HYDROGEN – A CATALYST FOR THE ENERGY TRANSITION

AS THE ASIA-PACIFIC ENERGY SECTOR SEEKS TO REDUCE AND ULTIMATELY HAVE NET ZERO CARBON EMISSIONS, THIS ARTICLE EXPLORES THE ROLE THAT HYDROGEN MAY PLAY IN THE REGION'S ENERGY TRANSITION, SOME POTENTIAL CHALLENGES TO HYDROGEN'S DEPLOYMENT ON AN INDUSTRIAL SCALE, AND ASSOCIATED RISKS THAT WILL HAVE TO BE ADDRESSED IN ORDER TO MEET BANKABILITY REQUIREMENTS. BY **JAMES ORME**, PARTNER SINGAPORE, **ALED DAVIES**, PARTNER TOKYO, AND **JAMES MURRAY**, PARTNER SINGAPORE, **MILBANK**.

The Paris Agreement – an international treaty on climate change – sets a key objective for signatory countries to reduce greenhouse gas emissions and limit increases in global temperature in this century to 2 degrees Celsius above pre-industrial levels. In a 2018 special report, the Intergovernmental Panel on Climate Change went further and recommended that countries must bring carbon dioxide emissions to net zero by 2050 to keep global warming to within 1.5°C of pre-industrial levels. Key to achieving these targets is what is commonly referred to as energy transition – the switch from a fossil fuel-based energy system with high carbon emissions to a carbon neutral system.

However, the path to decarbonisation is not without challenges. While renewable energy sources such as wind, hydro and solar are forming an increasingly significant part of the energy mix, it is far from a stand-alone solution as certain inherent features of renewable technologies, such as higher capital costs, geographic constraints (and the energy loss and infrastructure costs in transmission), transmission grid limits and unstable or time constrained output, will likely prevent them from entirely displacing fossil fuel energy, at least in the foreseeable future. The inherent shortcomings of traditional renewable energy sources have forced the energy supply industry (in addition to maintaining fossil fuels within the energy mix to balance supply needs) to consider solutions for, among other things, storing surplus energy, long-distance transportation of energy and alternative fuel to decarbonise hard-to-abate emission heavy sectors.

Hydrogen has the potential to help address some of these problems. In January 2017, the Hydrogen Council succinctly summarised the benefits of hydrogen, saying: "Hydrogen is a versatile, clean, and safe energy carrier that can be used as fuel for power or in industry as feedstock. It can be produced from (renewable) electricity and from carbon-abated fossil fuels. It produces zero emissions at point of use. It can be stored and transported at high energy density in liquid or gaseous form. It can be combusted or used in fuel cells to generate heat and electricity."1 Though hydrogen only represents a small share of the energy market today, many developers, financiers, governments and other market participants are betting that hydrogen could become a key part of the energy transition.

The Asia-Pacific market has embraced the potential of hydrogen, with countries such as Australia, China, India, Japan, Singapore and South Korea heavily backing it. With increasing frequency, nations, states and corporations in the region have been announcing hydrogen initiatives. South Korea was an early mover, with President Moon Jae-in unveiling a country-wide hydrogen blueprint in 2019 and declaring "now that the hydrogen economy has begun to emerge, it is important to take the lead in the global market. The hydrogen economy roadmap is a blueprint for leaping to become a world leader".2

More recently, the Singapore government was quoted on July 7 2021 as saying: "A key strategy for Singapore in our transition to a low-carbon future is the adoption of low-carbon technologies, such as hydrogen."3 and the Prime Minister of India, Narendra Modi, announced on August 15 2021: "We have to make India a global hub for green hydrogen production and export."

This momentum has resulted in some market commentators predicting that hydrogen could supply up to 25% of the world's energy, and become a US$10 trillion market, by 2050.4 In the much nearer term, Fitch Solutions have commented that substantial growth opportunities abound for green hydrogen in Asia-Pacific, with Asia's hydrogen electrolyser capacity alone projected to reach up to 10GW over this coming decade.

