

Hydrogen adds new shade

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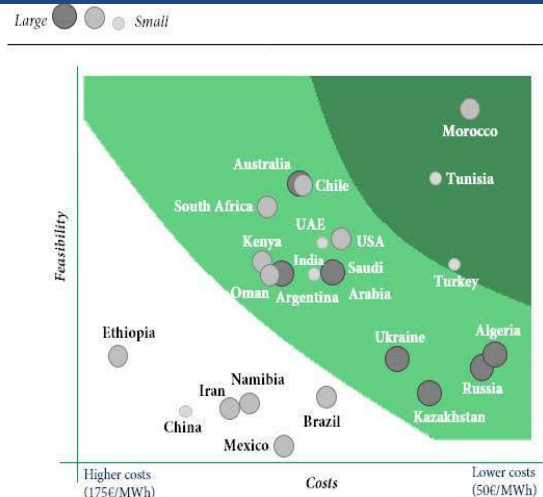
- We expect to see green hydrogen dominating the alternative energy market. It will be a key player in a successful energy transition for the MENA region.
- The GCC countries have the potential to be in pole position as future exporters of green hydrogen, while still possessing ample low-cost renewable energy for domestic consumption
- Short-term barriers include high costs, as well as production and transportation issues. Rapid technological advancement, however, means that production costs are expected to fall sharply in the long-term.

The green hydrogen rush

Clean hydrogen is becoming the poster child for decarbonisation globally, and the MENA region is rapidly increasing investments in the green hydrogen market. Given the quality of its renewable energy resources, it is well placed to lead the way.

- Hydrogen is widely used as a feedstock in various industrial settings, ranging from oil refineries to ammonia, methanol and steel production. Pure hydrogen is mostly produced using fossil fuels, including natural gas, oil and coal. It is therefore associated with the emission of carbon dioxide (CO₂).
 - Currently, 95% of global hydrogen production is grey hydrogen, which is produced via steam methane reforming (SMR) with natural gas as a feedstock, or through the gasification of coal.
 - According to IRENA, it is estimated that grey hydrogen will make up 6% of total final energy consumption by 2050.
 - Going even further, the Hydrogen Council expects hydrogen to supply 18% of global energy demand by the same year.
 - Based on IEA figures, the current pure hydrogen annual demand is about 70 Mt. Global demand for hydrogen in all forms is 120 Mt.
- As the world moves towards electrification through low/zero-carbon sources, demand for clean hydrogen is growing rapidly. This includes blue hydrogen, which is supplied from hydrocarbons with carbon capture utilisation and storage technology (trapping 90% of greenhouse gas emissions), and also green hydrogen, which is produced by electrolyzers supplied by renewable electricity.
 - In the short-to-medium term, blue hydrogen, the second-most-common form of clean hydrogen, will be a key source in the MENA region given the existing natural gas production infrastructure.
 - GCC countries are the largest and most cost-efficient producers of natural gas. Qatar, the third-largest global producer, leads the region with 25 TCM of natural gas reserves, followed by Saudi Arabia (6 TCM) and then the UAE (5.9 TCM).
 - Moreover, GCC producers have well-developed existing natural gas grids and significant CO₂ storage capacity. This is ideal for expanding the sector and

Figure 1 - Green hydrogen export potential by 2050¹



enables the transportation of hydrogen inland for domestic use.

- Moving forward, green hydrogen production in the MENA region may be more cost-competitive than it is in countries like Australia, China and the EU member states.
 - Currently, the green hydrogen sector in the MENA region is small. However, the region's reputation for embracing green technologies leads us to believe the market will expand rapidly.
 - The GCC is expected to drive the growth, primarily due to high-yield solar and wind resources that can generate power at a very low energy expense while integrating with lower-cost carbon-capture technologies. In short, this will allow the GCC to produce more for less.
 - Across the region, investment in renewable energy has seen a nine-fold increase in the past eight years. By 2025, investment in renewable energy is expected to reach USD 183B.
 - Around USD 150B is being invested in solar power over the next five years. An additional USD 28B has been directed towards wind, waste-to-energy, hydroelectric and geothermal power plants.
- For context, green hydrogen demand globally is forecast to reach about 530 Mt by 2050, up from 40 Kt in 2019. France (26%), Germany (24%) and Japan (23%) currently lead the green hydrogen sector globally.
 - By 2025, hydrogen production could replace around 10.4B barrels of oil, which is equivalent to 37% of pre-COVID-19 global oil production. It is expected to meet 25% of the world's energy needs by 2050. This underscores the crucial role of green hydrogen in the global energy transition.
 - In the EU, the hydrogen strategy published in July 2020 set a green hydrogen target for 40 GW of electrolyzers to be installed throughout the bloc by 2030, with another 40 GW of capacity imported from international producers, mainly in North Africa.
- However, countries face key challenges in scaling up green hydrogen production to a level that can fuel economies. One particular hurdle is the cost of producing high levels of clean hydrogen, an area in which the MENA region has a clear advantage.

¹ Qamar Energy.

GCC: Building a sustainable market

Over the past two years, there has been growing interest in both the supply and demand of green hydrogen, with the GCC leading the decarbonised edge.

