What's on the horizon for hydrogen?

By Jessica Obeid, Head of Energy Transitions, SRMG-Think

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Key Takeaways

- The hydrogen industry is rapidly evolving. However, only 5% of the planned low-carbon hydrogen projects have reached investment decisions. The market leaders of tomorrow will be those who can navigate the technical, financial, regulatory, and infrastructural challenges today.
- Gulf Cooperation Council (GCC) countries are among those seeking to strategically position themselves as leaders in low-carbon hydrogen production and trade. They possess several advantages that may give them an edge over competitors. Yet, navigating the infrastructure and export challenges will be crucial as they continue to implement their plans.
- GCC countries could leverage their positioning to develop green hydrogen's derivatives market for long-distance transport and to refurbish pipelines for short-distance transport. Investments in research and development are critical to scale electrolysers and carbon capture and storage (CCS). Robust certification processes are also needed to build an efficient hydrogen market.

As the global push for decarbonisation gathers momentum, hydrogen – a currently niche industry dominated by fossil-fuel-produced hydrogen for use in the refining and industrial sectors – is gaining attention as a future major energy carrier in a net-zero world.

Much of the excitement is centred on the potential of low-carbon hydrogen to fuel energy-intensive industries such as steel, cement, petrochemicals, and heavy transport. Together, these account for 30% of global greenhouse gas emissions and are difficult to decarbonise because the technology is either lacking or too expensive. Green[1] and blue hydrogen[2] are seen as promising solutions, expected to help reduce emissions by 20% by 2050.[i]

The hype around the hydrogen's potential is reflected in demand forecasts. By 2050 low-carbon hydrogen is expected to displace more than one third of current global oil demand.[ii] Global consumption is expected to reach 145 million metric tonnes by 2030 and up to 660 million by 2050, exceeding $1 trillion in value.[iii] This compares to 95 million metric tonnes overall in 2022, equal to just 2.5% the world's energy consumption.[vi]

The hydrogen industry is rapidly evolving as countries across the globe, seeking to capitalise on future demand, enact policies to incentivise implementing hydrogen projects. The US and EU are heavily subsidising the production of clean hydrogen, China is on a project and pipeline building streak, and the announced number of projects globally keeps growing.[v]

In MENA the outlook for the industry is already looking positive. The Middle East region is third globally in terms of hydrogen consumption (13%) after China (29%), and North America (17%); it ranks third after China and Europe in the concentration of planned low-carbon hydrogen projects.[vi] The Gulf is home to the world's largest green hydrogen project under construction: in Neom, Saudi Arabia. The project achieved financial closure in mid-2023 with a total investment value of $8.4 billion[vii] and is expected to start production in 2024. Saudi Arabia and other countries in the GCC are working to position themselves at the forefront of low-carbon hydrogen production and may possess significant advantages in financing and cost-reduction compared to Europe and North America.

Identifying Technological, Financial and Regulatory Barriers

For the countries with ambitions to become market leaders in hydrogen production, creating an environment conducive to scaling hydrogen projects is still a challenge. Only 5% of the planned low-carbon projects have reached investment decisions. The market leaders of tomorrow will be those who can navigate the technical, financial, regulatory, and infrastructural challenges today.

[1] Green hydrogen is created by splitting water is split into hydrogen and oxygen via an electrolyser using electricity generated by renewable sources.

[2] Blue hydrogen is extracted from natural gas through a chemical reaction using steam methane reforming (SMR). Carbon emissions are captured through carbon capture and storage.

[i] Barragan, Ricardo Roa, "White hydrogen can be a game-changer in Colombia's green transition. Here's why," January 16, 2024, World Economic Forum, accessed March 2024. https://www.weforum.org/agenda/2024/01/white-hydrogen-and-its-role-within-the-energy-transition/#:~:text=With%20an%20annual%20abatement%20potential,the%20global%20final%20energy%20demand.

