# The Emergence of the Clean Hydrogen Economy

Guidehouse

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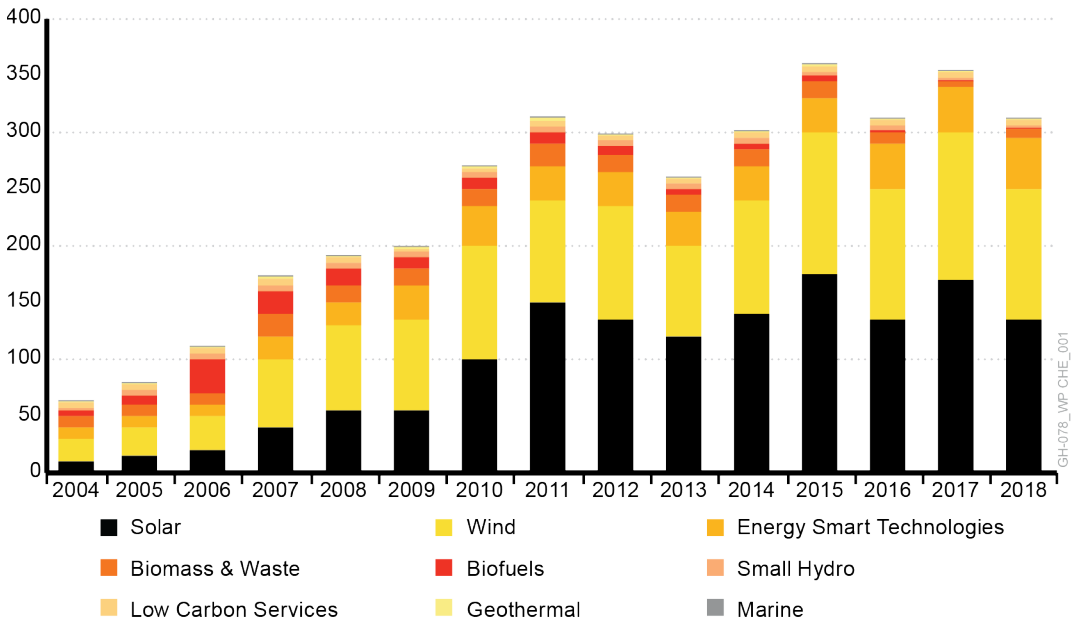
The shift to a low carbon economy is gaining more momentum globally. This transition is being enabled by a change in consumer preferences, implementation of policies that place a cost on emissions, and through the continued development of commercially competitive reliable technology.