It is clear that there is an ideological and political impetus for establishing hydrogen as a key component of the energy mix as part of the movement towards a carbon neutral environment. But there remain various challenges to overcome to make such ambition a reality.

What is hydrogen

In the context of the energy sector, hydrogen is a product that can be utilised as an energy carrier, a fuel for power and a feedstock for industrial products such as ammonia and plastics. It is produced by various methods and it is the underlying manufacturing process of the hydrogen product that gives rise to the different types of hydrogen – commonly associated with specific colours. The main types or colours of hydrogen products are brown, grey, blue and green.

Green hydrogen is considered the "green" standard for the energy transition and achieving a net zero carbon energy economy. However, the costs of producing it are currently considered to be two to three times more expensive than blue hydrogen.5 The simple economics of this is the main reason why around 95% of the hydrogen produced globally currently comes from brown or grey sources.6

The likely key for hydrogen to play a meaningful role in the energy transition in Asia-Pacific (and, indeed, globally) is for it to be deployed in one or more of these areas:

- *Energy storage* – Hydrogen can be converted to, and from, electricity and can be stored for long periods as either a gas in high-pressure tanks or a liquid under cryogenic temperatures. By storing hydrogen in this way, the use of hydrogen can be ramped up and down to match the output of existing non base-load energy sources. At least initially, storing and utilising hydrogen in a local country manner is likely to be the most practical and economically viable usage of hydrogen before long-distance and/or cross-border storage for hydrogen becomes available at scale.
- *Power* – It is possible to use hydrogen in gas turbines – either in addition to, or in substitute for, natural gas – to generate electricity. In some Asia-Pacific countries – including Australia, China, Japan and South Korea – there are plans, and indeed, some regulatory mandates, to mix hydrogen in low concentration with natural gas to be used in existing pipeline networks. More modern gas turbines are already able to accept fuel blends that include up to 50% hydrogen and some turbine manufacturers are aiming to deliver turbines in the near future that could run entirely on hydrogen.
- *Industrial feedstock* – Hydrogen is required in many industries as a feedstock for industrial processes. In these industries, its use is defined by its chemical characteristics, rather than its ability to provide energy. Some examples of hydrogen being used as a feedstock include ammonia plants, petrochemical and petroleum refineries and metal processing plants. Among the multiple industrial products, ammonia as a clean fuel that does not require high-pressure or cryogenic storage is gaining favour in the global shipping industry. International shipping and logistic companies are reportedly collaborating with local utilities to develop green ammonia supply chains with large-scale ammonia plants aiming to sell their offtake to industrial users in other jurisdictions.
- *Transportation* – Transport vehicles – aircraft, trains, vessels, buses and automobiles – are currently among the biggest contributors to emissions. Hydrogen fuel cell electric vehicles (FCEVs) reduce air pollution since they have zero tailpipe emissions and can be carbon emission-free. For personal cars, hydrogen is complementary to other alternatives, such as electric vehicles and advanced biofuels. The use of hydrogen as a fuel may help decarbonisation efforts in this area in a way that battery technology or electrification have only had limited success so far. Hydrogen buses and vehicles are becoming an increasing feature of the traffic flow in a number of locations (such as Tokyo).

Hydrogen and project finance

As momentum continues to grow around hydrogen, investors in the development and deployment of hydrogen will be presented with a range of financing options, across both the debt and equity markets. Indeed, there are already a number of hydrogen related corporate finance, project finance and capital market financings that have been announced in recent months.

While every transaction has its unique challenges to resolve and work through, it does seem like there will be financial solutions that can be tailored accordingly for each step in the hydrogen value chain. Upstream production of hydrogen is likely to be conducive to project financing, midstream pipelines and energy storage assets are likely candidates for bonds and infrastructure fund financings, and the downstream end-use of hydrogen – either as an industrial feedstock or in the power or transportation space – may have the greatest range of options, depending on the applicable investor's approach to financing.

