

# \$HDRO

DEFIANCE<sup>ETFs</sup>

Investment Case for HDRO: The Defiance  
Global Hydrogen & NextGen Fuel Cell ETF



**HDRO is a next generation ETF that allows retail clients to invest in hydrogen, by offering exposure to hydrogen stocks at the forefront of innovation towards a greener, more sustainable economy.**

Around 80% of the world's energy consumption is currently provided by fossil fuels, which are non-renewable and harm the environment, contributing to global warming.<sup>[1]</sup> As natural reserves dwindle, and populations grow, there is a clear need to find clean, sustainable energy solutions to meet increasing demand. None of the existing alternative energy sources such as solar, wind or biomass are able to provide sufficient, consistent and cost-effective energy supply. Electrification alone cannot reduce emissions to zero.

Global attention is now, more than ever, focused on sustainability and decarbonization. Biden's election to US President has further propelled the green agenda to the fore, with the USA and EU both committing to be climate-neutral by 2050. Environmental factors are combining with political will to make steps towards a greener future not just a luxury, but a necessity.

Attention has turned to hydrogen as a green fuel with the potential to transform how we harness, store and use energy. Extensive R&D budgets are pushing innovation in the sector, as governments, industry and science recognize the potential of the hydrogen economy.

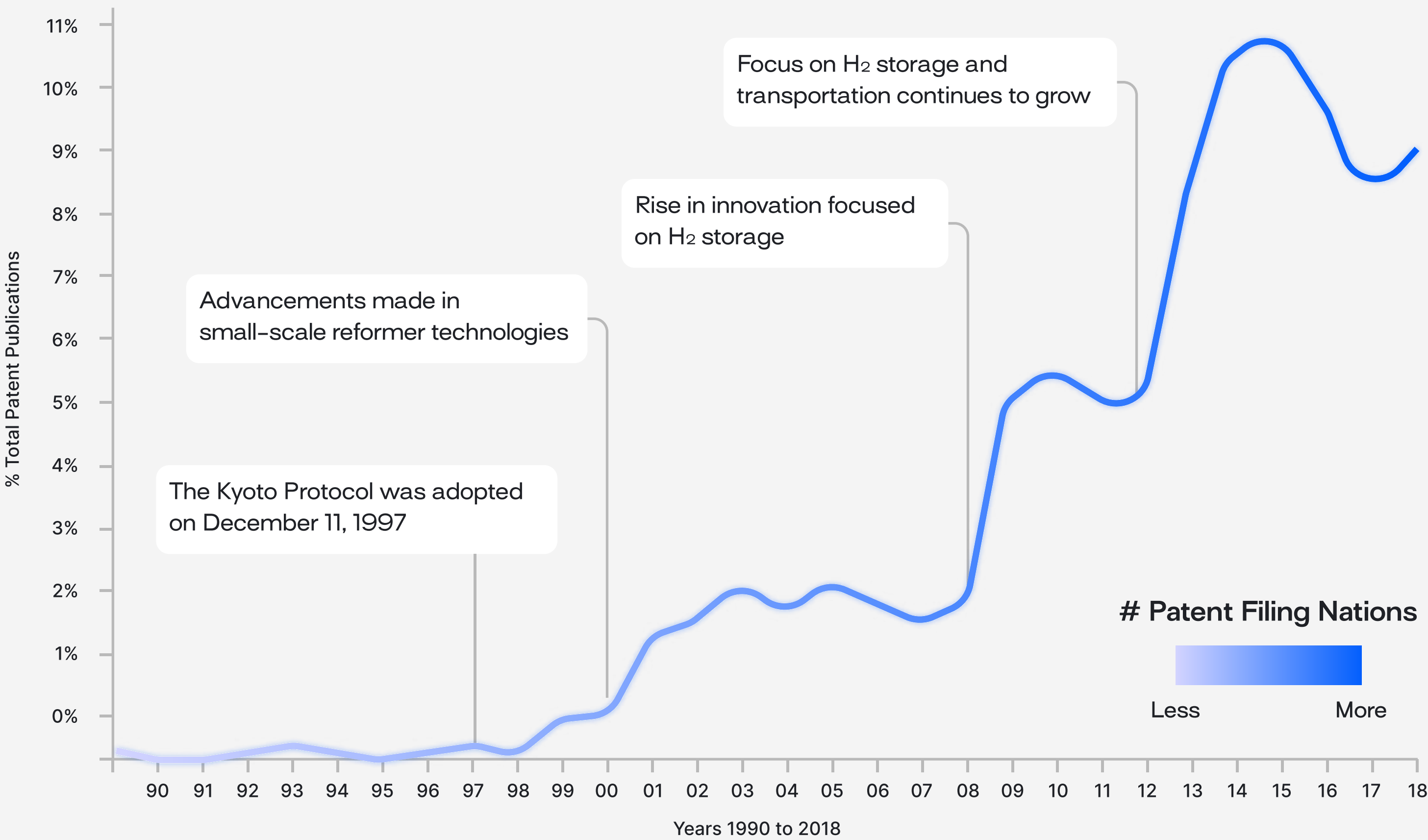


[1] "Fossil Fuels," Environmental and Energy Studies Institute, July 22, 2021. <https://www.eesi.org/topics/fossil-fuels/description>



