

**Antoine Champenier, Lazard Asset Management**

Antoine Champenier is a Research Analyst covering the chemicals sector. He began working in the investment field in 2017. Antoine joined Lazard as a summer intern and subsequently joined the firm in 2017. He graduated from Université Paris-Dauphine with a bachelor's degree in Management and Economics, and a master's degree in Corporate Finance.

# Hydrogen's role in the green economy

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*"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable"*

*Jules Verne, The Mysterious Island, 1874*

**H**ydrogen is the simplest and most abundant element in existence. People have imagined possible applications for hydrogen for a long time, but these ideas have often been full of promise yet short on delivery. So far, the element's uses have mostly been limited to large-scale, carbon-heavy industries. However, we believe hydrogen's potential in clean energy solutions is now becoming apparent, supported by innovations in technology, the falling cost of renewable energy, and global efforts to reduce emissions. The combination of these factors has opened up investment opportunities across the emerging hydrogen economy.

## Hydrogen's Role in the Green Economy

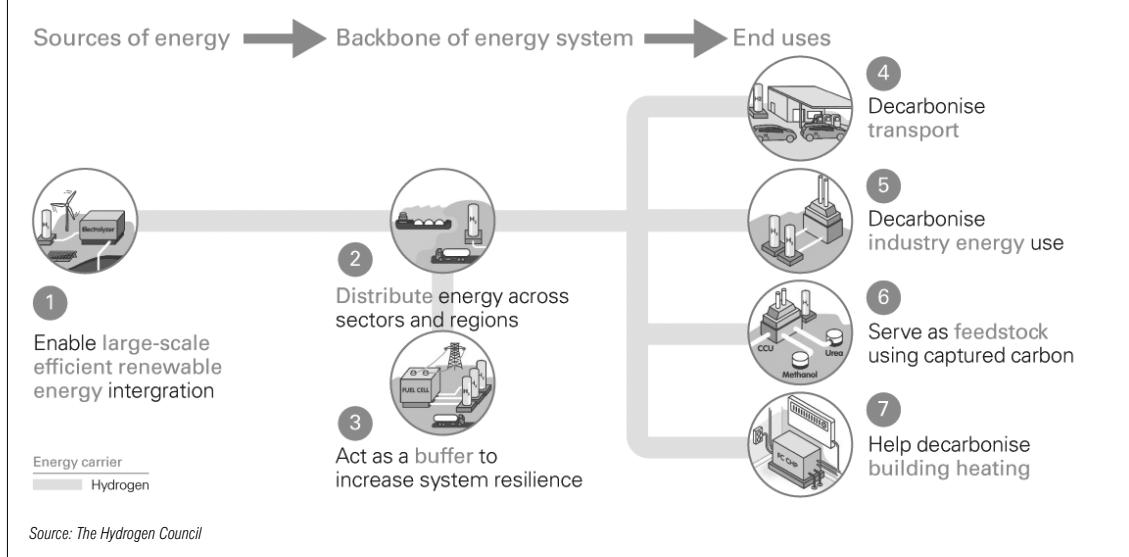
Hydrogen is a highly efficient way to decarbonise a wide range of carbon-emitting activities. It has the versatility to operate across the

transport, heat, industry and electricity sectors, which together account for around two-thirds of global carbon dioxide emissions.

One of the cleanest and most promising applications of hydrogen is in fuel cells. A hydrogen fuel cell combines hydrogen and oxygen to produce electrical energy, leaving only water vapour as emissions. Fuel cell technology has a vast number of applications, from small, portable devices to enormous power plants. Hydrogen fuel cells can also power commercial and public transport vehicles, such as buses, trucks, trains, and ships. Actually operating vehicles powered by hydrogen fuel cells produces zero emissions, and the use of such vehicles can become totally carbon-free if the hydrogen has been sourced from 'green' production methods such as renewable-powered electrolysis (see below). Hydrogen fuel cell vehicles also have shorter refuelling times and longer ranges than electric vehicles.

Hydrogen could play an important role decarbonising industrial processes. For example, in steelmaking it could replace carbon-intensive coke as a feedstock. The ability to store hydrogen for future energy demands means that it can also be used to provide carbon-free heat and power to buildings, in a similar manner to how natural gas is used today.

The Hydrogen Council was established in 2017 with the aim of driving a united vision for the development and possible future uses of hydrogen (Figure 1). It is comprised of over 80 members, including automotive suppliers, energy and chemical companies, and several large investment entities.

**Figure 1: The Hydrogen Council's Uses for Hydrogen in the Energy Transition****The quote**

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## Carbon-free Production Methods of the Future

Global demand for hydrogen has increased by over 300% since 1975 (Figure 2) and we believe this trend will accelerate over the next decade as more hydrogen economy infrastructure is built as countries look to use hydrogen technologies to decarbonise.

