THE FUTURE OF HYDROGEN

Part 2: Hydrogen in the Middle East

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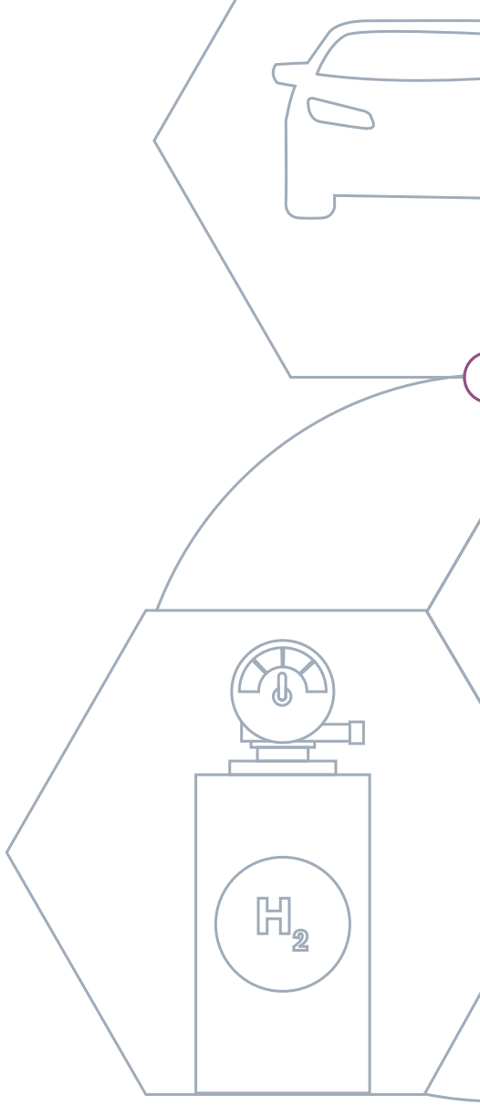
HYDROGEN IN THE MIDDLE EAST

INTERNATIONAL ENGAGEMENT WITH HYDROGEN IS ALREADY UNDERWAY WITH MORE THAN 200 LARGE SCALE PROJECTS AT VARIOUS POINTS OF THE HYDROGEN VALUE CHAIN ANNOUNCED GLOBALLY, AND A TOTAL INVESTMENT PIPELINE OF MORE THAN $300 BILLION.[1]

IN PART 1 WE PROVIDED AN INTRODUCTION TO HYDROGEN, A SUMMARY OF ITS KEY USES AND DISCUSS SOME OF THE BURGEONING OPPORTUNITIES. IN THIS PART 2 WE DISCUSS THE FUTURE OF HYDROGEN IN THE MIDDLE EAST AND REGIONAL OPPORTUNITIES, AND WHY THIS REGION IS PARTICULARLY WELL PLACED TO BE A NET EXPORTER OF HYDROGEN.

As outlined in the first article of this series, Introduction to Hydrogen, Hydrogen has transformative potential as a sustainable and renewable fuel, and has a broad range of chemical and industrial purposes. The Hydrogen Council[2] estimates that hydrogen will supply 18% of the world's energy demand by 2050.[3]

Whilst there is a growing interest in hydrogen globally, the Middle East has some unique advantages that could allow it to become a global leader in hydrogen. There is also an incentive to reduce the reliance on fossil fuels, on which the Middle East is famously somewhat reliant. Investment in green and blue hydrogen could be crucial to the Middle East transitioning to a more sustainable economy and energy market, especially in sectors such as transport and heavy manufacturing which cannot easily be powered through wind and solar. Whilst there are major challenges to overcome, the Middle East may be in an ideal position to capitalise on the increased global focus on green hydrogen, and in the same way that the Middle East became a global leader in oil and gas, could leverage upon the existing supply chains and expertise to become a leader in hydrogen.



[1] Ciel Jolley & Evelyne, 2021, Time to Accelerate the >$300 Billion Hydrogen Pipeline, Hydrogen Council Website, viewed February 2021, https://hydrogencouncil.com/en/time-to-accelerate-the-300-billion-hydrogen-project-pipeline/

[2] The Hydrogen Council is a global CEO-led initiative of leading companies with a united vision and long term ambition for hydrogen to foster clean energy.

[3] Pierre-Etienne Franc, 2019, Seizing the Opportunities of Hydrogen, Hydrogen Council Website, viewed February 2021, https://hydrogencouncil.com/en/seizing-the-opportunities-of-hydrogen/

OPPORTUNITIES

The Middle East is in position to be a significant net exporter of green hydrogen. Many Middle East countries (Saudi Arabia, Qatar, Kuwait) have abundant and low cost land, existing technical power expertise, an active international investment environment, and ideal renewable generation conditions (long hot days and windy nights). Consequently, green hydrogen could be competitively produced for export.