# Hydrogen Fuel

## Patents Publication Timeline



Source: "Hydrogen Fuel: Insights into a growing market" <https://www.cas.org/sites/default/files/documents/hydrogen-fuel-whitepaper-0320.pdf>. February 2020

Bank of America has compared the current phase of the hydrogen market to smartphones pre-2007 and the internet pre-dot.com. It estimates that hydrogen will generate 24% of our energy needs by 2050, creating as much as \$11 trillion in investment opportunities over the next three decades.<sup>[2]</sup>

Hydrogen fuel is already in use in specific pilot projects. The UK already has 11 active hydrogen refueling stations, with others in process.<sup>[3]</sup> As of April 2023, according to the US Department of Energy, there were 59 retail hydrogen stations open across California,<sup>[4]</sup> while the cost of these larger stations has decreased by 40 percent over the last few years.<sup>[5]</sup> California is also home to over half of the global population of Fuel Cell Elective Vehicles (FCEVs), and the largest number of FCEVs in the hands of private consumers in the world, with nearly 7,000 of them on the road. In further examples, Amazon and Walmart now use hydrogen-powered forklifts in their warehouses,<sup>[6]</sup> fuel cell bus fleets are being rolled out in China and Europe and the world's first fuel cell trains have been ordered in France, Germany and Italy.<sup>[7]</sup> At the 2021 Summer Olympics in Japan, plans to use 100 hydrogen-powered buses to transport athletes were only scuppered by Covid-19 supply chain disruption.<sup>[8]</sup>

For hydrogen fuel cell stocks investors, 2022 was encouraging. 680 large-scale projects were announced, reflecting \$240 billion worth of investment, a jump of 50% since November 2021, and 10% of those have reached FID, are under construction, or already operational . Stationery fuel cell capacity is estimated to have increased from under 200 MW in 2015 to over 500 MW in 2022. <sup>[9]</sup>

[2] "Thematic Investing: The Special 1 – Hydrogen primer," Bank of America Securities, Global Research, 23 September 2020, p.1 and 6.  
[3] <https://www.glpautogas.info/en/hydrogen-stations-united-kingdom.html>  
[4] "Alternative Fuels Data Center," U.S. Department of Energy, Jan 6, 2022. <https://afdc.energy.gov/stations/states>  
[5] "Roadmap to a US hydrogen Economy," Fuel Cell & Hydrogen Energy Association, 2020, p.70 <https://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/5e7ca9d6c8fb3629d399fe0c/1585228263363/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf>  
[6] "Thematic Investing: The Special 1 – Hydrogen primer," Bank of America Securities, Global Research, 23 September 2020, p.54.  
[7] "Worldwide hydrogen projects gain traction," International Rail Journal, October 21, 2021 [https://www.railjournal.com/in\\_depth/worldwide-hydrogen-projects-gain-traction](https://www.railjournal.com/in_depth/worldwide-hydrogen-projects-gain-traction)  
[8] "The 'Hydrogen Olympics' Lit a Torch for the Clean Fuel's Future," Tess Joosse, July 30, 2021 <https://www.scientificamerican.com/article/the-hydrogen-olympics-lit-a-torch-for-the-clean-fuels-future/>  
[9] "Global Hydrogen Review 2022" <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>



# What is hydrogen and how can it be used as a fuel?

Hydrogen is the first element in the periodic table and the most abundant atom in the universe. It comprises about 90% of the world's atomic material, but does not occur naturally alone. Once isolated, hydrogen functions both as a fuel and an energy carrier; it can store and transfer energy over time and space.

There are a number of ways to extract hydrogen from its compound elements, but electrolysis has emerged as the method with the greatest potential to produce large-scale, low-carbon hydrogen at a reasonable cost.

