The Prospect for Hydrogen

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Contents

Introduction

The EU's green ambition

- On 26 May 2020 the European Commission published its Green Recovery Plan, a multi-national financial framework for 2021 to 2027 agreed with Euro (EUR) 550 billion allocated to green projects in line with the European Green Deal approved by the European Parliament on 15 January 2020.
- An EU Hydrogen Strategy was published on 8 July 2020 as a road map to boost hydrogen production, hydrogen being presented as a key technology to reach the goals set out by the European Green Deal, and the production of hydrogen technologies a key part of the EU's post COVID-19 recovery plan.
- The EU Green Deal's zero carbon ambition for 2050 has driven the debate from carbon reduction to carbon elimination. With net zero as a new policy priority policymakers see hydrogen as the solution to decarbonisation in sectors where renewable electricity is not a viable option.

National initiatives

- In Germany, a support programme for greenhouse gas (GHG) neutral generation technologies as part of the coal phase out has been adopted.
- In the United Kingdom, the government has announced that it is investing nearly USD 1 billion to create carbon capture and storage (CCS) clusters.
- In the Netherlands the government has announced that it is investing USD 3.1 billion in offshore wind turbines to power green hydrogen production. Blue hydrogen also figures in the country's plans the Porthos project, focusing on the capture of carbon dioxide (CO2) within the port of Rotterdam.

The potential of hydrogen

- Hydrogen can play a significant role in the decarbonisation of hard-to-abate sectors. It is a versatile fuel in terms of how it can be transported and has a variety of potential end-use applications.
- Hydrogen can: be used in fuel cells as a transportation fuel; be added to natural gas to decrease the amount of carbon in heating; and, be used as a feedstock instead of hydrocarbons.
- Hydrogen can be converted into synthetic methane or diesel, these conversions affording hydrogen the potential to convert different parts of the energy system.
- Perhaps of greater significance is that hydrogen provides an excellent clean energy storage for long periods. As the share of variable renewables increases energy storage will play an increasingly important role in bridging the time lag between energy production and energy consumption.

The current use of hydrogen

- Currently hydrogen is not used as an energy carrier but is rather a form of final energy consumption used primarily as an industrial feedstock gas, in ammonia production, and in the conversion of crude oil to gasoline.
- 97% of hydrogen production is from unabated fossil fuels.
- Hydrogen produced from fossil fuel has a current levelised cost ranging from USD 1 to 2.50 per kilogramme (kg).
- The levelised cost of green hydrogen varies between USD 2.50 and 6 per kg depending the technology.
- Although the levelised cost of blue hydrogen ranges between USD 1.50 and 3.50 per kg, between 2015 and 2018 only 0.6 million tonnes (Mt) of blue hydrogen was produced.

Recognising reality

- Although hydrogen as an energy carrier has the potential to decarbonise a number of sectors, the commercial viability of using hydrogen is dependent on each sector's particular characteristics.
- The commercial viability of green hydrogen is dependent on its production being scaled up dramatically to transform it into an energy carrier that can support global energy supply.
- Furthermore, although public policy towards hydrogen has changed overnight the ability to deliver projects has not.
- Regions have access to different low cost feedstock, and have different carbon problems. As a result locally produced hydrogen will have a differentiated impact.
- The first hydrogen projects need to close the capability gap, the technology chosen depending on the region in which it is located and not the colour of the feedstock.

EU Hydrogen Strategy

The plan to 2030

- In Phases 1 and 2 EUR 24 to 42 billion is to be invested in the installation of electrolysers, and EUR 220 to 340 billion to scale-up and connect 80 to 120 GW of wind and solar power. Another EUR 65 billion is to be invested in hydrogen transport, distribution, storage, and refuelling stations.
- Phase 1 from 2020 to 2024 will see the installation of 6 gigawatts (GW) of hydrogen electrolysers, producing 1 Mt of renewable hydrogen per year. A regulatory framework and appropriate state aid rules will be implemented to kick start the hydrogen market.
- Phase 2 from 2024 to 2030 will see the installation of 40 GW hydrogen electrolysers, producing 10 Mt of renewable hydrogen per year. The aim in this phase is to secure cost competitive hydrogen by way of establishing large-scale infrastructure and international trade.

Support measures

- Measures to promote the use of hydrogen include support policies for the demand side, e.g. green hydrogen quotas for specific end use applications, in addition to the implementation of tendering systems for carbon contracts for difference (CfD).
- The EU Hydrogen Strategy also acknowledges how the competitiveness of low carbon hydrogen needs to be secured by way of the introduction of a carbon tax, noting that carbon prices in the range of EUR 55 to 90 per tonne of CO2 would be needed to make blue hydrogen competitive with hydrogen from fossil fuels today.
- Finally, the EU Hydrogen Strategy unequivocally supports the development of a green hydrogen value chain, emphasising how the generation of domestic demand will provide Europe with an opportunity to assume technology leadership along the entire value chain.

