Hydrogen

LOW CARBON SERIES

FINANCING

The Hydrogen Economy

JULY 2020

MUFG Bank Ltd
A member of MUFG, a global financial group

Contents

Introduction

Amidst a backdrop of a rapidly increasing focus on the impact of climate change from governments, regulators, investors and the general public, the move to a sustainable net-zero economy has moved to the top of the agenda for both politicians and industry. Good progress has been made in decarbonising power generation, however there has been limited success in reducing emissions from the heating, transport and industrial sectors. Although electrification (using low carbon technologies) was expected to provide substantial carbon reduction in these sectors, it is increasingly clear that to meet net-zero targets molecules as well as electrons will need to be decarbonised. As a result, industry and financiers must start embracing new and disruptive technologies to support the transition to a net zero economy.

Moving to a net-zero economy will require a fundamental change to our energy systems and hydrogen has been feted as the key technological solution which could provide a carbon-free source of energy across sectors. However moving from an exciting idea to large scale deployment of the level required, in the timescale required will require the support not just of government and industry but also of commercial financing. This report examines the potential applications of hydrogen as an energy source and the economic models which would support commercial bank financing.

Hydrogen Production

Hydrogen can be produced using a number of methods which are typically identified using the following colours.

	Production Methods
Green	Produced using electrolysis to split hydrogen from the oxygen in water. Electrolysis must be powered by renewables for this to be considered 'green'.
Blue	Hydrogen can be extracted from natural gas using methods such as steam methane reformation (SMR). The waste CO_2 is dealt with using carbon capture storage technology (CCS), meaning the overall process does not release CO_2 into the atmosphere.
Brown	A variation of blue hydrogen is brown hydrogen. The differentiation comes in the primary inputs as hydrogen is stripped out of more carbon dense fossil fuels such as lignite coal. Coal gasification coupled with CCUS is one example.
Grey	Hydrogen is derived from hydrocarbons via the same methods as blue or brown hydrogen, but without the use of CCS. No measures are taken to prevent carbon dioxide being released directly into the atmosphere.

Today, 96% of all hydrogen production is classified as grey, with most of the grey hydrogen produced used for the manufacture of ammonia, for use in oil refineries and other industrial processes. If hydrogen is to support the transition to, and play a key part in, the net zero carbon economy, the production and use of grey hydrogen must be phased out and replaced with hydrogen from more sustainable production methods. Although the natural end point in a zero carbon economy is to transition fully to use of green hydrogen, to drive the transition away from grey hydrogen and support the roll-out of hydrogen as a key energy source, making use of blue (or even brown) hydrogen during a transition period will be required to roll out the relevant infrastructure at sufficient scale.

Applications for Hydrogen in a net-zero economy

Power

Efforts to decarbonise the power generation sector have enjoyed by far the most success to date, with CO^2 emissions in the UK reducing by 68% between 1990 and 2018[1], and this advanced state lends electricity generation well to being the sector where hydrogen has the most bankable applications in the near-term. Small scale tests have already been carried out to test the production of green hydrogen from offshore wind, with Orsted's Gigastack demonstration in Denmark and at the Hornsea 2 project in the UK receiving government funding. The production of hydrogen from renewables has the potential to be an interesting solution to the subsidy-free environment emerging in Europe, providing an alternative additional revenue stream to corporate or utility PPAs. With an active global market for hydrogen already in existence, commercial banks could view long-term hydrogen sales contracts with investment grade counterparties akin to long-term power purchase agreements, providing a stable revenue stream based upon which financing can be raised. To-date however, the cost of producing green hydrogen from renewables is estimated at between EUR 3.5-5.0 per kg compared to EUR 1.5 per kg for grey hydrogen. Whilst there may be appetite from some existing hydrogen buyers to 'buy green', ultimately price is key and until the price of green hydrogen is comparable with the market price for hydrogen it remains a challenge for banks to consider long-term contracts for green hydrogen as viable. Government support for the roll out of green hydrogen production will be key in reducing the costs of production with the IEA stating that the cost of producing hydrogen from renewable electricity could fall 30% by 2030 as a result of declining costs of renewables and as hydrogen production is scaled up, the falling cost of electrolyser technology.

[1] *Committee on Climate Change (2019), "Reducing UK emissions. 2019 Progress Report to Parliament"*

Increased demand for hydrogen from other sectors, as we discuss below, may also support a wider increase in the cost of hydrogen as demand increases.

The production of green hydrogen also has the potential to play an important role in stabilising energy supply as the roll-out of renewables continues and the challenges of managing the intermittency of renewables increases.

Hydrogen as an energy store can be used not only to meet intraday peaks in electricity demand but can also be stored long-term to manage seasonal peaks in demand and the seasonal differences in renewables production with solar power production higher in the summer and wind generation higher in the winter . This is a key advantage for hydrogen over batteries which can store energy shorter term and can support the wider transition to renewables. However, whilst a valuable addition to the energy mix, there is currently no framework to monetise this energy storage, a similar challenge as is currently faced by battery storage projects in Europe. To raise financing against large scale energy storage projects, investors and banks would need to see a contracted revenue stream for energy released from storage rather than being reliant on the market price for power.