Some states, like the UAE, already possess a diverse energy sector and can produce comparatively cheap renewable energy, which remains the biggest barrier to green hydrogen. The Al Dhafra PV tender in 2019, for example, yielded the world's lowest PV bid at US$ 1.35-ct/kWh and technological improvements and economies of scale should see costs reduced further. For instance, capital costs of electrolysers are expected to decrease from $640/kW to below $200/kW.[4] Other regions in the world may struggle to achieve the right economics for sustainable green hydrogen projects where renewable generation costs are prohibitive.

While renewables projects continue to grow in number in the Middle East, before jumping straight to becoming a green hydrogen producer, many jurisdictions in the Middle East may look to blue hydrogen as an ideal bridging technology. Blue hydrogen is a type of hydrogen produced from natural gas through a process called steam reforming, and so it is not produced through the use of renewables (as with green).

Producing blue hydrogen would complement many natural advantages and features of the Middle East. Namely, substantial and low cost natural gas supplies, existing industrial gas facilities and extensive gas grids suitable for adaption. In the short term blue hydrogen could be scaled up quickly whilst in demand, prior to the longer-term implementation of green hydrogen.

New technology is being explored, like Technip FMC's Deep Purple system, an offshore facility utilising wind turbines, with excess available power transferred into green hydrogen through electrolysis. Hydrogen is stored under the sea bed at pressure and either piped to shore for sale or re-electrified during periods of low wind to maintain balanced generation.[5] Re-electrification of hydrogen is important for a balanced and sustainable electricity market, as it mitigates the inherent intermittency of renewable output as you can re-electrify at night or at grid low-points. That being said, throughout much of the year in the Middle East, high points of energy use actually correlates with maximum solar output (due to air conditioning usage) so less storage might be needed compared to in cold weather regions, however, it remains a useful facet of hydrogen and one which could support exports.

[4] United Arab Emirates Ministry of Energy & Infrastructure, 2021, The Role of Hydrogen for the Energy Transition in the UAE and Germany, page 13

[5] Energy Transition, Deep Purple™, TechnipFMC, viewed February 2021, https://www.technipfmc.com/en/what-we-do/subsea/energy-transition-deep-purple/

CHALLENGES

Access to these promising markets though, will prove a major challenge. Shipping is the current chief method of export but is only currently viable for small amounts. While shipping terminals incur lower initial capital costs than pipelines, conversion losses are up to 6% in "boil off" during liquefaction.[16] Derivatives such as ammonia are more suitable for shipping due to lower volatility and, when converted alongside hydrogen production the high energy costs of the process can be reduced. For greater distances shipping (often as ammonia) will remain the preferred method.

A major pipeline from the Gulf to Europe could save substantial transit losses if volumes of trade are sufficiently large, but none exist and construction would require massive investment and negotiating a route through politically difficult terrain. Pipelines to India or the modification of existing gas pipelines from North Africa or Iraq to Europe are alternative options. Existing gas pipelines can run with a low blended ratio of hydrogen, but for large scale transportation either substantial retrofitting or dedicated pure hydrogen pipelines would be needed. Given the massive capital costs and small existing volumes, investors would need to be secure about the amount of trade that would follow.

The production of green hydrogen by electrolysis currently requires that the water used as feedstock is of drinkable levels of purity. Moreover, electrolyser efficiency generally stands at 60-81% and requires around 9 litres of water to produce 1 kgH2[17]. This is a major barrier in a region which dominates the World Resources Institute's highest baseline water stress band. All top ten nations ranked by this water stress metric in 2019 were in the MENA region[18]. Production is therefore limited by the price of desalination or imported fresh water, unless the electrolysis of saltwater is proven to be commercially viable. At present this is still an area of research and development. This said, the price of water accounts for only a small portion of generation costs.[19]

Overall, the sheer scale of required investment is daunting. PWC has estimated that $2.1 trillion will be needed to meet global green hydrogen demand by 2050, including $1 trillion invested in renewable energy capacity. In the Middle East large capital cost infrastructure like multi-Mw scale electrolysers would need to be rolled out quickly at some speed. Even though CCS and modified gas infrastructure are less costly options, they will still require very significant capital investment and installation.

[16] United Arab Emirates Ministry of Energy & Infrastructure, 2021, The Role of Hydrogen for the Energy Transition in the UAE and Germany, page 19

[17] Qamar Energy, 2020, Hydrogen in the GCC (a report for the regional business development team gulf region), page 8

[18] Rutger Willem Hofste, Paul Reig and Leah Schleifer, 2019, 17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress, World Resources Institute, viewed February 2021, https://www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress

[19] Qamar Energy, 2020, Hydrogen in the GCC (a report for the regional business development team gulf region), page 9

POTENTIAL MARKETS FOR EXPORTED MIDDLE EAST HYDROGEN

As mentioned above, the Middle East is in position to be a significant net exporter of green hydrogen. In this section we look at some of the potential markets for export from the Middle East.