Blue hydrogen

Utilising infrastructure and experience

- The potential for the centralised production and distribution of blue hydrogen offers opportunities to co-opt segments of the fossil fuel industry into energy transition.
- Existing gas infrastructure can to some extent be repurposed for the transportation of hydrogen, providing E&P companies with a way of avoiding stranded assets, and providing then with access to a new market in terms of selling hydrogen and its derivatives.
- CCS presents an opportunity for E&P companies to be part of the solution to GHG emissions.

Integral to the net zero ambition

- Although he EU Hydrogen Strategy has expressly recognised a role for blue hydrogen in the medium-term in reducing emissions and supporting the development of a viable market it understates the role of CCS.
- Given the mathematics of the net zero ambition CCS is necessary for both CO2 reduction and removal, the answer to the question of blue versus green that we need both due to the cost of not deploying them.
- IRENA has estimated that 60 ExaJoule (EJ) of blue hydrogen needs to be produced from the utilisation of fossil fuels, this figure representing the deployment of up to 100 CCS facilities a year together with the necessary transportation and storage infrastructure.

A geographically restricted impact

- Existing CCS projects are concentrated around industrial clusters and existing pipeline infrastructure close to storage sites.
- Indeed, blue hydrogen production is only likely in regions: where there is a consistently low gas price or where it is possible to use project structures that effectively mitigate against variations in gas pricing; and, where there is suitable transportation infrastructure and CO2 storage facilities
- Blue hydrogen project delivery, however, comes with risk and uncertainty: a dependence on natural gas pricing, a reliance on competitive project capital expenditure (CAPEX), and the cross chain risk in amalgamating different market sectors into one project team.

The need for comprehensive policy

- The deployment of CCS requires the adoption of comprehensive strategies encompassing: one, consistent policies on carbon value; and, two, targeted financial support.
- Policy is needed with the aim of: establishing targets and long-term policy signals; supporting demand creation; mitigating investment risks; promoting research and development and knowledge sharing; and, harmonising standards and removing barriers.
- Such policies include tax credits, feed in tariffs, carbon pricing, carbon Cfd, grants, emission caps, and procurement mandates.
- Further, such policies must balance contradictory priorities: one the one hand to attract private capital and provide a framework for project finance; and on the other to balance the provision of public subsidies with value for the consumer. The development of hydrogen should be left to the largest possible extent to market signals, with carbon abatement being achieved at the lowest possible cost.

State support and the supply chain

- The large-scale deployment of CCS is also dependent on front-end infrastructure investment in shared transport and storage infrastructure that improve the economics of CCS facilities by lowering costs and risks. The very lack of investment in CCS transport and storage infrastructure to date underlines that the perceived risks are too high without government loan guarantees or investment.
- Yet there is a need from the outset to demonstrate how blue hydrogen can be produced on a commercial basis without subsidies. The hydrogen industry is in its nascent phase with uncoordinated demand and supply, and significant gaps in supply chains. These gaps need to be closed.

A second choice to green

- CCS projects currently benefit from lower energy costs and lower capital costs in comparison with the production of green hydrogen by water electrolysis.
- The carbon abatement cost, however, is still relatively high for peak power generation and industrial heat.
- Coupled with the expected significant decrease in the cost of green hydrogen production this explains the EU's clear preference for green hydrogen as a long-term solution to GHG emissions reduction.
- Blue hydrogen suffers from its association with the continued usage of fossil fuels and the opportunity it provides to E&P companies to maintain their share of the energy market.
- Regional differences between the choice of feedstock should be the focus and not the colour of the feedstock as the only way to achieve the net zero ambition in 2050 is to focus on the carbon intensity of the end product now.

Green hydrogen

Making it cost competitive

- As already noted green hydrogen is not yet cost competitive with hydrogen produced from fossil fuel. According to the IEA 1kg of green hydrogen costs from EUR 0.10 to EUR 0.15 per kilo watt hour (KWh) to produce. In contrast hydrogen costs EUR 0.045 KWh to produce from fossil fuel.
- The IEA and IRENA predict, however, that the gap will close with economies of scale and greater renewable energy deployment.
- The factors to make green hydrogen cost competitive are: investments beyond a critical mass in renewable power generation and electrolysis capacity; breakthrough technologies; the construction of large-scale transmission and storage infrastructure; and, a tailor made and enabling regulatory framework.