Although there is and will increasingly be significant potential liquidity in the bank market for hydrogen project financings, banks will need to make hard-headed decisions on how to allocate scarce capital and management time as they are presented with an increasingly diverse array of energy transition projects. It's reasonable to expect that they will tend to focus their efforts on projects where they see a pipeline of follow-on deals – for example green steel, where the expectation is that once the first project financing is closed a strong pipeline will follow, or green ammonia.

In order for any financing to be successful though, risks will need to be identified, mitigated and allocated to the participant best suited to manage it. Some key risks that will need to be thought through include:

- *Change in law, policy or regulatory risk* – The regulatory framework for hydrogen is the subject of extensive discussion and development. Governments in Asia-Pacific are having varying degrees of success in translating that into support mechanisms for the development of hydrogen projects – from soft road map commitments to develop hydrogen to firmer legislative commitments. Those countries that can establish such supportive policies are likely to help make hydrogen more competitive more quickly, at least in their own jurisdiction.

It will be necessary to show developers a clear path to obtaining permits and approvals as and when required for a hydrogen project. This is a key concern in Asia-Pacific, where myriad international borders and laws will need to be navigated, made more complicated if the use of hydrogen is contemplated outside the state or country where it is produced. Greater policy clarity will also be important to help increase confidence that future changes in law will not materially increase the cost of producing or using hydrogen, weaken demand for hydrogen or impact on the feasibility of delivering infrastructure for carbon capture or hydrogen transportation facilities.

Once such governmental support arrangements are in place, careful thought will also need to be given to how such incentives and arrangements work and for how long. Project lenders are likely to focus on the duration of incentives and any political or regulatory uncertainty around renewals or incentive conditions. Similarly, if the incentives are primarily aimed at equity sponsors or are in the form of cost savings for a project, it may be that lenders will want to benefit indirectly in such measures too.

For governments, policy incentives need to be pitched in a manner that will incentivise users to switch to low carbon hydrogen. While there is already a market for hydrogen as an industrial feedstock (particularly in the chemical sector and for ammonia plants), in order for hydrogen to reach its full potential as a low carbon fuel, incentives and government subsidies will likely need to be larger (and more impactful) to help reduce the cost of building out green hydrogen plants and developing pipeline and storage infrastructure so that early hydrogen projects are not captive to just local or a limited number of end-users. As such market demand is created though, investors and financiers should expect such government subsidies to be reduced as they will have fulfilled their purpose.

- *Technology risk* – The technology necessary to support in particular green hydrogen and blue hydrogen is either still under development or not entirely commercially viable. The developing nature of hydrogen technology creates bespoke issues that will need to be carefully examined from both a construction and operations perspective too, including issues around cost overruns, construction completion and adequate operational arrangements. It is likely that plant manufacturers/contractors will be required to provide extended ongoing warranties and technical support arrangements. This is not so dissimilar to the experience of the last decade with new wind or battery facilities being installed. Similarly, producing and processing hydrogen and oxygen creates process safety risks that make the experience and track record of an operator a key point of significance.

To the extent that the technology and equipment being used is well established, proven, and reliable, these construction and operational costs will be reduced, which ultimately makes a particular project more attractive to both debt and equity investors alike. By analogy, the initial project financings of LNG plants in the mid-1990s came at a time when there had been a number of sponsor-financed plants in operation around the world for 15–20 years and to that extent the technology was proven and so more acceptable to the bank market. As such, in the near term, it might be that there is a mix of sponsors assuming the technology risk underpinning a hydrogen project by way of equity support or, alternatively, hydrogen is introduced as part of an existing power plant or industry feedstock on a larger scale to help demonstrate that the technology is more widely used and accepted.