Electrolysis involves passing electricity through water in order to separate its atoms (hydrogen and oxygen), thereby allowing for the harvest of hydrogen. Until now the overwhelming majority of hydrogen has been produced using fossil fuels or natural gas (so-called "grey hydrogen"), but if the electricity used to activate this process is from renewable energy sources, the product is termed "green hydrogen." The cost of electrolyzers to produce hydrogen has fallen by up to 50% in the past 5 years, and is projected to fall a further 40-60% by 2030.<sup>[10]</sup>

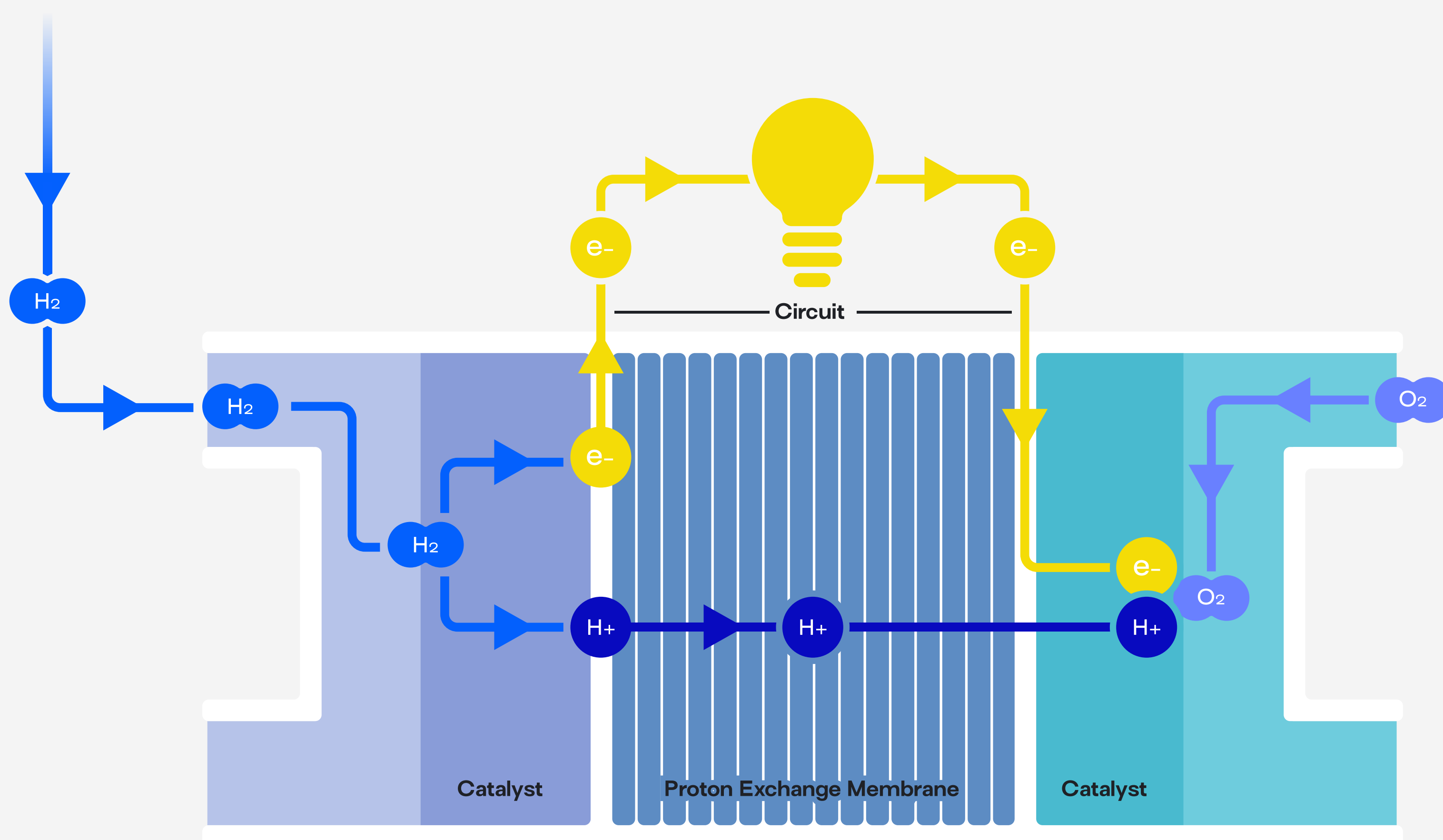
After electrolysis, the hydrogen is **stored** to be used later. Hydrogen can collect excess energy created at certain times of the day or year or in particular locations, and distribute it at other locations or times where supply is lower. It can meet peak demand and offer long-duration discharge cycles (greater than 12 hours) that other technologies currently lack. Hydrogen is much less dense than air, and therefore requires high quality storage conditions in a pressurize container. Its storage has posed one of the biggest commercialization challenges, and finding the balance of durability, weight and cost of storage has therefore been the focus of most hydrogen-fuel research over the past decade.



[10] "Thematic Investing: The Special 1 – Hydrogen primer," Bank of America Securities, Global Research, 23 September 2020, p.5.