The need to scale up

- One of the key impediments to green hydrogen production is the generation capacity and cost of renewable power. Wholesale and retail power prices in the EU remain high as a result of the additional cost in the feed-in-tariff paid for renewable power generation and the system costs caused by the more widespread renewable power generation.
- The potential for green hydrogen is also based on the production of electrolysers on an industrial scale. Electrolyser costs are expected to halve in 2030 due to the increased scale and standardisation of manufacturing.
- An improvement in the efficiency of electrolysers is also critical to their competitiveness.

State support and its limits

- Green hydrogen will remain a relatively expensive energy carrier, requiring targeted support. Much discussed examples are: one, the use of a tender based carbon Cfd structure to reduce the cost of capital for projects; and, two, the introduction of a carbon tax, the carbon price or implied carbon cost depending on the end use.
- EU Member States are unlikely to support an increase in EU carbon prices to a level which would render EU industries uncompetitive without significant carbon import tariffs being imposed. Indeed, in the EU Hydrogen Strategy it is provided that the Commission will propose a carbon border adjustment mechanism in 2021 to reduce the risk of carbon leakage.

Transportation and storage

Revising regulations

- The European Commission has identified the repurposing of the existing European gas infrastructure as a fast and cost-effective option to provide the hydrogen sector with transport and storage infrastructure.
- The EU Commission has proposed the revision of the Trans European Network for Energy and a review of internal gas market legislation to support a competitive decarbonised gas market. With increasing demand, the production, use and transport of hydrogen needs to be more effectively regulated.
- The EU Commission has stated that this process should be combined with a strategy to promote and meet transport demand through a network of refuelling stations linked to the review of the Alternative Fuels Infrastructure Directive and the revision of the Trans European Transport Network.

Technical challenges

- Hydrogen is comparatively small in size and as a consequence more easily leaks from pipelines than methane. As it easily ignites and explodes it must be handled differently by way of adapting pipeline dimensions, volumes and pressures.
- It also causes structural damage to pipelines due to embrittlement. Whilst only retrofitting and adapting gas infrastructure is required when blending up to 20% hydrogen, material costs are incurred after blending more than this with the replacement of pipes and compressors.

A prohibitive cost?

- The cost of hydrogen transportation is comparatively expensive due to the energy density of hydrogen as a fuel versus oil products and LNG.
- For long distance transportation hydrogen may be converted to liquid ammonia. Liquid ammonia still has a significantly lower energy density than either oil or LNG, the conversion process from hydrogen consuming considerable energy.
- The energy cost of the conversion is unlikely to be significantly reduced, the quantity and quality of steel needed in pipeline construction fixed.
- The impact of hydrogen is therefore likely to be limited to regions with gas supply or large-scale renewable power generation, and the corresponding industrial demand.

A solution to intermittency

- The above having been said lithium ion batteries are an inferior means of storing energy than either pure hydrogen or liquid ammonia.
- Furthermore, it is highly unlikely that lithium ion batteries can achieve the cost effectiveness or scale to provide either the seasonal demand balancing that the European power system requires, or cope with the seasonal intermittency that renewable generation creates.
- In contrast, hydrogen is capable of storing energy for long periods and in large quantities, providing the only feasible alternative option to gas for seasonal energy storage.

Conclusion

Is the zero ambition achievable?

- The EU Green Deal sets out highly ambitious targets which will significantly impact on the European economy and population. The question remains, however, as to how to implement a renewable energy strategy, a strategy that combines energy security and affordability with the reduction of GHG emissions.
- A successful coal phase out and a near doubling of the capacity of renewable power generation will only get the EU to around 30% of the way towards its new Green Deal 2030 target.
- The EU target of 10 Mt of green hydrogen production a year by 2030 demands a doubling of renewable power generation capacity dedicated to it, a demand that will inevitably deny the EU the necessary renewable power to feed its other energy transition ambitions.
- With regards to the 2050 net zero ambition the deployment of renewable power generation and the electrification of energy consumption are not accelerating fast enough, the former constrained by intermittency issues and the lack of effective storage options.

The need for an audit

- A comprehensive audit needs to be undertaken which considers: the total cost for industry and households of the production of hydrogen and its integration into the power system; its impact on the reliability of the power and related systems; its impact on the overall GHG reduction savings that result; its impact on economies in terms of their growth and ability to provide employment; and, its impact on relations with other countries.
- Governments may then make considered policy decisions about: the prioritisation of green ahead of blue hydrogen; the provision of direct support in reducing the cost of production; the provision of credits and the implementation of a carbon tax; investment in necessary transmission, transportation and storage infrastructure; making hydrogen mandatory for certain end users; and, the use of public procurement in catalysing supply chains.