Hydrogen, in the form of ammonia, can also be transported globally to meet energy demand. The applications of this are potentially significant. Australia has recently announced plans for The H2U project in Queensland, which will utilise existing LNG production and export infrastructure to produce and export green hydrogen and ammonia at scale. Proposed offshore wind hubs in the North Sea which are not connected to a grid at all but rather produce hydrogen for export to multiple countries demonstrate the potential scale of application however such solutions could not currently be competitive with grey hydrogen and in the future would need to be developed in tandem with the increase in demand for hydrogen from other sectors transitioning to use hydrogen as a fuel source.

In the near to mid-term, blue hydrogen has an important role to play in the transition to a net-zero economy. Whilst Europe has successfully developed renewables at scale, there has been limited success in developing a solution to low-carbon baseload power generation. Combining natural gas-fired power stations with steam methane reformation to produce hydrogen, which could be sold, and carbon dioxide, which could then be stored using carbon capture and storage technology, offers a relatively quick route to decarbonising baseload power generation. The challenge for investors is making the investment case stack-up. Development of new-build CCGT's in Europe has stalled since the mid-2000s as the economics and uncertainty of revenues did not support investment. However the consultation by the UK Government in 2019 indicated support for CCUS may become available, potentially in the form of a Contract for Difference or Regulated Asset Base model. This combined with a potential revenue stream from the sale of blue hydrogen could make such investments more compelling. Blue hydrogen would also likely be cheaper than green hydrogen in the mid-term, making it more cost competitive with grey hydrogen. It should be noted however that this business model will only work if the market price of blue hydrogen exceeds the marginal cost of production. Banks will certainly be comfortable with CCGT technology and have historically spent some time getting comfortable with CCUS technology so should acceptable Government support for this be rolled out, this represents a potentially viable option for low carbon power generation in the near-term. Such developments will also support the development of other hydrogen in other sectors as more hydrogen becomes available, until the production of green hydrogen is scaled-up.

The applications of hydrogen in the power sector are diverse, and as with the move to renewables this sector has the potential to lead the way in new low carbon technology.

Gas Networks and Heating

To-date there has been limited success in decarbonising residential or commercial heating in the UK. One proposed solution to decarbonise residential heating is to switch from natural gas heating to hydrogen heating. Repurposing gas distribution grids to carry hydrogen for the supply of boilers, potentially alongside efforts for the electrification of heat via heat pumps, could almost completely displace fossil fuel use in buildings and industry. Encouragingly enough the UK is now over halfway through the Iron Mains Replacement Programme; a 30-year programme that started in 2002 to switch gas distribution pipework from iron to polyethylene pipes to reduce gas leaks. This will help to accommodate hydrogen which, given its molecular properties, is much more susceptible to leakage than natural gas.

Prototype and trial studies such as that at HyNet North West will test the economics and practical application of hydrogen as a source of heating without large scale technological change for households. However with a levelised cost of hydrogen calculated at around £38/MWh, representing a £23/MWh uplift on the current price of natural gas, plus the cost of investment and opex on the infrastructure, government funding will be required to be cost competitive with natural gas heating. It has been proposed by the developers of HyNet North West that a CfD, RAB or similar mechanism could be used to provide the price certainty required for private financing to be raised for the project. Should such a mechanism not be available it would be challenging for a Project of this nature to be developed.

Even if a trial project such as HyNet North West receives government support, the wider roll-out of this model will not only require revenue support, but also the wider-scale change from natural gas to hydrogen boilers for household heating would require new government policy and as we have seen with the roll out of smart meters would require funding either from natural gas heating providers themselves or from government. The smart meter roll out perhaps is the closest commercial model to the roll out of hydrogen boilers and an adapted model could be a solution as to how this may be privately financed. In addition, governments could legislate that all newly installed boilers be “hydrogen ready” which would allow conversion (following minor adjustments) to switch from natural gas to hydrogen at the appropriate time.

Transport

Transport remains a focus sector for decarbonisation, as one of the biggest contributors to emissions and where there has been limited success in reducing emissions. Whilst there has been a focus on the development and roll-out of electric vehicles using battery technology for personal vehicles, there has been little development in the decarbonisation of heavy transportation such as heavy haulage, buses and ships. In these sectors battery technology does not yet provide a feasible route to decarbonisation where such vehicles typically need to travel long distances with little stoppage time. Hydrogen as a fuel is more energy dense and refuelling can be completed in a similar time scale to existing fuels. The aircraft industry is another heavy polluter which is struggling to transition to a low carbon environment, and hydrogen has the potential to make significant in-roads into decarbonisation of the sector.

A transition in these industries to the use of hydrogen is closely linked to the production of green hydrogen and could support the expanded production of green or blue hydrogen (as discussed above). However given the cost of transition to hydrogen powered vehicles, there would likely need to be financial incentives to industry to invest in a technology that will undoubtedly be more expensive than ‘conventional’ technology in the near to mid-term. Whilst public sentiment supports climate change action in general terms, additional consumer costs are unlikely to be popular in reality. Whilst change in these sectors is undoubtedly required it is likely that the changes will be longer term.