Europe could be a market of particular significance, the European block has both high energy usage and ambitious commitments in pivoting towards cleaner fuels. In their 2020 Hydrogen Strategy the European Commission described green hydrogen as "the missing part of the puzzle to a fully decarbonised economy"[6], and have indicated that hydrogen is to become a key pillar of the European Green Deal[7]. A raft of hydrogen specific legislation is expected in 2021 which will inform the potential for trade, and as we understand it sustainability incentives and certificates of origin may also be introduced. In some European countries, infrastructure development has already begun with a group of 11 gas companies announcing plans for a 6,800 km hydrogen pipeline network by 2030, rising to 23,000 km by 2040[8].

The German Government's hydrogen strategy foresees a hydrogen demand of 90 TWh to 110 TWh in 2030[9] and their Covid-19 stimulus package sets aside $10 billion for hydrogen expansion, both of domestic production and import relationships.[10] The Federal Government has made €100 million per year 2019-2022 available for pilot projects, leaving the country technologically and financially well positioned to invest. Germany imported 72% of their primary energy in 2019 and while some of increased demand will be covered by domestic production, they will remain a major energy importer.[11]

Although Russia has traditionally held a dominant position as oil supplier to the market, in 2018 providing 29.8% of crude oil to the EU, with the second and third suppliers being Iraq at 8.7% and Saudi Arabia at 7.4%[12], many MENA nations have arguably far more potential as hydrogen suppliers (as discussed in previous sections).

Japan could be a further target market; the country remains the largest importer of Saudi oil. The country has received blue hydrogen from Saudi Aramco and are operating the world's first dedicated liquid hydrogen carrier, the 8,000-tonne "Hydrogen Frontier". Japan is purchasing blue ammonia for a price of $400-500/tonne, compared to grey ammonia at $200-399/tonne[13]. These favourable prices may well continue, Japan is aiming to develop a commercial hydrogen supply by 2030 in order to meet its sustainability goals.[14]

While the impact of the Biden administration's nascent sustainability policy on trade with the Middle East is unclear, they have identified hydrogen as a point of focus including a recent pledge of $100m in funding.[15] Despite this, transportation costs and domestic energy supplies in the US mean that the Middle East may be better situated to cater to large emerging energy markets, such as India.

[6] Jim Robbins, 2020, The new fuel to come from Saudi Arabia, BBC, viewed February 2021,

[7] The Oxford Institute for Energy Studies, 2021, The Heralds of Hydrogen: The economic sectors that are driving the hydrogen economy in Europe, page 1

[8] Qamar Energy, 2020, Hydrogen in the GCC (a report for the regional business development team gulf region), page 3

[9] United Arab Emirates Ministry of Energy & Infrastructure, 2021, The Role of Hydrogen for the Energy Transition in the UAE and Germany, page 7

[10] Reuters Staff, 2020, Germany earmarks $10 billion for hydrogen expansion, Reuters, viewed February 2021, https://www.reuters.com/article/us-health-coronavirus-germany-stimulus-idUSKBN23B10L

[11] United Arab Emirates Ministry of Energy & Infrastructure, 2021, The Role of Hydrogen for the Energy Transition in the UAE and Germany, page 17

[12] 2020, From where do we import energy and how dependant are we?, eurostat, viewed February 2021, https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-2c.html

[13] Qamar Energy, 2020, Hydrogen in the GCC (a report for the regional business development team gulf region), page 16

[14] Robin Harding, 2019, Japan launches first liquid hydrogen carrier ship, Financial Times, viewed February 2021, https://www.ft.com/content/8ae16d5e-1bd4-11ea-97df-cc63de1d73f4

[15] Molly Burgess, 2021, Biden-Harris Administration targeting low-cost hydrogen production, Hydrogen View, viewed February 2021, https://www.h2-view.com/story/biden-harris-administration-targeting-low-cost-hydrogen-production/

MIDDLE EAST CASE STUDIES

UAE - In a collaboration with Siemens Middle East, Dubai Electricity and Water Authority are constructing a 10,000 square green hydrogen facility. Solar will be used to generate green hydrogen for industrial purposes, re-electrification and to power a range of vehicles. The electrolyser which Siemens' will be trialling at this pilot plant can produce 20kg of hydrogen per hour, so 240kg of gas per operating cycle per unit.[20]