**Global New Investment in Clean Energy**



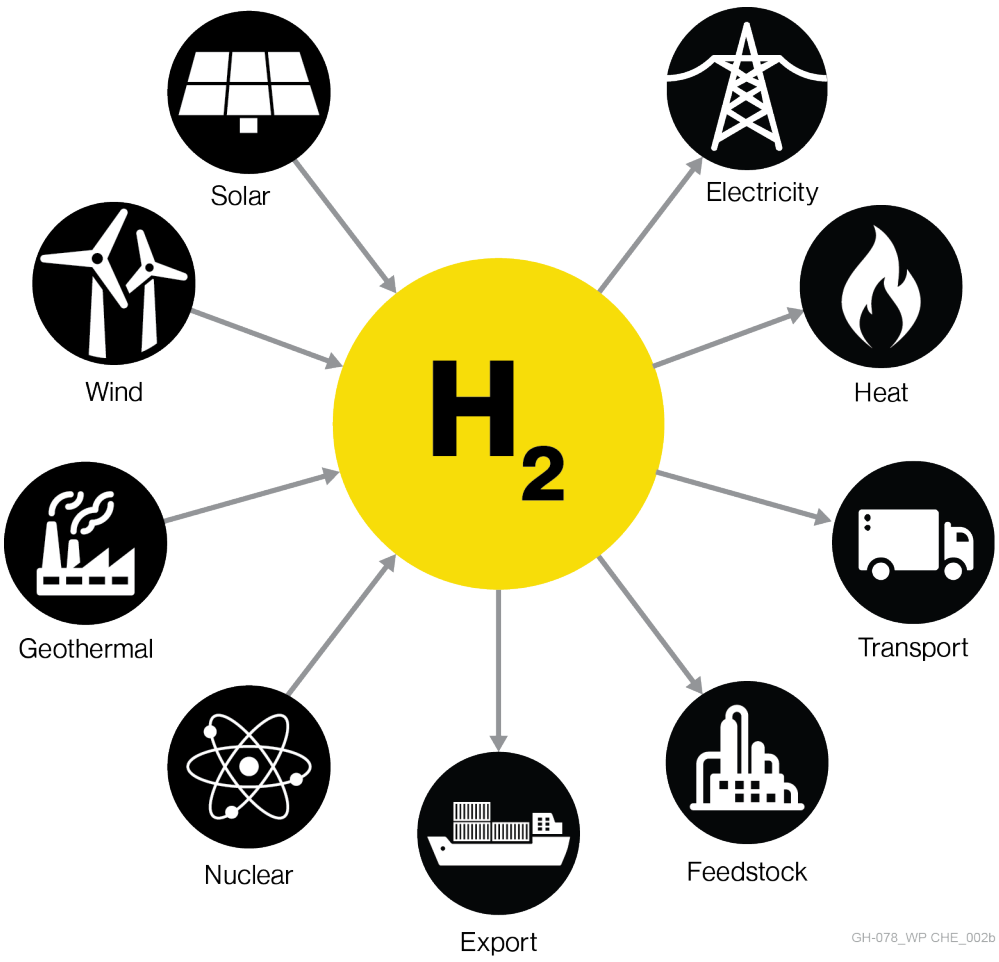

***Source:*** *Bloomberg New Energy Finance*

To date, one of the lower hanging fruit within this transition has been the decarbonization of the electricity sector. This has been made possible by a rapid decline in the cost of variable renewable energy (i.e. solar PV and wind energy) which is now the cheapest form of new build electricity generation in a number of states globally. However, although material, the electricity sector represents only one of a number of pieces in the decarbonization puzzle. Further, the rapidly increasing proportion of solar and wind in energy systems around the globe is also bringing with it a new set of electricity network reliability and stability challenges that need to be overcome.

## Enter hydrogen, **the most abundant element in the universe.**

Although energy is required to convert hydrogen to its useable gaseous state (typically via electrolysis of water), if done so using zero or low emissions electricity, the result is a clean and versatile energy carrier with no carbon emissions. It can be used across different applications resulting in achievable decarbonization in a number of sectors including electricity. As shown in the below, hydrogen is a single product that can be used for:

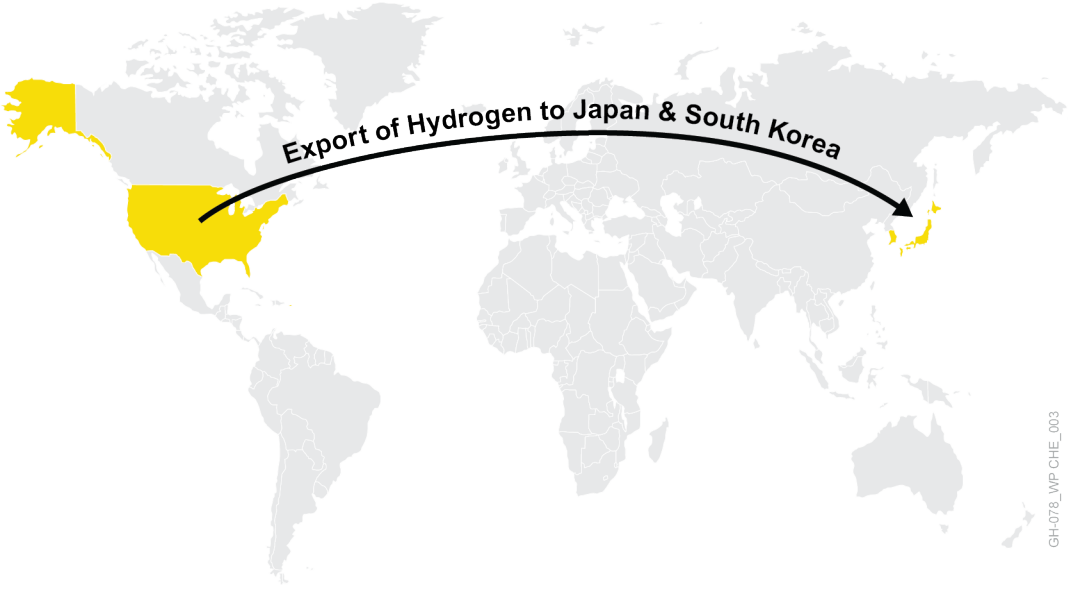
- **Transport:** Fuel cells to power passenger and heavy vehicles, materials handling, rail, shipping and potentially aviation
- **Heat:** Circulated in gas networks and combusted to produce heat
- **Industrial processing:** Feedstock for a number of chemicals such as ammonia and other higher order liquid fuels.
- **Energy storage/electricity generation:** Used as a method of longer term energy storage and electricity generation to overcome the reliability (or energy storage) challenges associated with increasing proportions of variable renewable energy.



