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Hydrogen—Recent Developments in Hydrogen Projects

Hydrogen Series – Part 2

SUMMARY

As we noted in Part 1 of this two-part series, hydrogen presents opportunities for decarbonisation across a wide range of sectors with high greenhouse gas emissions, including transportation, power generation, buildings and industrial processes. However, this potential has not previously resulted in the widespread adoption of hydrogen technologies. Recently, the climate change challenge has given rise to supportive high-level governmental policies which, coupled with the declining cost of renewable energy and technological advances, have increased the potential for a more rapid development of a hydrogen economy.

In this Part 2, we look at the key market players and the industries in which investment opportunities are likely to arise. We also consider what government support might be necessary to facilitate the investment needed to achieve the targets embedded in the high-level government policies.

A. KEY MARKET PLAYERS

The breadth of potential applications of hydrogen is matched by the range of potential market players. The membership of the Hydrogen Council, a private-sector initiative launched in 2017, illustrates the growing global interest in hydrogen and wide number of market participants, including international oil and gas majors, car, truck and airplane manufacturers, industrials, utilities, mining and construction firms, as well as banks and investors. The key aims of the Hydrogen Council are to (1) accelerate significant investment in the development and commercialization of the hydrogen and fuel cell sectors and (2) encourage key stakeholders to increase their backing of hydrogen as part of the future energy mix.

Individual companies across different sectors are increasingly focused on incorporating hydrogen into their long-term strategies, and the market has seen a range of joint venture (JV) collaborations across

industries, such as Equinor and Ansaldo Energia's recent project to validate a hydrogen gas turbine combuster.

B. EXISTING AND POTENTIAL INVESTMENTS ACROSS INDUSTRIES

Examples of existing or potential hydrogen applications and collaborations across different industries include:

1. Power Generation

The use of hydrogen in power generation is still at a relatively early stage. Off-grid and back-up electricity generation are some of the most promising potential applications for hydrogen fuel cells. Given that deployment of traditional centralised grids in remote or rural areas may be expensive and practically difficult, hydrogen may provide a "clean" alternative to diesel generation with more limited logistical constraints, particularly in emerging economies. Additionally, hydrogen fuel cells are increasingly being used as an alternative to rechargeable batteries and generators as backup power supply, including in telecommunications systems and data processing centres. Production of electricity through stacking fuel cells has been pioneered in Hwasung City, South Korea in a fuel-cell park built by FuelCell Energy (a U.S. supplier of stationary fuel cells) for POSCO Energy, an independent Korean power producer, producing 59 MW in total. For larger scale generation, turbine manufacturers Mitsubishi and Ansaldo are currently developing hydrogen-powered turbines, and Siemens has committed to ensuring that its gas turbines are able to run 100% on hydrogen by 2030.

2. Transportation

Major car manufacturers (including Toyota, Hyundai and Honda) have begun to develop fuel cell electric vehicles (FCEVs), which are electric propulsion vehicles powered by hydrogen using a fuel cell. Toyota has announced plans to increase production of its Mirai fuel-cell car from 3,000 to 30,000 for the 2021 model year. Manufacturers such as Nikola, Toyota and Kenworth are also currently developing heavy-duty fuel cell trucks, and this segment is likely to grow as refueling station infrastructure develops. In the mining sector, Anglo American plc announced an agreement with ENGIE in 2019 to develop and fuel the world's largest hydrogen-powered mine haul truck. In 2019, Toyota and Eni announced a collaboration to expand hydrogen refueling infrastructure in Italy. Additionally, there have been early-stage investments and demonstration projects for hydrogen fuel cell buses in various countries.

Hydrogen-powered aircraft have been successfully flown in the past, and the use of hydrogen technologies for aviation has a longer history than other transportation applications. Hydrogen fuel cell-powered unmanned aerial vehicles (UAVs) have been commercialised and are used by both civilian and military operators. However, a range of challenges limit the development of hydrogen applications in commercial flights, including safety concerns, on-board storage and the need for dedicated infrastructure at airports. The aviation industry has a long cycle and widespread replacement of existing fleets is not expected over the next decade.