The need for market-based solutions

- What is clear is that the support provided for long-term carbon solutions must be market-based, and achieve the right balance of providing support and retaining value for consumers.
- To this extent the EU Hydrogen Strategy recognises that the provisions of support schemes must be subject to compliance with competition rules.
- Refining and expanding the EU Emission Trading Scheme (ETS) should be the main driver for decarbonisation as such a systemic approach encourages the adoption of least cost applications and solutions.
- The EU energy market needs to be recognised as the most efficient way for system integration, and for preserving competition and fostering liquid markets.

Certification and competition

- A cross-border approach should be adopted for any financial support schemes provided for renewable, decarbonised gases. An integrated EU certification regime is the only way to provide a fair competitive approach towards the carbon intensity of energy, and to foster a market in which there are options and liquidity.
- The EU Hydrogen Strategy acknowledges this, maintaining that only an open and competitive EU market with prices that reflect energy carriers' production costs, carbon costs, and external costs and benefits can efficiently provide clean and safe hydrogen to end users who most value it.
- The EU policy of unbundling should be also preserved, preventing hydrogen network operators from restricting access to supply and storage infrastructure. Network operators must remain neutral, and hydrogen infrastructure should be accessible to all on a non-discriminatory basis.

Aligning targets and regulations

- The EU Hydrogen Strategy and different national ones provide only a framework. Indeed, nineteen countries have issued hydrogen roadmaps and strategies that differ in terms of production and application.
- There will be considerable legislative and regulatory activity going forward, not all of this activity necessarily aligned.
- As examples:
  - national targets should be aligned with EU level targets as this is the only way to reach 2030 and 2050 goals.
  - the regulation of the transportation of hydrogen needs to be uniform to ensure that the increasing use and long distance transportation of hydrogen is both safe and efficient;
  - national tax policies that tend to discriminate against hydrogen in favour of electricity need to be amended, e.g. the double taxation of green hydrogen production for industrial fuel switching.

The need for specific legislation

- Transparent and predictable legislation and regulation are essential prerequisites for investment in CCS: the lack of past projects as precedent results in inconsistencies in approach between the competent authorities.
- The emerging role of CCS has encouraged policymakers to adopt specific legislation that provides clarity with regards to: the right to use and ownership of storage space; government oversight of operational activity; and, concerns connected to the long term-liability of operators.
- For CCS to be deployed globally governments need to implement regulations that embody a consistent approach towards such liabilities in terms of either the operator bearing the risk only during the operational phase of a project or the government bearing the risk during and after operations phase above a prescribed cap on the operator's liability.

The impact on third parties

- Finally, there is a need to evaluate the impact of hydrogen's development on relations and contracts with other countries.
- This evaluation should not only focus on the impact on existing gas supply arrangements, and on the construction and financing of LNG terminals and gas pipelines, but consider the impact of carbon import taxes on international trade in general.
- The cost of achieving the net zero ambition compels the EU to either accept the loss of a large part of its industrial basis or impose a carbon border tax on products entering the EU from such countries.
- A carbon border tax creates the potential for trade disputes with the US and China, disputes that the World Trade Organisation (WTO) and its rules at present are not designed to handle.

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Louis, an English-qualified solicitor, joined Dentons in May 2017, having worked in the project finance and energy practice of a leading international law firm in both its London and Moscow offices. Before that he spent a number of years working as a leading legal counsel in the international development and production team at Statoil.

His oil and gas practice has primarily been based on advising E&P companies on their participation in upstream and midstream projects in Russia & the CIS, project sponsors on the negotiation of finance and project documents, and project operators on a variety of contractual and regulatory issues.

In terms of his power practice, Louis has advised project sponsors of a variety of renewable power generation projects, principally solar, wind, and hydro, in Russia, Ukraine, and Uzbekistan on their structuring and financing, and the operators on the negotiation of the key project documents, e.g. EPC contracts and offtake arrangements. In addition, he advised international financial institutions on the development and implementation of legislation and project documentation supporting the competitive tendering of renewable power generation projects, and the development of battery storage projects.

Louis has used the experience he has gained working in the energy sector to provide advice to governments across the region, both on the implementation of concession and public-private partnership arrangements for energy and infrastructure projects, and on unbundling and the development of competitive power markets.

In addition to his legal practice, Louis has authored numerous articles on Eurasian energy market regulation, economics and politics. He is an Associate Fellow at the Forum for Central Asian Studies at the University of Cambridge, and has previously worked as: an Associate Professor of Finance Law at the New Economic School in Moscow; an Associate Professor of Energy Law at the European University in St Petersburg; and, as an Associate Fellow of the Energy, Environment and Development Programme at the Royal Institute of International Affairs in London.