- Green hydrogen will allow hydrocarbon producers to continue utilising their resources in environmentally friendly ways. We therefore expect the GCC to become competitive suppliers globally as they widen their export markets.
- Saudi Arabia is already leading the sector regionally and is competing to become the global green hydrogen powerhouse.
 - Saudi Arabia's ACWA Power is building a USD 5B green hydrogen plant in the new mega-city Neom as part of a joint venture with US chemical company Air Products & Chemicals.
 - The plant is set to open in 2025 and is expected to reduce the cost of green hydrogen to below USD 2 per kg by 2026 from the current USD 15.
 - When completed, the facility will use 4 GW of solar and wind power to produce 650 tons of green hydrogen per day. This would be enough to run a total of 20,000 hydrogen-fuelled buses.
 - Production will not only be used domestically. Saudi Arabia plans to export hydrogen overseas as ammonia at an annual capacity of 1.2 Mt.
 - Due to these production levels, the kingdom has the potential to lead the green hydrogen export market, which is estimated to be worth USD 300B yearly by 2050.
- In the UAE, the Abu Dhabi Hydrogen Alliance was formed in January 2021 to accelerate the country's adoption and use of green hydrogen in sectors such as utilities, mobility and industry.
 - In a related deal, the Abu Dhabi Future Energy Company, also known as Masdar, announced an agreement with Siemens Energy to develop a facility to make green hydrogen at Masdar City in Abu Dhabi.
 - The first phase focuses on the production of green hydrogen for passenger cars and buses in Masdar City. In parallel, a kerosene synthesis plant will be built to convert most of the green hydrogen into sustainable aviation fuel.
 - The production of decarbonised fuels will also be used for the maritime sector as part of the second phase of the programme.
 - Siemens Energy, alongside the Dubai Electricity and Water Authority (DEWA) and Dubai Expo 2020, are already building the UAE's first 1 GW solar-based hydrogen electrolysis facility at the Mohammed bin Rashid Al Maktoum Solar Park in Dubai.
- Oman is also showing an interest in green hydrogen and has announced its HyPort green hydrogen project.
 - In March 2020, the Belgian firm Dredging, Environmental and Marine Engineering (DEME) announced the development of a 500 MW green hydrogen plant in the port of Duqm, as well as its intention to export to international markets.
 - A feasibility study is currently underway, with the final investment decision regarding the scale of the project expected to be finalised by the end of this year.
- As the region develops a green hydrogen strategy going forward, GCC countries are presented with the challenge

Figure 2 - CO₂ Emissions per Hydrogen Technology²

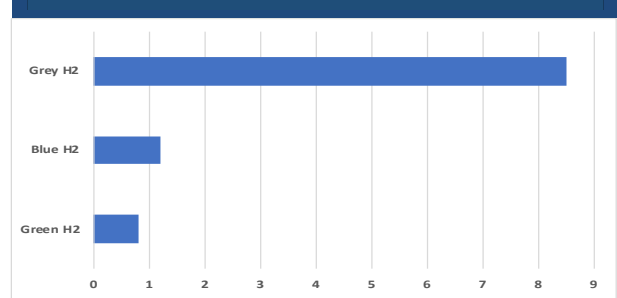
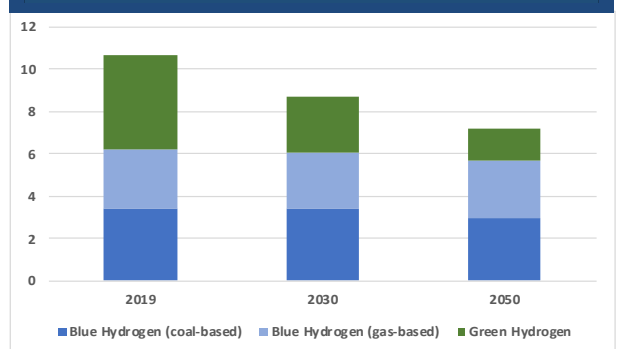


Figure 3 - Global Cost of Hydrogen Process (USD/Kg)³



of scaling their green energy capacity and becoming global hydrogen suppliers.

- The biggest challenge is the absence of a developed local market. A short-term roll-out will therefore be highly dependent on securing contracts in export markets.
- The lack of a dedicated infrastructure for green hydrogen in the MENA region is another downside risk.
 - Hydrogen, to date, has been produced close to where it is used, with limited dedicated transport infrastructure.
 - Currently, there are only about 5,000 km of hydrogen transmission pipelines, compared with more than 3M km for natural gas.
 - While synthetic fuels made from green hydrogen could possibly use the existing hydrogen infrastructure, expansion is crucial for long-term sustainability.
 - Extensive pilot and demonstration projects for full implementation are also needed to gain experience with associated technical, economic and regulatory variables.
 - Once the domestic green hydrogen sector is fully operational, technological advancements and economies of scale will help reduce production costs even further. This is a key determinant to unlock global export opportunities.
- Green hydrogen exports will initially be in the form of industrial and energy-intensive intermediate products.
 - In time, we believe that the GCC will shift focus to direct energy exports. Once the right markets are established, governments will be able to build export terminals and infrastructure for shipping and pipeline channels.
- We also expect GCC governments to create supportive regulatory and investment frameworks to deepen sector activity and to encourage investments, while also accelerating diversification plans.

² Arabia Monitor; ICIS.

³ Arabia Monitor; BloombergNEF.

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