After storage and transportation, the hydrogen is passed into a **fuel cell** in order to transfer its energy. The fuel cell includes a catalyst which separates the protons and electrons in the hydrogen. The protons then pass through a selectively permeable membrane, but the electrons are unable to pass, forcing them through a circuit and thereby creating electric current. When the electrons and protons reunite on the other side of the circuit, they reform into hydrogen. Oxygen is then introduced, and the hydrogen combines with the oxygen in the air to form H<sub>2</sub>O or water, the harmless and environmentally friendly waste product of such a fuel cell.

### The positive and negative particles reunite in the fuel cell and oxygen is introduced



Source: "Game Changer: How Green Hydrogen Could Fuel Our Future", Merrill Analysis. <https://www.ml.com/articles/green-hydrogen-climate-change.html>



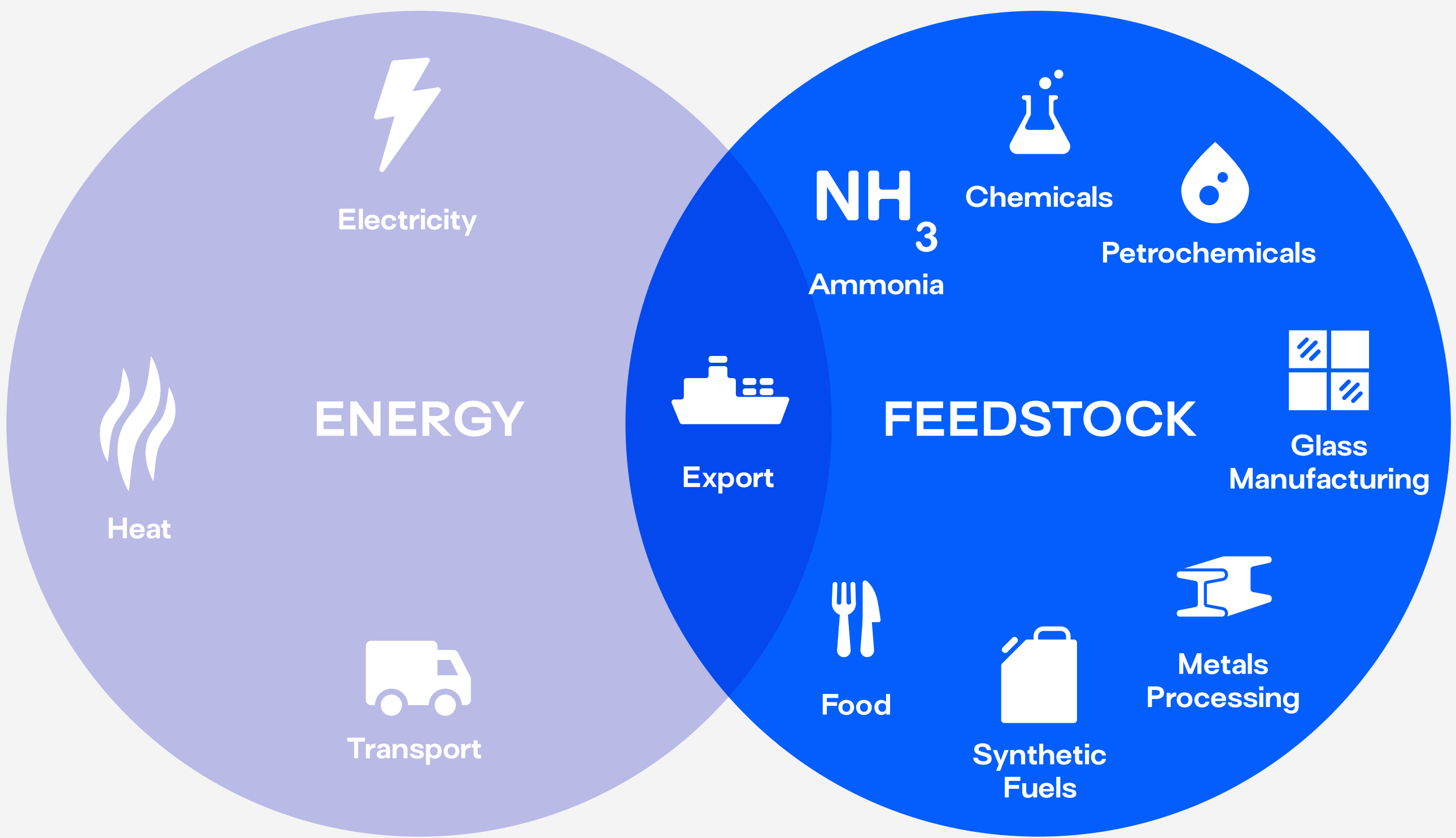
# Isn't it too dangerous / costly / difficult to use hydrogen this way?

Positioning hydrogen as the energy carrier of choice and creating a vibrant, competitive hydrogen economy, depends on the coalescence of three factors: 1. Technology, 2. Economics and 3. Environment. Once these three elements are aligned, they have the potential to overcome challenges and drive the market forward towards a hydrogen-powered future.