- *The colour of the hydrogen* – The method by which hydrogen is processed will likely be a factor in determining its bankability and the type of liquidity that can be accessed. Green finance is a very in-vogue term. This likely translates into an expectation that green hydrogen projects will be favoured by, or attract better terms from, investors compared with blue, brown or grey hydrogen projects. That is not to say that blue and grey (and maybe even brown) hydrogen projects would not be bankable but rather the relevant stakeholders will need to demonstrate how any emitted carbon will be minimised or offset, either in the form of carbon capture technology or the purchase of renewable certificates to the extent that the market continues to evolve and be available to stakeholders in Asia-Pacific. The steel making industry is an obvious candidate to benefit from this as almost all steel is produced using iron oxide and "met" coal and so is a sector to which green finance has not historically been available. That could all change though if "met" coal can be replaced with electricity from renewable energy or a hydrogen source, as some major mining companies in the region have announced they are trying to do.
- *Price risk* – A fundamental point that will need to be addressed is ensuring that the achievable market price of a unit of hydrogen exceeds its production costs by an acceptable margin. Very simply, if it is not economic to produce hydrogen, it will be extremely challenging to attract the necessary debt and equity investment.

As discussed above, it may be that there needs to be some level of government support in order to help mitigate the price risk associated with "first mover" projects and developing larger-scale hydrogen facilities that are not in a captive cluster or are not supplied to industrial end-users on a contracted basis. As hydrogen capacity becomes more prevalent, and network and storage facilities become more accessible, the cost of producing hydrogen is likely going to decrease, thus potentially creating a "first-mover disadvantage" for participants locking unto expensive long-term capital investments.

Paradoxically, these early movers are crucial in helping to achieve scale and a more viable global hydrogen market.

Some potential pricing structures that Milbank is aware of as having been considered include, with respect to each unit of hydrogen that can be produced, establishing a fixed price, a fixed premium or a variable premium that a government or government affiliated offtaker may be willing to pay. Dealing with each in turn:

i) A fixed premium could be paid for every unit of hydrogen produced, with the price reflecting expected costs of production. Examples of such arrangements include feed-in tariffs, which have been used in the renewable energy space. Such arrangements would require governmental bodies to facilitate a market and pay producers a fixed price, rather than producers having flexibility to sell hydrogen direct to offtakers at the price that they negotiate. Feed-in tariffs have in the past been very successful in helping to meet renewable energy demand in Vietnam and Taiwan.

ii) A fixed premium could be paid for every unit of hydrogen sold in addition to whatever price the producer is able to achieve contractually with its offtaker. The size of the premium could be calculated by reference to production costs or the cost of producing other carbon-heavy fuels.

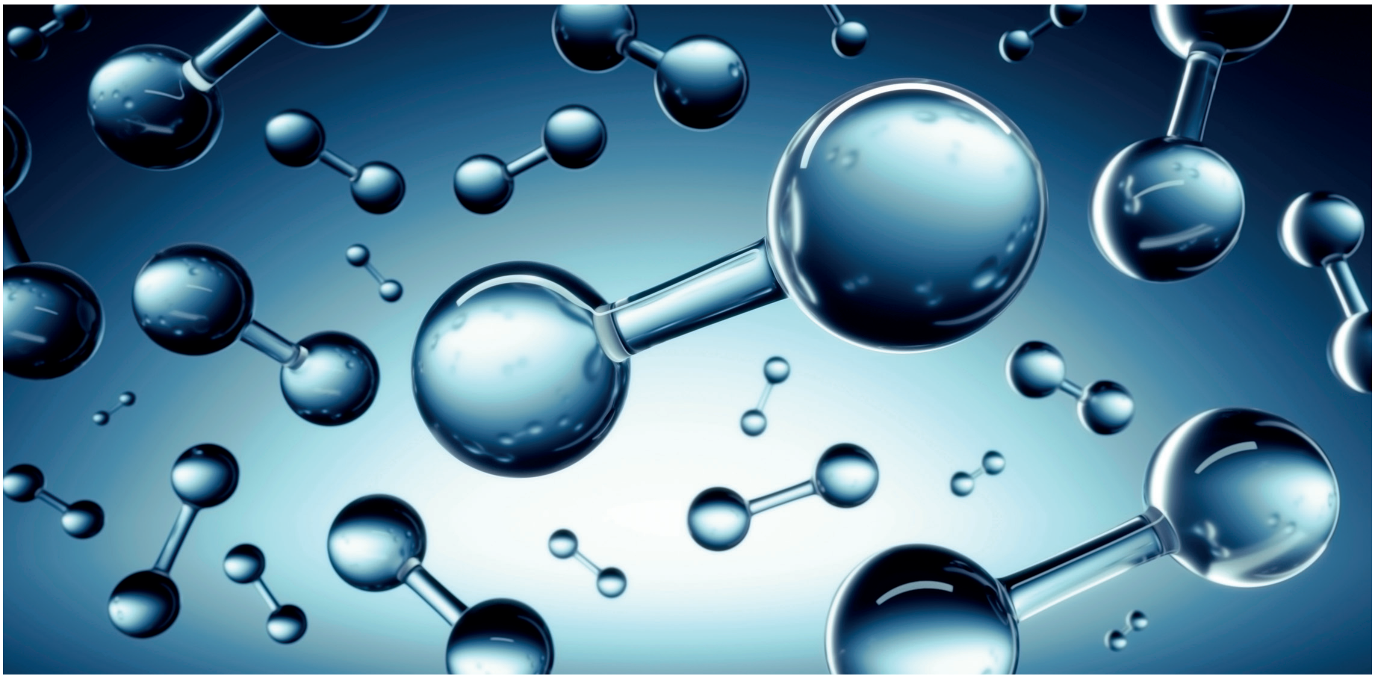
iii) A premium could be paid to the hydrogen producer based on the difference between a strike price and a reference price for each unit of hydrogen sold. The strike price would reflect the overall cost to the producer in producing the hydrogen, eg fixed and variable costs, financing costs and a return on equity. The reference price would in theory represent the then-current "market price" for the unit of hydrogen and the payment to the producer would be the difference between the reference price over the strike price.

