might offer a technological solution for airlines, but technological progress, as well as safety and feasibility tests (on small planes) are needed first. Policy focus on decarbonizing air traffic is however becoming an increasing priority.

Related Research

- How Far Off Is the Hydrogen Economy, Dec. 3, 2020
- WEBCAST/SLIDES: How Hydrogen Can Fuel The Energy Transition, Nov. 25, 2020
- How Hydrogen Can Fuel The Energy Transition, Nov. 19, 2020

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