While the popularity of hydrogen has fluctuated in recent decades, there are a confluence of factors that have distinguished renewed interest from what has been observed previously. Climate change policies in certain jurisdictions and the drop in cost of renewable energy (a material cost input for hydrogen production) have both contributed. However, more important is the fact that the hydrogen value chain is now underpinned by mature technologies. De-risking these technologies from a technical perspective has meant that the 'narrative has now shifted from R&D to market activation' (CSIRO National Hydrogen Roadmap, 2018), evidenced by the number of large multinational companies such as Shell, Siemens and Toyota investing in hydrogen activities to diversify their portfolios. Recent reports have suggested that the global market for hydrogen is expected to reach 155 billion by 2022 (International Energy Agency, 2017).

Hydrogen powered fuel cell electric vehicles (FCEVs) represent one of the more likely near term applications for hydrogen as the industry continues to scale. In many ways, this technology is complementary to battery electric vehicles (BEVs) and likely to be preferable for customers that typically drive longer distances and do not have readily available access to recharging infrastructure. One of the primary barriers to the uptake of FCEVs is the requirement for refueling infrastructure, similar to use of conventional gas stations. This challenge is being overcome in regions such as Germany and closer to home, California which now have approximately 60 and 40 stations respectively. This volume also illustrates the shift from new technology to the roll out of standardized equipment, also resulting in a significant decline in cost.

Increasing hydrogen related activity is also being demonstrated via government investment across the globe. In Asia for instance, governments in countries such as Japan and South Korea have proclaimed hydrogen to be a key part of their future energy mix, identifying key demand targets from 2025 onwards. Japan in particular has labelled the upcoming 2020 Olympics as the 'Hydrogen Games' and in many ways represents the world's pilot project for the integration of various hydrogen applications. Further, given these countries also lack the required natural resources to produce clean hydrogen at scale, they have signaled an intention to import hydrogen in the same way they do liquefied natural gas (LNG). This represents a new export opportunity for comparatively resource-rich countries, such as the United States.



An assessment of the current state of the global clean hydrogen industry reveals the roll out of a significant number of commercial demonstration projects (i.e. outside of the laboratory) where relatively high capital and operating expenditure means they are not yet bankable assets. There is therefore a crucial role for governments in continuing to attract private investment so that the industry can reach the required economies of scale to drive down costs. This may be via initiatives such as tax incentives, upfront grants and commitments to underwriting initial investment risks.

Guidehouse is a leading provider of management, technology, strategy and risk consulting services to the public and commercial markets. We help our clients navigate and solve their toughest challenges through the co-creation of scalable, innovative solutions to prepare them for future growth and success. As good global citizens, our diverse professional leaders in over 20 locations go beyond the expected, building trust in society through our quality work and the value provided to our clients and their organizations.

In the global economic shift to more low-carbon solutions, Guidehouse helps clients understand the options, evaluate risks, develop scalable strategies, and implement solutions tailored for their unique business and the markets they serve. We recognize the challenges, and also the opportunities that come with the development of new industries such as hydrogen. From analysis of macro and micro trends to the development of policy and regulatory frameworks, investment program development, public private partnerships and project financing, Guidehouse leads the future of business forward.

# About Guidehouse

Guidehouse is a leading provider of management, technology, and risk consulting services to the public and commercial markets. We help our clients solve their toughest challenges through the co-creation of scalable, innovative solutions to prepare them for future growth and success. Headquartered in Washington DC, the company has more than 1,800 professionals in over 20 locations. Guidehouse is a Veritas Capital portfolio company and led by seasoned professionals with proven and diverse expertise in traditional and emerging technologies, markets and agenda-setting issues driving national and global economies.

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