There are multiple and quite different ways of establishing the reference price – for example, looking at natural gas prices, input energy prices, market benchmark prices, carbon prices, achieved sales prices and various others. The UK Government has issued a consultation paper7 on this point with a view to establishing a reference price that might best equate to the market value of hydrogen. For initial hydrogen projects, a mechanism deploying the highest of two proxies – a natural gas price and achieved hydrogen sales price – might be best suited before an integrated market benchmark price can be established for the reference price. An example of this type of pricing structure would be what is commonly referred to as a "contract-for-difference".

Until one or more of these pricing models becomes prevalent though, the price of hydrogen will likely continue to be negotiated on a contract-by-contract basis with it being a key issue for a producer and an offtaker to agree upfront before a hydrogen project is constructed and financed.

- *Demand risk* – According to the International Energy Agency, global demand for hydrogen in 2018 was approximately 73.9m tons. The vast majority of this was for consumption in refineries and ammonia plants. In order to generate investment that supports the development of hydrogen projects on a large scale, it will be critical that there is a clear assurance as to the demand risk. In industrial sector projects this can be achieved, as is the case currently, through a robust volume or "take-or-pay" or equivalent contract with the ultimate industrial user that assures a minimum volume of hydrogen can be produced and purchased.

However, it is less clear that demand risk can be appropriately mitigated for all potential uses of hydrogen – for example, in the transportation sector, the solution may vary depending on where the project sits on the spectrum. In the context of vehicles, there will be uncertainty as to the number of consumers, the level of demand, the build-out of service stations and the like that suggest



an intermediate would need to play the role of assuming market risk; whereas in the context of vessels, trains or buses there may be a private or public sector participants that can provide assurances as to volume throughput to the hydrogen producer.

As the scale of the hydrogen market grows, factors that could otherwise impact demand should be reduced, such as the availability of hydrogen distribution and storage infrastructure, the ability to blend hydrogen into the existing gas grid, as well as a deeper pool of end-users.

• *Potential offtake structures* – The structure of hydrogen sale/offtake agreements remains to be fully developed and it may be that hybrid arrangements will need to be adopted with features borrowed from both classic IPP arrangements in Asia and some elements taken from oil and gas structures.