[ii] Department for Business, Energy & Industrial Strategy, Hydrogen Analytical Index, August 2021. https://assets.publishing.service.gov.uk/media/611b34f9d3bf7f63a906871e/Hydrogen_Analytical_Annex.pdf.

[iii] Barragan, Ricardo Roa, "White hydrogen can be a game-changer …".

[v] International Energy Agency, Global Hydrogen Review 2023, IEA Website, accessed March 2024. International Energy Agency, Global Hydrogen Review 2023, IEA Website, accessed March 2024. https://iea.blob.core.windows.net/assets/ecdfc3bb-d212-4a4c-9ff7-6ce5b1e19cef/GlobalHydrogenReview2023.pdf..

[vi] International Energy Agency, Global Hydrogen Review 2023, IEA Website, accessed March 2024. nternational Energy Agency, Global Hydrogen Review 2023, IEA Website, accessed March 2024. https://iea.blob.core.windows.net/assets/ecdfc3bb-d212-4a4c-9ff7-6ce5b1e19cef/GlobalHydrogenReview2023.pdf

[vii] Neom, "Neom green hydrogen company completes financial close at a total investment value of $8.4 billion in the world's largest carbon-free green hydrogen plant," May 22, 2023, NEOM website, accessed March 2024. https://www.neom.com/en-us/newsroom/neom-green-hydrogen-investment.

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Innovation and Production

Scaling up production is a key challenge for, and focus of, innovators and industry players in low-carbon hydrogen. A key constraint is the scalability of interlinked technologies: 1) electrolysis and renewable energy in the case of green hydrogen, and 2) CCS technologies in the case of blue hydrogen production.

Increasing both the size and efficiency of electrolysers while reducing costs is a key barrier in green hydrogen production. The process is currently energy-intensive, and the amount of energy lost significant; meanwhile, capital costs exceed $1,000 per kilowatt (KW) and must fall to under $400 per KW to be competitive with fossil fuel technologies.

Installing sufficient renewable energy to power electrolysers is another technical challenge. A ramping up of renewable energy installations is needed but often constrained by large land requirements and lack of land availability, high inflation, high component costs, and lengthy licensing processes.

In the field of blue hydrogen, mass deployment of CCS remains challenging due to technical limitations, including inefficiency and cost.

Financial and Regulatory Complexities

To create more certainty in the emerging hydrogen market, it will be important to address the low development rate of the technology as well as the lack of standard regulations across the supply chain.

Without these elements, the market faces a set of financial complexities. The high capital investment costs – billions of dollars for large-scale hydrogen projects – coupled with high inflation driving up the costs of equipment, and low financing incentives, makes traditional lenders and financing institutions risk averse. In 2020 green hydrogen was expected to sell at $2.5 per kg by 2030; however, inflation and interest rates have seen this figure shoot to an estimated $5-6 per kg by 2030,[viii] particularly driven by the cost of renewables and electrolysers. The total investment gap in the global hydrogen market is expected to reach $460 billion by 2030.

Developing regulatory frameworks and standardising transport, storage, and safety requirements and certifications will be key to facilitating the market's development. The implementation of safety regulations is vital given that hydrogen is a highly flammable gas.

Infrastructure and Global Trade

Building the required infrastructure remains a major impediment to the development of the global hydrogen trade market. Production, storage, and transport needs are estimated at several trillion dollars.

At the root of the issue is the cost and complexity involved in storing and shipping hydrogen, which has a lower energy density by volume than fossil fuels. The most promising storage medium is compressed hydrogen in a gaseous state, which is difficult to transport. While technically and financially challenging, some natural gas pipelines can be retrofitted to transport the fuel over short distances. However, long-distance transportation requires liquefaction by cooling (to below -253 °C), a process that results in total energy losses of 30–40%. Storing hydrogen in liquid state at that temperature also requires special insulated cryogenic storage tanks, the cost of which are substantial.