However, since hydrogen does not exist naturally on Earth as a gas it must be manufactured. This is generally done using natural gas in a process called steam-methane reforming (SMR). This natural gas-to-hydrogen pathway is the lowest-cost production method, but it does result in carbon emissions. For hydrogen to be a truly clean, zero-emission energy source, its production needs to be decarbonised. The most promising ways to achieve this are:

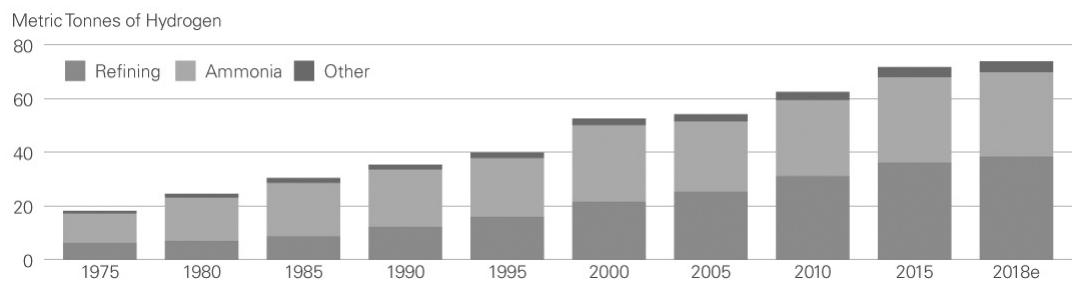
- Adding carbon capture technologies (CCS) to existing production methods to capture carbon dioxide
- Biomass conversion, which involves evaporating biological waste and capturing the resulting carbon dioxide
- Electrolysis of water

In electrolysis, electricity splits water into its hydrogen and oxygen components. The electricity required may be sourced directly from renewable, zero-emission sources, such as solar and wind, making the hydrogen production process totally carbon free.

Electrolysis is becoming a more economically compelling solution for truly green hydrogen production, and that in turn is a driving force behind the increased interest in hydrogen technologies. Renewable energy prices have declined 80% on average since 2010, and global electrolysis capacity has also expanded rapidly.

## Challenges to Widespread Adoption

Hydrogen has great potential, but challenges around its production, storage, and infrastructure must be addressed if it is to achieve widespread adoption. Though costs continue to fall and capacity continues to expand, 'green' hydrogen production methods such as electrolysis are neither available at a large enough scale nor mature enough to be cost competitive with legacy carbon-heavy production methods.

**Figure 2: Global Demand Has Tripled Since 1975**

**The quote**

*Hydrogen has great potential, but challenges around its production, storage, and infrastructure must be addressed if it is to achieve widespread adoption.*

The Hydrogen Council estimates that the cost of hydrogen solutions should fall by around 50% by 2030, a target they have recently upgraded due to faster-than-expected progress. While it is hard at this stage to assess how realistic this claim is, comparing the speed at which solar and wind costs fell over the last 10 years may offer some insight into the future path of hydrogen production costs (Figure 3).

From a storage perspective, hydrogen's low density (around four times less dense than gasoline) means it is necessary to develop larger or more advanced tanks. Liquefaction (storing hydrogen in liquid form) can greatly reduce storage volume, but the process of turning hydrogen gas to liquid is in itself capital- and energy-intensive.

Developing the infrastructure to support a hydrogen energy economy, including refuelling stations for fuel cell vehicles, has been slow in the Western world, with the exception of California which has the most hydrogen refuelling stations of any state in America. China, Japan, and Korea have all moved much faster in preparing for a future that includes hydrogen for energy and transport solutions. In the United Kingdom, there are around 8,500 petrol stations and over 5,000 electric charging locations, but still less than 20 hydrogen stations. The Hydrogen Council is targeting 3,000 refilling stations globally by 2025, which would support around 2 million fuel cell powered vehicles<sup>2</sup>. There is a clear need for this extensive expansion if fuel cell vehicles are to offer the reach and freedom of conventional modes of transport.

### Public Initiatives Driving Increased Hydrogen Adoption

To ensure development and eventual adoption of hydrogen-producing technology and hydrogen-supporting in-

rastructure, support from the public sector will be critical. We are seeing increasing signs that such support will be forthcoming. The European Commission's European Green Deal stated that it aims to deploy some 1%-2% of annual GDP (around €270bn per year) to support the bloc's energy transition<sup>3</sup>. This initiative will lead to increased investment across all low-carbon technologies, including clean hydrogen production and fuel cells.

