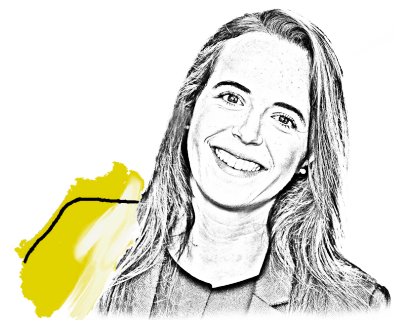


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# GREEN HYDROGEN – TAKING ANOTHER LOOK

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Hydrogen has been tipped to play an important role in the global transition to renewable energy. Over the last couple of years, a surge in the number of new projects and a flood of capital into the hydrogen industry suggests the pace of development is increasing fast. Investment Manager Ashley-Jane Kyle takes another look at hydrogen and assesses recent developments from the perspective of two companies in the industry.



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Russia's invasion of Ukraine has had significant economic consequences. One of them is huge volatility in the price of crude oil and natural gas. These price gyrations highlight the fragility of the global energy market. Commentators have speculated that such ructions could curtail the movement towards renewable energy by encouraging a return to coal and oil. We think it likely that some countries will look to restart their own exploration and production of fossil fuels to secure supply, which is worse for the environment, but potentially better than having to import fuels which are carbon intensive to transport. However, at the same time, many of these countries may also look to accelerate their investment in renewables to cut emissions and diversify away from particular geographical areas, whether Russia or the Middle East.

In the renewable energy space, solar, wind and tidal often take the limelight, overshadowing another fuel with a long history. Hydrogen, the lightest and most abundant element in the universe, was identified as a discrete substance in 1766 by scientist Henry Cavendish and given the name 'hydrogen' by Antoine Lavoisier in 1783. The first hydrogen fuel cell, in which oxygen reacts with hydrogen to produce energy and water, dates back to 1838.

*“Hydrogen trade flows are unlikely to become weaponised or cartelised”*

Hydrogen offers a number of benefits in the energy market. It supports the transition towards lower-carbon sources of energy from natural gas; it can be used as a store of renewable energy; and it can be generated using renewable energy by electrolysis. Another benefit,

particularly pertinent at this time of conflict in Ukraine, is that hydrogen trade flows are unlikely to become weaponised or cartelised. Hydrogen can be produced from many energy sources across a wide variety of locations worldwide, so the trade in hydrogen is unlikely to lend itself as easily to geopolitical influence as has been the case with oil and gas.<sup>1</sup>

*“The hydrogen industry is showing strong momentum around the globe, with more than 520 projects announced in 2021, up 100% compared to 2020”*

Hydrogen can be compressed into gas or liquefied to make it easier and cheaper to transport. Currently, most hydrogen is used in chemical plants or refineries, but it will have a role to play in transport, especially in hard-to-electrify areas such as heavy-duty freight, trains and buses, ferries and ocean-going shipping. It has been suggested that by 2030, hydrogen-powered vehicles could achieve cost parity with internal combustion engines, leading to a significant expansion in their use.<sup>2</sup>

At the moment, most hydrogen is produced from natural gas, so-called 'grey' hydrogen or, if combined with the process of carbon capture and sequestration (storage of carbon dioxide so it is not released into the atmosphere), 'blue' hydrogen. The most environmentally friendly type is 'green' hydrogen, produced using sustainable energy from water molecules broken apart by the process of electrolysis into hydrogen and oxygen.

We are still in the early phases of the development of green hydrogen. The costs of production, both in terms of

a renewable energy source and the electrolysis infrastructure, are still high. Research suggests the cost of producing hydrogen from renewables will need to fall by more than 50 per cent to make it a viable alternative to traditional energy.<sup>3</sup> However, this could occur over the next decade as substantial amounts of investment is flowing into the industry. About \$65bn has been earmarked for hydrogen production over the next decade, with Germany, France and Japan set to be the biggest investors.<sup>4</sup> The hydrogen industry is presently experiencing a significant growth spurt around the globe with more than 520 projects announced in 2021, up 100% from 2020. More than 15 countries across Europe, Asia and North America have integrated hydrogen into their national strategies with significant stimulus plans. The International Renewable Energy Agency (IRENA) estimates that hydrogen could provide 12% of the world's energy needs by 2050.<sup>5</sup> A study by the Hydrogen Council, established in 2017 as a global CEO-led initiative bringing together leading companies to promote the use of hydrogen, suggests that the global hydrogen market could be worth €2.5 trillion by 2050.<sup>6</sup>

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Hydrogen is therefore likely to become an increasingly important part of the global renewable energy mix. Industrial gas groups Linde and Air Liquide are supporting the growth of green and blue hydrogen. Both companies are active in the production, transport, storage and distribution of hydrogen. We



caught up with the management of both companies during the quarter and our discussions covered their developing hydrogen businesses.