Hydrogen fuel cells might also represent an opportunity to reduce the significant emissions profile of the international shipping sector and achieve the ambitious decarbonisation goals set by the

International Maritime Organisation. Current applications are mostly limited to recreational craft, ferries or smaller passenger ships and will need to be scaled up and optimized to compete with alternatives such as LNG. The world's first hydrogen-powered vessel, Oceanwing, completed its initial voyage between European ports in 2019. This ship produces hydrogen from sea water through an onboard desalination unit and a solar-powered electrolyser.

3. Ammonia

Ammonia's potential to facilitate efficient and cost-effective storage and distribution of renewable energy as a hydrogen carrier has been recognised in particular. Global fertiliser manufacturer Yara intends to develop a pilot project in Western Australia with Engie to produce ammonia using photovoltaic solar power and electrolysis rather than fossil fuels. It is expected to be financed by Yara and Engie, but has also received approximately AUS $1M in government funding from the Australian Renewable Energy Agency (AREA) to conduct the feasibility study. Once completed, the plant would have an anticipated solar capacity of 100 MW and approximately 66 MW electrolysis, and it would be the largest hydrogen-to-ammonia plant globally.

In July 2020, Air Products & Chemicals and ACWA Power announced plans to construct in Saudi Arabia the largest green hydrogen plant to date using 4 GW of wind and solar energy. This project would cost an estimated USD $5 billion to construct, producing 650 tonnes of green hydrogen on completion which will be shipped as ammonia to international markets before conversion back into hydrogen.

4. Other sectors

A number of major steelmakers have focused research and development efforts on reducing their greenhouse gas emissions through hydrogen use, primarily through the replacement of coking coal with hydrogen. For example, steel maker SSAB, iron ore producer LKAB and utility Vattenfall recently announced plans to build a full-scale demonstration plant in Sweden that uses green hydrogen instead of coking coal feedstock.

The heating sector is another area with significant potential for hydrogen applications, and market participants have explored different approaches including mixing hydrogen with natural gas (or substituting it entirely) to heat residential and commercial buildings. One of the largest prospective developments is H21 North of England, which seeks to adapt urban gas infrastructure for resupply using hydrogen. Key stakeholders, including Northern Gas Networks, Equinor and Cadent, propose to convert 3.7 million UK homes and businesses from natural gas to hydrogen, commencing in 2028. The project would require approximately GBP £22.7 billion of financing and would involve a 125-GW capacity hydrogen transmission system and 12.15-GW natural gas-based hydrogen production.

C. ADDITIONAL GOVERNMENT SUPPORT NEEDED

While the EU and many national hydrogen strategies announced thus far have ambitious goals, they will need to be consistently implemented in the coming years through appropriations and legislative and regulatory policymaking. Significant government support in addition to that already announced will likely

be needed to accelerate the development of a global blue and green hydrogen market to a meaningful degree. Additional government support for hydrogen might be provided in the following forms:

- *Government-funded research and development to improve efficiencies and demonstrate reliability.* Funding for hydrogen-related technology research and pilot projects has increased significantly over the last five years, particularly in Europe and Asia. The EU is expected to implement an ambitious hydrogen research programme through its "Horizon Europe" initiative and a "European Partnership" dedicated to hydrogen research with the objective of addressing "market failure for first-movers."
- *Public-Private-Partnerships (PPPs) and other government support to de-risk investments.* PPPs involving public and private investors, infrastructure developers and vehicle manufacturers are likely to be an important driver for the development of the necessary infrastructure to make FCEVs viable. There are existing examples of these projects, including H2Mobility Germany, the Scandinavia Hydrogen Highway Partnership and the California Fuel Cell Partnership. Other financial support mechanisms that have been promoted as part of various government hydrogen strategies include tax incentives, government guarantees, preferential long-term loans, equity-loan hybrids or refinancing schemes for first-movers. Developers of hydrogen refueling stations and other infrastructure may benefit from government payment guarantees linked to utilization rates, to account for market ramp-up periods.
- *Public procurement and fleet regulation.* Governments could increase demand for hydrogen through public procurement of vehicles, such as hydrogen buses or government fleets or the procurement of green or blue hydrogen electricity or heating. On the regulatory side, fleet regulation (e.g. preferred licenses for taxis) could also stimulate demand. These support mechanisms have been used in different cities and countries to promote FCEVs and the corresponding recharging infrastructure. Such initiatives could reduce the barriers to entry for first-mover companies and assist efforts to scale by vehicle manufacturers and infrastructure developers.