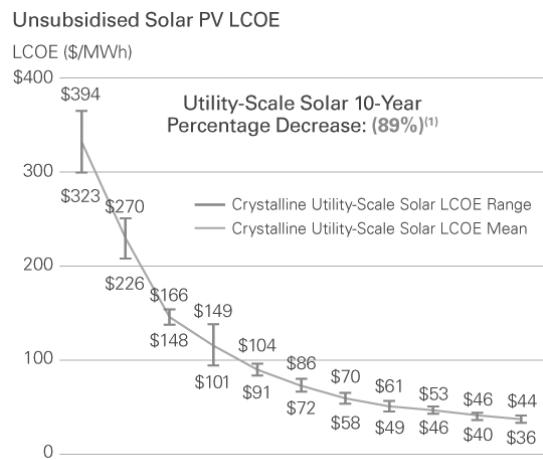
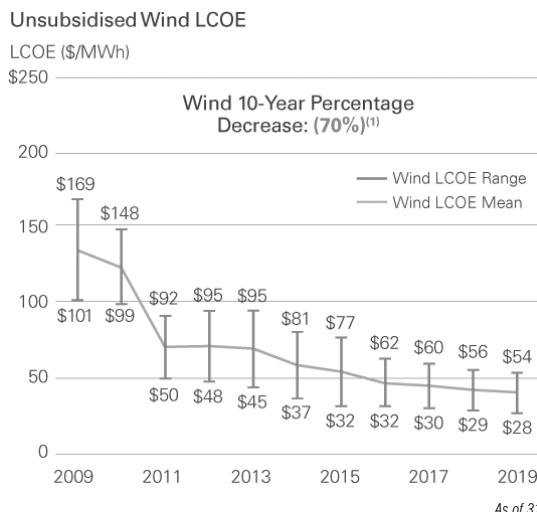
Meanwhile, the ground-breaking hydrogen H21 project in the United Kingdom aims to convert a portion of the UK gas network to carry up to 100% hydrogen, switching over 3.7 million homes and 40,000 businesses and industries in the north of England from natural gas to hydrogen heat by 2034. The success of this project would represent an important step for the uptake of hydrogen, as it would prove that existing infrastructure can be converted to safely transport and store hydrogen without the disruption and cost that would result from building new infrastructure.

Over the past few years there has been an enormous shift toward increased public and political awareness of environmental sustainability, as well as rising pressure on institutions such as pension funds to justify the companies owned in their investment portfolios. These sustainability and ESG issues will also help drive interest in low-carbon options and financing of green projects, including hydrogen.

### Identifying Investment Opportunities in the Hydrogen Economy

As investors, we see opportunities across the entire value chain, from production to end applications. We've been developing an investment framework to assess

**Figure 3: 'Green' Hydrogen Production Should Benefit from Falling Solar PV and Wind Power Costs**



As of 31 December 2019

(1) Represents the average percentage decrease of the high end and low end of the LCOE range.

Source: Lazard estimates.

what we will look for in a hydrogen-exposed company.

Our framework revolves around three key characteristics of an attractive investment in the hydrogen economy. Ideally, we are looking for companies that:

1. Help solve the cost issue, as it is the main challenge for the industry;
2. Do so through a clear competitive advantage – ideally via technology, but scale and first-mover advantages could also prove to be a strong barrier to entry;
3. Are exposed to the most promising application areas of hydrogen

There are still a limited number of investable hydrogen “pure-plays” available for equity investors. Those that exist tend to be early-stage businesses with a high degree of uncertainty about future profitability, but they can still be interesting potential investments. The more mature opportunities currently available tend not to have pure exposure, but on the other hand we can more straightforwardly assess how they will yield high returns from their hydrogen-related operations.

We think companies developing technologies and selling products that allow for accelerated hydrogen penetration in the most likely growth areas, such as electrolysis and commercial transport, are the right place to start thinking about hydrogen investment, especially if these companies have competitive advantages that will support sustainably high returns in the future.

For example, upstream industrial gas companies could serve growing hydrogen gas demand through existing distribution networks. Their scale and already-built infrastructure would allow them to provide this service at high margins.

Looking further down the value chain, companies closer to hydrogen applications, such as electrolyser developers and fuel cells catalyst manufacturers, could also be compelling investments as their costs fall and demand grows for low- or zero-emission technology in the transport and industrial sectors.

If governments and companies are to achieve their ambitious emission reduction targets and drive future growth using hydrogen applications, they will need to invest across all areas of the growing hydrogen economy. Companies that are able to anticipate these needs and provide cost-effective solutions are likely to be better positioned as hydrogen gains further prominence.

## A Pivotal Role in the Energy Transition

Hydrogen technologies offer innovative solutions for the transition to a low-carbon world and the fight against climate change. While we expect costs to fall and performance to improve for ‘green’ hydrogen production methods and fuel cell applications, just as they have for other renewables, there are still challenges that must be overcome for hydrogen to live up to its potential. Hydrogen will not be the only solution for a greener way to meet the world’s energy demands, just as solar PV, wind, or electric battery storage cannot perform that function on their

own. Rather, hydrogen will likely be one of a wide range of carbon-free technologies working together to meet the ever-growing energy needs of the planet. For investors, the time to start learning about hydrogen is now. **FS**

### Notes

1. Source: *The Hydrogen Council*, [www.hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective](http://www.hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective)
2. Source: *Energy & Environmental Science Journal*, *The role of hydrogen and fuel cells in the global energy system*, 10 December 2018
3. Source: *The European Commission*, *The European Green Deal*, 11 December 2019
4. Source: *H21*, [www.h21.green/news/worlds-first-100-hydrogen-testing-facility-unveiled/](http://www.h21.green/news/worlds-first-100-hydrogen-testing-facility-unveiled/)

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### The quote

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