*“Linde will be a clear beneficiary of the long-term trend of industrial decarbonisation driving demand for hydrogen”*

Industrial gases group Linde has a long history in hydrogen technology. We had an update call during the quarter with Sanjiv Lamba, the chief operating officer, who will become chief executive later this year. Lamba stressed how Linde will be a clear beneficiary of the long-term trend of industrial decarbonisation driving demand for hydrogen. He pointed to examples such as demand for blue hydrogen from the US refining industry, often to obtain government incentives, and the chemicals industry to generate blue methanol.

Lamba discussed the company's upcoming hydrogen projects. Linde has \$4bn worth of risk-adjusted potential projects (\$20bn unadjusted), with \$500m in the current pipeline. In the area of transport, there are many small projects with momentum behind them, including a bus network in South Korea, although final decisions on these investments will be made in coming years. Linde will also play a part in the decarbonisation projects of steel companies, which have longer lead times of between two to four years, and large decarbonisation projects in the energy sector which are likely to start from 2025.

Linde has recently announced some significant hydrogen projects. The company has formed a joint venture with ITM Power to build and, from mid-2022, operate the world's largest proton exchange membrane

electrolysis plant in Leuna, Germany, which should produce 4,500 standard cubic meters of hydrogen every hour. The site will generate up to 3,200 metric tons of green hydrogen each year, enough for 600 fuel cell buses to travel 40 million km. This will save up to 40,000 tons of carbon dioxide emissions per year.<sup>7</sup> Linde has also signed a long-term agreement with semiconductor company Infineon Technologies for the on-site production and storage of green hydrogen, the first time green hydrogen has been used in Infineon's semiconductor manufacturing process.

*“Air Liquide is aiming to invest €8bn in low-carbon hydrogen projects by 2035”*

Global industrial gas group Air Liquide is also a pioneer in hydrogen production. During the quarter, we held our first meeting with François Jackow who takes over as the company's CEO in June 2022. The company has had very few CEOs in its history and Jackow has been with the group since 1993. We discussed the company's energy transition strategy, including its production of green hydrogen. Air Liquide is aiming to invest €8bn in low-carbon hydrogen projects by 2035, which will involve investing in 3GW of electrolysis capacity by 2030.<sup>8</sup>

Jackow stressed how government policy is an important driver of hydrogen adoption by industry in the European Union where regulation requires refiners to use 100% renewable electricity in new plants. Refiners, therefore, have no option but to use green hydrogen and companies are signing 15-year supply contracts. However, the rules for European steelmakers are less strict, allowing low-carbon alternatives.

As the European industry gradually recognises that sufficient renewable capacity is not being added quickly enough, management teams are becoming more pragmatic. Air Liquide is proposing an alternative solution for these companies involving blue hydrogen at a third of the cost of green hydrogen, combined with carbon capture and sequestration. Blue hydrogen offers significant near-term emissions reduction, cost savings over green hydrogen, the ability for customers to meet regulatory and internal carbon life cycle assessment requirements, as well as the potential to charge end-customers a premium for low carbon products.

Air Liquide has also recently announced other hydrogen projects. The company will receive French government support to launch an electrolyzer with an initial capacity of 200 MW to provide green hydrogen for the Normandy refinery of TotalEnergies. This will be one of the first electrolyzers of this size in the world and should be commissioned in 2025.

Another example is a liquid hydrogen production plant in North Las Vegas, Nevada, due to come on stream soon. It is Air Liquide's first large-scale investment dedicated to the hydrogen-fuelled mobility market in the US, which includes automobiles, buses, coaches, forklifts and heavy-duty vehicles. The plant is aiming to produce 30 tons of liquid hydrogen and supply 40,000 vehicles every day by 2025.<sup>9</sup> The startup of this plant is a significant step in decarbonising the transportation sector in the west of the US, and will use biogas, landfill gas and waste-water treatment gas, rather than natural gas, to drive down carbon emissions.

Both Air Liquide and Linde are playing an important role in the development of hydrogen as a renewable energy source. They are

both world-leading industrial gas companies at the forefront of the hydrogen revolution. Over the long term, they should both contribute to the creation of a more diverse and sustainable global energy market.

<sup>1</sup> <https://www.irena.org/newsroom/pressreleases/2022/Jan/Hydrogen-Economy-Hints-at-New-Global-Power-Dynamics>

<sup>2</sup> [https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness\\_Full-Study-1.pdf](https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf)

<sup>3</sup> <https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/electric-power/112020-green-hydrogen-costs-need-to-fall-over-50-to-be-viable-sampp-global-ratings>

<sup>4</sup> Financial Times, 15 January 2022

<sup>5</sup> [www.irena.org](https://www.irena.org)

<sup>6</sup> <https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf>

<sup>7</sup> <https://www.linde.com/news-media/press-releases/2021/>

[linde-to-build-own-and-operate-world-s-largest-pem-electrolyzer-for-green-hydrogen](https://www.linde.com/news-media/press-releases/2021/)

<sup>8</sup> <https://www.airliquide.com/group/activities/hydrogen>

<sup>9</sup> <https://www.airliquide.com/stories/hydrogen/hydrogen-mobility-west-coast-air-liquides-response-growing-demand-united-states>

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