To the extent hydrogen is sold direct to an industrial end-user, one potential contract structure would be for a producer to be paid based on its availability, as is often seen in the Asia power sector. Alternatively, to the extent the proposed offtaker for the hydrogen projects is a government (or government affiliated offtaker) the contract might be structured for a fixed volume or minimum contracted "take-or-pay" offtake obligations sufficient to support certain pre-agreed debt service cover ratios.

Similarly, if governments are keen to stimulate demand in their home country (at least initially), other structures that might be helpful to mitigate demand risk would be for a government to agree an offtake "back-stop" to address a scenario where certain volumes are not sold or for a government offtake front-stop, whereby a government has an obligation to lift certain hydrogen volumes coupled with an obligation on the hydrogen producer to re-sell such volumes before selling any other volumes. The back-stop or the front-stop could be sized by reference to the costs incurred by the developer of the hydrogen project.

A possible alternative to a sale and purchase agreement for hydrogen would be a tolling model seen in LNG and petrochemical projects. A tolling customer could supply the inputs required to produce the hydrogen, rather than this being the responsibility of the hydrogen plant owner. Such a structure would shift certain risks to the tolling customer but could still be attractive to the customer as the overall cost might be lower than building their own hydrogen facility. To the extent a tolling customer owns (directly or indirectly) a stake in a hydrogen project, that may help align interests and reduce overall financing needs for the hydrogen project.

• *Hydrogen transportation risk* – At least initially, the transportation risks associated with hydrogen may be somewhat mitigated by point-to-point projects, with the early hydrogen projects coupled with one or two end-users. The concept of "industrial clusters" is a feature in some countries where a hydrogen producer is located in the same area as the industrial end-user and so is able to take advantage of existing pipeline and storage infrastructure located in that area. As scale is increased though, a network of new pipelines and large-scale storage facilities will surely be required and so it will become important to secure transportation (and, potentially, storage) arrangements so that capacity is available when it is required.

Hydrogen producers will, ultimately, face different hydrogen distribution and storage infrastructure costs depending on the location and specificities of their projects and this will need to be considered when calculating the overall cost for the hydrogen being produced. In the longer term though, it may be hoped that the hydrogen market will start to look like that of natural gas, where non-integrated, third-party actors provide distribution and storage services to a liquid developed market.

What's next

While there are challenges for the hydrogen sector to overcome, it is clear that with a collaborative approach to market and technology development and continued government and investor support, hydrogen is on its path to become commercially viable on a large-scale. In the near future, it is likely that some of the first hydrogen projects that come "on-line" will be in heavily industrialised countries where there are large steel, mining or refining needs (such as China or Japan), most likely in the form of blue hydrogen or from renewable energy-rich countries (such as Australia). In the medium to longer term though, green hydrogen is as likely as anything else to be a key contributor in helping the Asia-Pacific transition to a net zero carbon economy.

With fossil fuel energy still taking up a relatively large percentage in the energy mix of countries in the Asia-Pacific region, there remains substantial room for growth for clean energy, and hydrogen in particular. Thanks to the increasing government commitments and public support for the hydrogen industry in countries such as Australia, China, India, Japan, Singapore and South Korea, hydrogen offers the potential to be a game changer for the region in the years to come. ■

Footnotes

1 - See: https://hydrogencouncil.com/wp-content/uploads/2017/06/Hydrogen-Council-Vision-Document.pdf

2 - Article headed "President Moon unveils new energy roadmap for 'hydrogen economy'". NNA Business News dated 18 January 2019.

3 - Speech by Tan See Leng at Chile and Singapore Low-Carbon Hydrogen Webinar on July 7 2021.

4 - See: https://www.goldmansachs.com/insights/pages/gs-research/green-hydrogen/report.pdf

5 - See: https://www.irena.org/newsroom/pressreleases/2020/Dec/Making-Green-Hydrogen-a-Cost-Competitive-Climate-Solution

6 - See: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Green_hydrogen_policy_2020.pdf

7 - See Department for Business, Energy & Industrial Strategy consultation paper issued in August 2021 named "Low Carbon Hydrogen Business Model: consultation on a business model for low carbon hydrogen".