Competitive Edge of GCC and Future Pathways in Hydrogen

The Arab Gulf countries are among those seeking to strategically position themselves as leaders in low-carbon hydrogen production and trade. A total of 10 out of the 14 planned or newly completed trade pilot projects for low-carbon hydrogen between 2020 and 2023 are located in the GCC countries, particularly Saudi Arabia.[3] The Kingdom, together with the UAE and Oman, lead the region in low-carbon hydrogen projects. They are home to 37 projects under development overall. A large number, 75%, are in green hydrogen. In total, 14% of the projects have already reached final investment decision, according to data from the IEA.

The Arab Gulf countries possess several advantages that may give them an edge over competitors going forwards, particularly in overcoming the technical and financial challenges of the market. Yet, navigating the infrastructure and export challenges will be crucial as they continue to implement their plans.

viii Neom, "Neom green hydrogen company completes financial close at a total investment value of $8.4 billion in the world's largest carbon-free green hydrogen plant," May 22, 2023, NEOM website, accessed March 2024.Data compiled by the author using International Energy Agency, Global Hydrogen Review 2023, IEA Website, accessed March 2024. https://iea.blob.core.windows.net/assets/ecdfc3bb-d212-4a4c-9ff7-6ce5b1e19cef/GlobalHydrogenReview2023.pdf

3 Data compiled by the author using International Energy Agency, Global Hydrogen Review 2023, IEA Website, accessed March 2024. https://iea.blob.core.windows.net/assets/ecdfc3bb-d212-4a4c-9ff7-6ce5b1e19cef/GlobalHydrogenReview2023.pdf

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Techno-Financial Advantage

The GCC countries benefit from financial robustness – although at different levels – enabling them to invest in capital-intensive technologies and infrastructure as well as in much-needed research and development. Saudi Arabia and the UAE are also well-positioned to tap into foreign debt issuance.

Additionally, the Gulf region boasts significant renewable energy resources, coupled with vast cheap land, and relatively speedy licensing and development processes compared to the US and EU countries. These factors, in addition to financial resources, have led to record-low renewable energy prices. Competitive prices are vital for powering electrolysers and producing cost-competitive green hydrogen.
Going forwards, these financial resources can be diverted into low-carbon technologies that can scale up hydrogen, such as renewable energy developments, electrolysers, and CCS.

Strategic Leverage

Beyond hydrogen production, a key asset of the GCC region is in optimising distribution
infrastructure and export, by exploring possible linkages with the existing ammonia trade market.

Despite the cost, re-purposing pipelines, when applicable, for transporting green hydrogen short distances is the path forward. For long distances, green ammonia, a hydrogen-derivate, could emerge as viable solution. Green ammonia can be liquefied at higher temperatures than hydrogen and thus potentially be transported across long distances at lower cost. Ammonia is already a globally traded commodity for industrial uses, mostly fertilisers. However, green ammonia is still at a nascent stage of technological development and therefore requires significant feasibility assessments and research and development resources.[7]

Additionally, the GCC countries are geographically well-positioned to meet the ambitious green hydrogen goals of the EU and some Asian markets, and to service routes for the trade of green ammonia. The development of the dedicated infrastructure would require, in addition to financing, establishing market regulations and safety standards. Building hydrogen hubs can also leverage the region's location to facilitate the distribution and storage of hydrogen across the region and to Europe and Asia. Hubs can optimise supply chain efficiency and reduce transport costs.

GCC countries are strategically positioned to become key players in the hydrogen market. They could leverage their positioning to develop green hydrogen's derivatives market for long-distance transport and refurbish pipelines for short-distance transport. Components such as electrolysers and CCS must be scaled, and their efficiency improved. All of this requires substantial investment in research and development, and in project deployment, requiring innovative financing mechanisms and government support. Finally, the harmonisation of international standards and the development of robust certification processes will be key to fostering an efficient global hydrogen market. If all these factors are met, the hydrogen economy will provide the same leverage for GCC countries as the hydrocarbon economy,[9] placing them in an advantageous position as the rest of world catches up.