SAUDI ARABIA – As part of the design of the concept city Neom, in Saudi Arabia, which is intended to be home to a million people, the US gas and petrochemicals company Air Products & Chemicals have been building what is claimed to be the world's largest green hydrogen facility as part of a $5 billion deal with ACWA Power. It will be powered by 4 gigawatts of wind and solar power facilities in the surrounding desert.[21] The facility will use ThyssenKrupp's electrolyser which can produce 650 tonnes of hydrogen per day. This will provide power in Neom but will also be converted into ammonia using an air separator for which Air Products will be the sole offtaker and global distributor.[22]

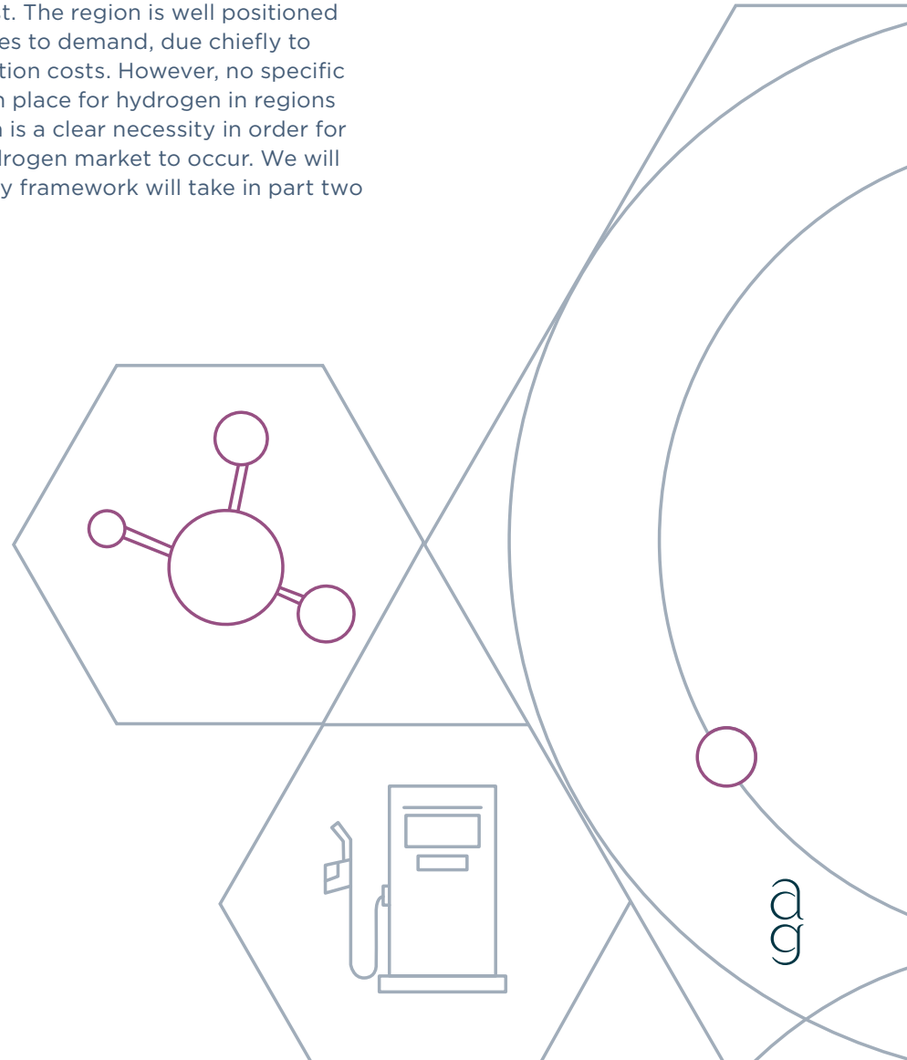
[20] Garvin Gibbon, 2020, Green hydrogen to be 'the new oil' in the next 20 years, says Siemens Middle East, Arabian Business Industries, viewed February 2021, https://www.arabianbusiness.com/energy/438001-green-hydrogen-to-be-the-new-oil-in-the-next-20-years-says-siemens-middle-east-chief-manuel-kuehn

[21] Jim Robbins, 2020, The new fuel to come from Saudi Arabia, BBC, viewed February 2021, https://www.bbc.com/future/article/20201112-the-green-hydrogen-revolution-in-renewable-energy

[22] Qamar Energy, 2020, Hydrogen in the GCC (a report for the regional business development team gulf region), page 17

CONCLUSION

Hydrogen has cross-cutting potential with application to the majority of energy intensive sectors and is capable of being rolled out at significant scale in the Middle East. The region is well positioned to capitalise on projected increases to demand, due chiefly to substantial advantages in production costs. However, no specific policy or regulatory structure is in place for hydrogen in regions like the Gulf. Altering this position is a clear necessity in order for investment into a full-fledged hydrogen market to occur. We will consider what form this regulatory framework will take in part two of this article.



FURTHER INFORMATION

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