## 1. Technology

Use cases for hydrogen fuel are multiplying (see below for further examples). From power generation and grid balancing to industrial fuel, feedstock for industry and transportation fuel, to heating, aerospace and shipping, the potential applications are already being developed. Concerns over safety have been addressed – Hydrogen is as flammable as other fuels, but its low density means that it very quickly dissipates into the air and if it does burn, it does so at a lower temperature.<sup>[11]</sup>

### Hydrogen’s versatility as a source of energy, feedstock, or storage/export



Source: Adapted from Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO): National Hydrogen Roadmap (2019)

[11] “So just how dangerous is hydrogen fuel?” Jacob Leachman, Washington State University, March 17, 2017. <https://hydrogen.wsu.edu/2017/03/17/so-just-how-dangerous-is-hydrogen-fuel/>



## 2. Economics

Hydrogen extraction tech has been around for decades, but the falling cost of renewable energy and electrolyzers used to produce green hydrogen, is bringing us ever closer to commercially viable hydrogen use. The challenge of safe and effective storage for hydrogen has largely been met, with affordability coming from economies of scale and supported by policies and government incentives.

## 3. Environment

As costs come down, the economics of the hydrogen market remain inseparable from the policy environment. Global commitment to sustainability and decarbonization are manifesting in concrete policies that penalize emissions and incentivize green energy. For example, the Energy Policy Act of 2005 calls for a wide-reaching research and development program on technologies relating to the production, purification, distribution, storage, and use of hydrogen energy, fuel cells, and related infrastructure with the goal of demonstrating and commercializing the use of hydrogen for transportation, utility, industrial, commercial, and residential applications. The European Commission's European Hydrogen Strategy, and various national hydrogen strategies also promote the use and export of renewable energy (e.g. Australia, Germany, France, China). Biden's famous Infrastructure Plan allocated \$15bn to hydrogen technology.<sup>[12]</sup>



[12] "Biden Details \$2 Trillion Plan to Rebuild Infrastructure and Reshape the Economy" March 31, 2021  
<https://www.nytimes.com/2021/03/31/business/economy/biden-infrastructure-plan.html>



Green hydrogen production currently costs substantially more than the more common “gray” hydrogen made from natural gas. However government policies and incentives are already combining with established industries to pursue progress towards clean energy goals. Market forces also point to potential in the hydrogen market, as ESG (environmental, social and governance) criteria increasingly figure in investment decisions.

Global stock of fuel cell electric vehicles (FCEVs) grew by 15% from the end of 2021 to June 2022, and key infrastructure increased, with many countries in Europe growing investment in hydrogen hubs. The global number of hydrogen refueling stations rose from 700 at the end of 2021 to 975 by June 2022.<sup>[13]</sup>

We also saw initial steps towards a global hydrogen market when the first shipment of liquified hydrogen traveled from Australia to Japan in February 2022.<sup>[14]</sup> The Hydrogen Council predicted a potential annual trade market of 140 million metric tons (Mt) by 2030, and Germany launched a tender to import green ammonia, beginning in 2024.<sup>[15]</sup>

In good news for hydrogen power stocks, 2022 saw demand rise too. The EU set a target of 10 million Mt/year of local renewable hydrogen production, and the equivalent again in imports, by 2030.<sup>[16]</sup> This inevitably requires more investment, with one report concluding that spending on hydrogen projects needs to triple to \$700 billion by 2030.<sup>[17]</sup>

## Green hydrogen is becoming more competitive

One unexpected fallout from the invasion of Ukraine is that high energy prices have made green hydrogen production, which relies on renewable energy, more competitive in comparison with gray hydrogen, which uses fossil fuels.<sup>[18]</sup> At the same time, electrolyzer costs are falling. The IEA predicts that costs for electrolyzers could drop by 70% by 2030, if manufacturing capacities scale successfully.

Together with lower prices for renewable energy, green hydrogen prices could drop by 60–64% by 2025, and by up to 72% by 2030. "Our analysis suggests that with today's fossil energy prices, renewable hydrogen could already compete with hydrogen from fossil fuels in many regions," observed the IEA.<sup>[19]</sup>

As the price drops, hydrogen production is rising, making it increasingly viable as an alternative fuel. The IEA estimates that global production of low-emission hydrogen from electrolysis could reach 240 GW by 2030.<sup>[20]</sup>



[13] "Global Hydrogen Review 2022" <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>

[14] "Global Hydrogen Review 2022" <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>

[15] "Commodities 2023: Europe struggles to maintain hydrogen momentum" December 31, 2022 <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/122322-europe-struggles-to-maintain-hydrogen-momentum-into-2023>

[16] "Commodities 2023: Europe struggles to maintain hydrogen momentum" December 31, 2022 <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/122322-europe-struggles-to-maintain-hydrogen-momentum-into-2023>