Enhancements to climate policies such as emission trading schemes or carbon taxes could also have the indirect effect of assisting the development of blue and green hydrogen markets.

D. INVESTMENT STRUCTURES AND FINANCING

As illustrated by the innovative and often vertically integrated JV partnerships highlighted above, and others recently announced, the varied nature of the hydrogen market will yield novel investment structures for hydrogen projects. Collaboration allows JV participants to share risks and costs of development of new technologies and incentivises innovation across the value chain, which will be essential for a successful transition to hydrogen technologies. As demonstrated in the LNG sector, projects may benefit by involving offtakers in such JV structures. However, the evolving legislative framework in which such partnerships operate and the concentration of risk and cost in integrated projects—likely compounded by the need to analyse and allocate the unique technology, offtake and market risks involved—means that careful planning of joint venture terms by corporate players and their counsel will be essential.

Counsel experienced in structuring projects in challenging environments, drawing on past experience from other first-of-kind projects and technologies, including renewables and the LNG markets, can add value in the structuring of hydrogen projects. The key issues that will need to be considered include the following:

Multiple Project Risk. Many new hydrogen projects will be one part of developments across the hydrogen value chain. For example, a hydrogen production facility might require the construction of a

renewables project to provide the electricity for the process, a new pipeline or other transportation infrastructure and, potentially, end user facilities. Developers and financiers will need all elements of the infrastructure to be completed and operating in order for hydrogen projects to be successful. Multiple project risk is by no means unique to hydrogen projects but the risks will be heightened as a result of innovation being required across the value chain.

Market Risk. In the absence of a liquid market for hydrogen and taking into account the limited number of end users, long-term offtake arrangements, potentially with captive users, with fixed pricing structures and limited scope for price adjustments should be expected for early projects. Early green hydrogen projects that feed into a grid are likely to require feed-in tariffs, favourable tax treatment or other price support (together with certainty that such treatment will extend for a minimum period) in order to be economically viable and to allow developers to receive a return on their investment.

Technology Risk. The use of new or scaled up technologies carries with it a number of risks, including potential cost, performance and reliability issues. In the early stages, market players may not yet be comfortable with these risks, and there will need to be an education process as well as consideration regarding appropriate risk allocation and sharing.

Regulatory. As we have discussed in these articles, a helpful regulatory regime and incentives are likely to be critical for the development of the nascent hydrogen market. Levels of government support and willingness to provide incentives is a fast evolving area. There should be room for early market entrants and their counsel to help shape the relevant regimes, taking advantage of the current governmental focus on developing the industry. Additionally, examples of helpful support from local communities (including investments) have already been observed.

As seen with other emerging technologies and markets over the years, including renewables and LNG, we expect initial investments to be done on the balance sheets of large players and/or to require a significant element of government support through favorable tax policy, tariffs or concessional lending.

In the medium term, “green” investors and financiers may be eager supporters of hydrogen projects, in particular when projects can be aligned with their ESG and responsible investment strategies. As the hydrogen market grows and matures, and lenders and investors become more comfortable with the technology and other hydrogen-specific issues, the available sources of financing are likely to expand. The European Investment Bank in particular is expected to play a major role in financing the initial build out of the EU hydrogen market.

Counsel with experience in balancing different investment objectives and multi-source financings can facilitate the successful development of bankable structures for hydrogen projects. As with LNG and renewables, it will take creativity, a sound understanding of the risks and their mitigation strategies and resilience from dealmakers and their counsel to get the pioneer deals closed and financed. Hydrogen fuel cells and hydrogen products such as ammonia could be used in a range of different forms of transportation. In the case of shipping, hydrogen is currently being developed for on-board power supply, engine start-up and ship propulsion. Fuel cell-operated trains (an example of which is already

running on a commuter line in Germany) offer a pollutant-free alternative to diesel or electric locomotives powered by expensive overhead lines or conductor rails.

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