

Unveiling the hydrogen industry's evolution

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In an era marked by the pressing concerns of climate change and the need for energy security, the emergence of the green hydrogen industry is key to a sustainable future. Particularly in light of recent global events, notably in Europe, where the need for energy security has become increasingly pronounced, the emergence of the green hydrogen sector is poised to play a pivotal role in addressing these pressing challenges.

Over the past half-decade, the hydrogen industry has undergone a remarkable transformation, transcending its previous status as a niche technology to emerge as a mainstream energy solution. This transformation owes itself to a combination of factors, including significant technological breakthroughs, strategic collaborations, and a global shift towards decarbonisation and energy security. Notably, the utilisation of hydrogen has started to be explored across diverse sectors, including transportation, industry, and power generation. From once being confined to laboratory experimentation, hydrogen projects now manifest in oil refineries, steel production, energy storage, and various manufacturing processes worldwide. At the same time, governments worldwide have unveiled ambitious hydrogen strategies, underscoring a collective

commitment to harnessing its transformative potential.

If we looked at the transportation sector, hydrogen fuel cell vehicles have gained traction, offering zero-emission mobility without compromising on range or refuelling time. Companies like BMW, Toyota, Hyundai, and Honda have rolled out commercial hydrogen-powered vehicles, laying the groundwork for a hydrogen-fuelled transportation revolution.

Moreover, the industrial sector has embraced hydrogen as a key enabler of decarbonisation, particularly in sectors with hard-to-abate emissions such as steel and chemicals production. Pilot projects and demonstrations have showcased the feasibility of hydrogen as a clean alternative to fossil fuels in industrial processes, paving the way for large-scale deployment.

At Chart Industries, we've had the privilege of witnessing the dynamic growth of the hydrogen market, and we take pride in our significant role in this evolution. Our involvement in groundbreaking projects globally, including the world's first green steel project in Sweden, China's largest hydrogen refuelling station, Europe's largest green hydrogen production in the Netherlands, the world's first e-fuel plant in Chile and numerous hydrogen liquefaction plants in the US, has resulted in an exponential growth of our business, nearly nine times in less than three years. This robust expansion demonstrates the rapid expansion of the global hydrogen market and the promising opportunities the future holds for this industry.

However, amidst these successes, the hydrogen industry has encountered its fair share of

challenges. One of the primary obstacles has been the higher cost of green or low-carbon hydrogen production via electrolysis using renewable energy resources.

Furthermore, the lack of infrastructure presents a significant barrier to scaling up hydrogen deployment. The establishment of a robust hydrogen infrastructure, including production, storage, distribution, and refuelling stations, requires substantial investment and coordination among stakeholders. Without adequate infrastructure, the full potential of hydrogen cannot be realised, limiting its integration into existing energy systems.

Looking ahead, the hydrogen industry is at a pivotal stage, faced with opportunities and challenges. To achieve meaningful scale, addressing key hurdles is imperative.

First and foremost, achieving cost competitiveness is crucial. Expanding the landscape of wind and solar farms is essential to bringing down costs to a level that makes hydrogen projects financially viable. Additionally, lowering the cost of hydrogen production through technological innovation, economies of scale, and supportive policies is vital to driving widespread adoption. Investments in research and development in key areas such as hydrogen production, storage, compression, and liquefaction, along with targeted incentives and subsidies, can significantly

accelerate the transition towards cost-competitive hydrogen.

Additionally, building a robust infrastructure network is critical to unlocking hydrogen's full potential. Governments, industry players, and investors must collaborate to develop a comprehensive infrastructure roadmap, encompassing production facilities, transportation pipelines, storage facilities, and refuelling stations. Strategic investments in infrastructure will facilitate the seamless integration of hydrogen into existing energy systems, driving market growth and innovation.

Moreover, fostering international collaboration and standardisation efforts is vital to harmonising regulations, codes, and practices across borders. A cohesive global framework will promote interoperability and facilitate the cross-border trade of hydrogen, enabling countries to leverage each other's strengths and resources to accelerate the transition to a hydrogen-based economy.

The market developments over the past two years have instilled in us a strong sense of optimism regarding the future of the hydrogen industry. In particular, the introduction of various incentives and supportive schemes, such as the Inflation Reduction Act (IRA), the establishment of the European Hydrogen Bank, and initiatives like Headstart in Australia, among others worldwide, has attracted a greater

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number of players and increased investment. These measures have significantly enhanced the market's appeal across different regions globally. Moreover, we have observed a healthy competition emerging among different regions, whether in technology development, hydrogen production, or export capabilities. This competition undoubtedly enriches the market and accelerates progress in all of these areas, reinforcing our positive outlook for the future of the hydrogen industry.

The enthusiasm and momentum surrounding hydrogen are unparalleled, presenting a unique opportunity for countries, industries, companies, and individuals to capitalise on its potential. This exceptional opportunity allows us to – together – shape a new energy landscape and structure for the world. As we forge ahead, it's crucial that we continue to push the boundaries of innovation and collaboration within the hydrogen industry. Despite the challenges we may encounter, the future of hydrogen shines brighter than ever before. With unwavering commitment to overcoming obstacles and seizing opportunities, we stand on the cusp of a transformative era in energy. It is only through our collective efforts that we can fully harness the power of hydrogen and propel ourselves towards a cleaner, greener, and more sustainable future for generations to come. **H₂V**