[17] "New hydrogen projects achieve record numbers globally with even greater urgency for final investment decisions to attain net zero" September 20, 2022 <https://hydrogencouncil.com/en/new-hydrogen-projects-achieve-record-numbers-globally-with-even-greater-urgency-for-final-investment-decisions-to-attain-net-zero/>

[18] "Outlook 2023: Can hydrogen pass the energy trilemma test?" December 14, 2022 <https://pemedianetwork.com/hydrogen-economist/articles/strategies-trends/2022/outlook-2023-can-hydrogen-pass-the-energy-trilemma-test/>

[19] "Global Hydrogen Review 2022" <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>

[20] "Global Hydrogen Review 2022" <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>



# Hydrogen-friendly policies are adding to the momentum

2022 saw the US adopt the Inflation Reduction Act (IRA), acclaimed as "the single largest investment in climate and energy in American history."<sup>[21]</sup> Under IRA, green hydrogen is now eligible for up to \$3 per kg of tax credits, with some experts predicting that this alone will halve the cost of green hydrogen and make it a competitive energy source.<sup>[22]</sup> Projects to develop green hydrogen will enjoy tax breaks until 2032, as will domestic production of components for solar and wind energy, which are used in many green hydrogen projects. There are additional investment tax credits of up to 30% for qualified projects for domestic manufacturing facilities for renewable energy production, plus even more for those using certain components produced in the US.<sup>[23]</sup>

Taken together, the IRA promises the creation of a serious renewable energy ecosystem in the US. Interest is already growing in hydrogen hubs, with private investment in renewables hitting a record high of \$10 billion in the past year<sup>[24]</sup> Deloitte declared that "the incentives will likely bring significant new manufacturing of clean energy components to the United States."<sup>[25]</sup>

Nor is the impact of IRA limited to the US. David Brown, director of Energy Transition at energy intelligence group Wood Mackenzie, forecasts that "other countries will need to introduce incentives that are closer in value to what is now available in the U.S. to remain competitive," which he predicts will "unlock new business opportunities for the entire globe."<sup>[26]</sup>

In the UK, the British Energy Security Strategy aims to double the country's hydrogen production from 5GW to 10GW by 2030, with at least half to be achieved through green hydrogen,<sup>[27]</sup> and it recently announced plans to attract another \$4.64 billion of investment for its hydrogen economy. China revealed a five-year plan to make hydrogen one of the country's six industries of the future.<sup>[28]</sup> The UAE's investment in low-carbon energy production is expected to prod other oil producers in the Middle East into a rush of green energy adoption. "The UAE and the Middle East more widely could have a similar eureka moment to the Inflation Reduction Act in the U.S.," noted Kavita Jadhav, Wood Mackenzie's Research Director, Corporate Research.<sup>[29]</sup>

## Green hydrogen is becoming more competitive

The other driver for renewable energy is the global energy crisis sparked by the Russian invasion of Ukraine. Many governments, particularly in Europe, are looking at low-emission hydrogen as a way to reduce dependency on fossil fuels.<sup>[30]</sup> Caroline Justet, VP of Europe for supply chain company Strohm, observes that "with the global energy sector in flux, the versatility of hydrogen is attracting stronger interest from a diverse group of governments and companies."<sup>[31]</sup>

The need to transition the global energy mix also requires more energy storage production. This could offer a boost to lithium stocks, but with Russia accounting for almost 20% of global lithium supply, companies are facing a shortage of vital metals. Hydrogen fuel cells have proven a viable alternative for green energy storage.<sup>[32]</sup>

[21] "Clean Energy Outlook 2023" January 2, 2023 <https://www.tomorrowstoday.com/2023/01/02/clean-energy-outlook-2023/>

[22] "Clean Energy Outlook 2023" January 2, 2023 <https://www.tomorrowstoday.com/2023/01/02/clean-energy-outlook-2023/>

[23] "2023 renewable energy industry outlook" <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-renewable-energy-outlook-2023.pdf>

[24] "2023 renewable energy industry outlook" <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-renewable-energy-outlook-2023.pdf>

[25] "2023 renewable energy industry outlook" <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-renewable-energy-outlook-2023.pdf>

[26] "Energy outlook: Oil making a comeback in 2023, says WoodMac" January 3, 2023 <https://www.offshore-energy.biz/energy-outlook-oil-making-a-comeback-in-2023-says-woodmac/>

[27] "The UK Hydrogen Economy: Policy Announcements Support a 10GW Ambition" June 24, 2022 <https://www.fticonsulting.com/insights/articles/uk-hydrogen-economy-policy-announcements-support-10gw-ambition>