The railway sector is another area where hydrogen can offer a competitive de-carbonisation alternative to electric since electrification of the entire rail network may not prove cost effective. Hydrogen, by contrast, can act to replace diesel and for the most part fit around existing infrastructure. There are currently only two hydrogen trains in service in Germany and a prototype train in the UK so the technology is available, however large-scale deployment will require significant investment. Some manufacturers argue that battery can offer a competitive solution also for some routes. Ultimately once the technology is proven, the financing structures currently in place for railway investment and rolling stock could be adapted for hydrogen and battery trains, although currently there is limited incentive for train lessors and operators to make the sizeable investment.

For personal vehicles, Electric Vehicles (EV’s) have to date taken the market share of low carbon vehicles in Europe and large investments have been made not only in EV technology but also in the charging infrastructure which has multiple economic models which could be suitable for bank financing. Outside of Europe, countries such as China and Japan have shown an interest in large scale roll-out of hydrogen fuel cells for personal vehicles with China announcing more than USD 17bn worth of investment plans through to 2023 and the Chinese government anticipating 1m fuel cell vehicles to be on the roads in a decade. At this stage there is still much uncertainty as to how this will be rolled out, particularly in Europe, with some arguing that electric will take precedence and others believing there is a space for both.

Discussions on potential financing structures of hydrogen refuelling stations (HRS) are well underway in Europe as fuel cell electric vehicles (FCEVs) are anticipated to play an important role in the de-carbonisation of EU member states. In a study conducted by the ‘Fuel Cells and Hydrogen Joint Undertaking’ it is largely accepted that the HRS roll out could not be immediately bankable given cash flows are unlikely to meet annual debt service coverage ratios and public financing cannot provide enough of a buffer for commercial debt. One financing structure suggested would involve an initial period of debt provision from a government related or development banks such as the EIB or KfW. Once the network has been operating without issue for several years then there could be the ability to access loans from commercial banks assuming sufficient hydrogen demand is established, a solid risk mitigation concept is in place, and there is a realistic business plan for further network extension.

Our Outlook

Hydrogen has huge potential to support significant decarbonisation across key carbon emitting sectors. This potential has led to great excitement in the finance world and industry as all parties are under increasing pressure to support the transition to a low carbon world. However there are few financial models at this stage that would support commercial bank financing and without government support across all sectors, we consider it unlikely that the low carbon hydrogen sector will really take off.

However multiple governments globally are beginning to provide incentives or financial support for hydrogen projects either through grants for prototype projects or research and it is increasingly likely in some countries that additional government support may be available in some technology areas, such as the potential for UK government support for CCUS technology. Commercial bank financing, once achievable, will certainly be the key to the large-scale roll out of hydrogen technology required as can be evidenced by the success of the renewables industry globally. At MUFG we are following the hydrogen market closely as we believe that it will become an important element of the energy mix globally.

Contacts

If you would like to speak to MUFG about Hydrogen please contact:

Stephen Jennings
Head of Energy and Natural Resources
investmentbanking.emea@uk.mufg.jp

Andrew Doyle
Power and Renewables
investmentbanking.emea@uk.mufg.jp

MUFG

References

Berger, R., (2014). A roadmap for financing hydrogen refuelling networks–Creating prerequisites for H2-based mobility| A study for the Fuel Cells and Hydrogen Joint Undertaking (FCH JU)– Final report |Publications| Media| Roland Berger.

Cadent (2018), HyNet North West: From Vision to Reality,
https://hynet.co.uk/app/uploads/2018/05/14368_CADENT_PROJECT_REPORT_AMENDED_v22105.pdf.

Committee on Climate Change (2019) "Net Zero – Technical Report"
https://www.theccc.org.uk/publication/net-zero-technical-report/

Committee on Climate Change (2018), "Hydrogen in a Low-Carbon Economy"
https://www.theccc.org.uk/publication/hydrogen-in-a-low-carbon-economy/

Committee on Climate Change (2019), "Reducing UK emissions. 2019 Progress Report to Parliament"
https://www.theccc.org.uk/wp-content/uploads/2019/07/CCC-2019-Progress-in-reducing-UK-emissions.pdf

IEA (2019), "The Future of Hydrogen", IEA, Paris
https://www.iea.org/reports/the-future-of-hydrogenxlarge

IEA (2019), "The clean hydrogen future has already begun", Hydrogen Envoy at the Ministry of Economic Affairs & Climate Policy of the Netherlands
https://www.iea.org/commentaries/the-clean-hydrogen-future-has-already-begun

World Energy Council (2019), "New Hydrogen Economy – Hope or Hype"
https://www.worldenergy.org/publications/entry/innovation-insights-brief-new-hydrogen-economy-hype-or-hope

RENEW Economy - Queensland unveils "gigawatt" scale green hydrogen plans for Gladstone, Michael Mazengarb
https://reneweconomy.com.au/queensland-unveils-gigawatt-scale-green-hydrogen-plans-for-gladstone-93253/