[28] "Outlook 2023: Predicting tomorrow's decarbonisation agenda" December 27, 2022 <https://pemedianetwork.com/hydrogen-economist/articles/green-hydrogen/2022/outlook-2023-predicting-tomorrow-s-decarbonisation-agenda/>

[29] "Energy outlook: Oil making a comeback in 2023, says WoodMac" January 3, 2023 <https://www.offshore-energy.biz/energy-outlook-oil-making-a-comeback-in-2023-says-woodmac/>

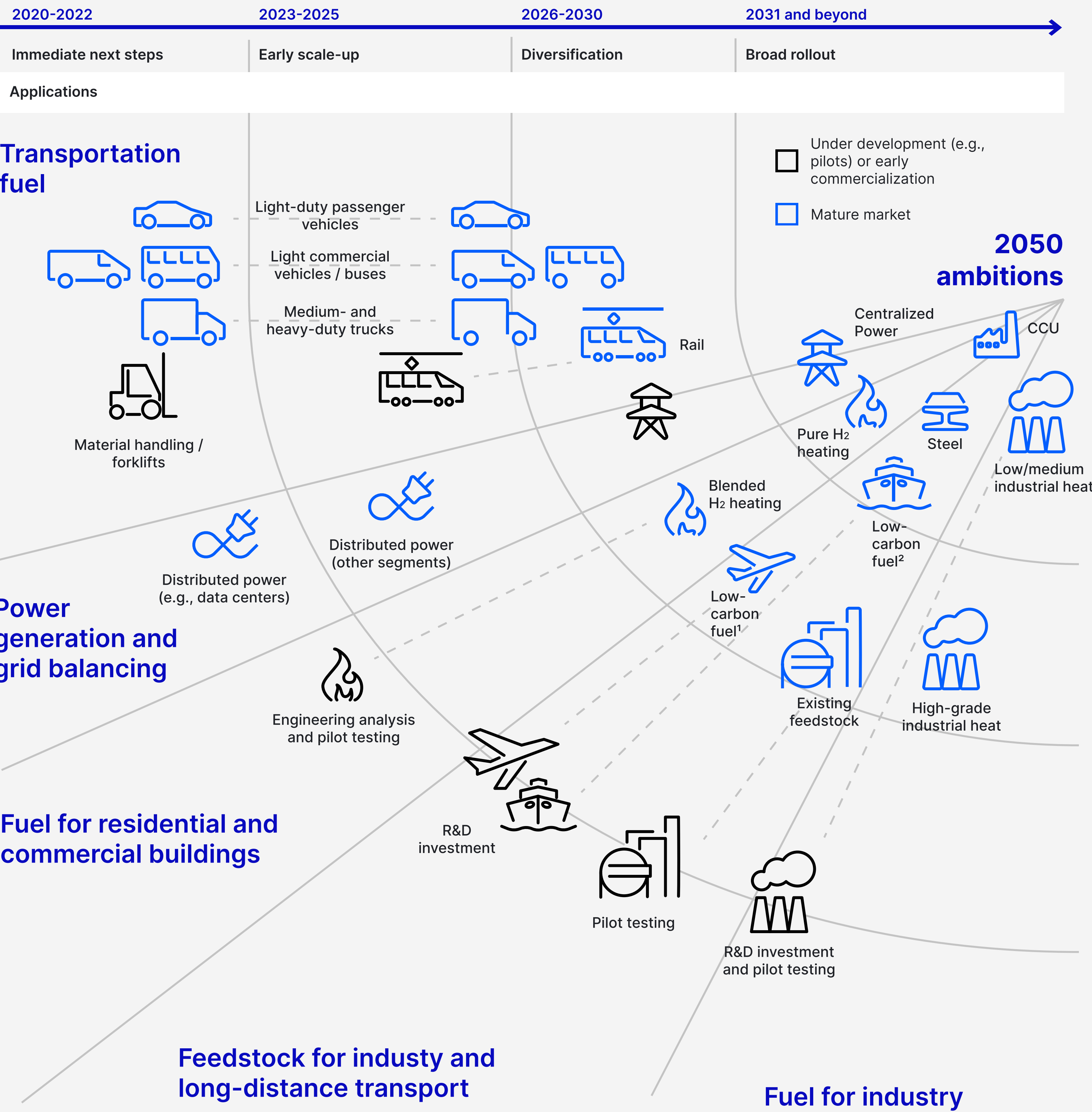
[30] "Global Hydrogen Review 2022" <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>

[31] "Outlook 2023: Predicting tomorrow's decarbonisation agenda" December 27, 2022 <https://pemedianetwork.com/hydrogen-economist/articles/green-hydrogen/2022/outlook-2023-predicting-tomorrow-s-decarbonisation-agenda/>

[32] "Energy outlook 2023: The growth in renewables, batteries, CCS and hydrogen infrastructure" December 20, 2022 <https://think.ing.com/articles/new-energy-technologies-growth-in-renewables-batteries-ccs-and-hydrogen-infrastructure>



Hydrogen applications road map



1 Carbon capture and utilization (for chemical production)  
2 Biofuel, synfuel, ammonia



Hydrogen fuel cells often receive the most attention. But the potential economic implications of hydrogen fuel are much more far-reaching. Metals, mining and steel production, which currently tend to have large carbon footprints, could also see significant up-take. Commercial adoption of hydrogen-fueled transport fleets would stimulate demand for the fueling infrastructure—pipelines, storage and transport. Longer-term, we may even see the adoption of green hydrogen among companies involved in aerospace and shipping and new component industries could also capitalize on the increased demand – platinum for example, is a key part of both fuel cells and electrolyzers.

Assuming a context of strong state and regional support for low-carbon initiatives, collaborative partnerships with key stakeholders to resolve the challenges in scaling hydrogen, and business recognition of its potential, hydrogen demand in the US could reach 17 million metric tons by 2030 and 63 million metric tons by 2050, roughly equivalent to 14 percent of final energy demand (excluding demand from industrial feedstock).<sup>[33]</sup>

The energy density of compressed hydrogen allows for much longer distances than Battery Electric Vehicles (BEVs). FCEVs are a better option for those seeking quicker refueling, longer range, higher payload, and more cargo volume. Commercial FCEV fleets of small delivery trucks, buses, and medium- and heavy-duty trucks could therefore make up around 10 percent of commercial fleets and trucks sales in 2030, and 35 percent by 2050.<sup>[34]</sup>

Uptake of private use for FCEVs will depend on falling costs. Estimates show that increasing fueling station size for light-duty vehicles from 350 kg of hydrogen per day to 1,000 kg of hydrogen per day, plus reducing the cost of capital-intensive equipment like compressors, liquid pumps, and storage materials through supply chain development, economies of scale, manufacturing innovations, and increase in station utilization, could lower hydrogen cost at the pump by approximately 50 percent by 2025, reaching \$7 per kg.<sup>[35]</sup> With further system design and manufacturing improvement and station capacity increased to 3,000 kg per day, hydrogen cost at the pump could reach \$5 per kg, rendering it competitive with other fuel options.

An estimated 45 percent of data centers could use hydrogen fuel cells as backup power by 2030, rising to 65% by 2050. Industry leaders like Amazon, Apple, Facebook, Google, and Microsoft could create annual demand for 1,500 MW of stationary power capacity by 2030.<sup>[36]</sup>



[33] "Roadmap to a US hydrogen Economy," Fuel Cell & Hydrogen Energy Association, 2020, p.26. <https://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/5e7ca9d6c8fb3629d399fe0c/1585228263363/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf>

[34] "Roadmap to a US hydrogen Economy," Fuel Cell & Hydrogen Energy Association, 2020, p.36-37. <https://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/5e7ca9d6c8fb3629d399fe0c/1585228263363/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf>

[35] "Roadmap to a US hydrogen Economy," Fuel Cell & Hydrogen Energy Association, 2020, p.63. <https://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/5e7ca9d6c8fb3629d399fe0c/1585228263363/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf>

[36] "Roadmap to a US hydrogen Economy," Fuel Cell & Hydrogen Energy Association, 2020, p.55. <https://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/5e7ca9d6c8fb3629d399fe0c/1585228263363/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf>



# What can investors expect from HDRO?

HDRO, the Defiance Global Hydrogen & NextGen Fuel Cell ETF, tracks the BlueStar Global Hydrogen & Next Gen Fuel Cell Index. The index is rules-based and tracks the performance of a group of globally listed equities and of companies, who generate at least 50% of their revenue from their involvement in the development of hydrogen-based energy sources, fuel cell technologies and industrial gases.

HDRO allows investors to express a targeted view of future energy markets. It offers diversified exposure to the full spectrum of the hydrogen economy without over exposure to any one company in this new and developing market. The index seeks the most liquid, best hydrogen stocks in the marketplace.



## Examples Include:

- **Plug Power**, developer of hydrogen and Fuel Cell technology whose customers include NASA, Amazon, Home Depot, Boeing, Wal Mart, and BMW;
- **Bloom Energy**, who have developed an on-site electric power solution that is one of the most efficient and cleanest in the world;
- **Fuel Cell**, who have already created SureSource power plants over 3 continents that can provide local hydrogen production, on-site power generation, and long duration energy storage;
- **ITM Power**, who already built 7 hydrogen refueling stations in the UK and aim to reach 100 within five years.

*The Funds' investment objectives, risks, charges, and expenses must be considered carefully before investing. The prospectus contain this and other important information about the investment company. Please read carefully before investing. A hard copy of the prospectuses can be requested by calling 833.333.9383.*

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HDRO is new with a limited operating history

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