Renewable Hydrogen – Seizing the UK Opportunity

We now know that hydrogen will be an essential component of the low carbon economy and the UK has the opportunity to lead the way in integrating renewable hydrogen across sectors[i]. Already, the UK is a world leader in another essential part of the low carbon transition: offshore wind. Over the past ten years, the offshore wind industry, in partnership with government, has innovated to take a nascent technology through to full commercialisation. As a result of this partnership, offshore wind is now one of the cheapest forms of new build power. The renewables industry is now confident that it can once again innovate to drive down costs and reduce emissions, this time with renewable hydrogen. Seizing the opportunity of renewable hydrogen will offer significant economic benefits as well as helping to decarbonise our economy in line with net zero.

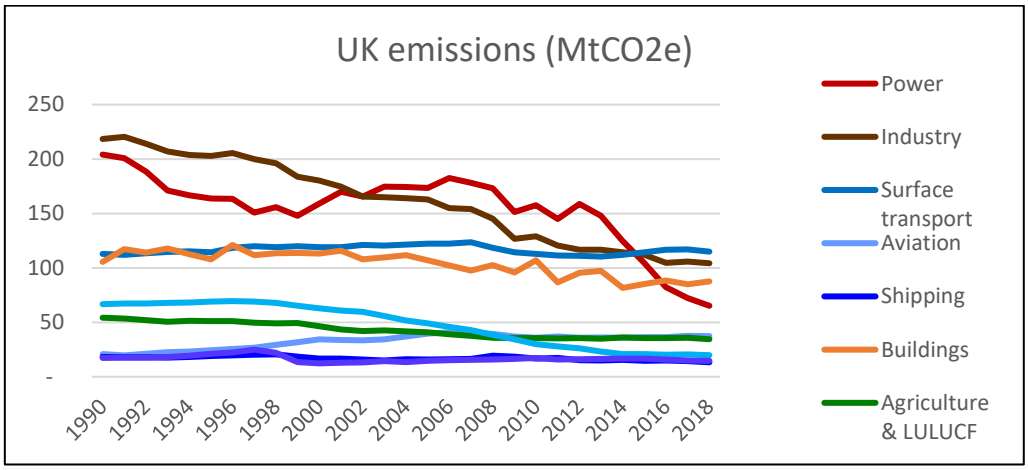
Renewable hydrogen – also known as green hydrogen - is a zero-carbon technology. It is produced by using renewable energy to power electrolysis to split water into hydrogen and oxygen. The only by-products are oxygen, which can be used in other processes, and water, when the hydrogen is used.

Renewable hydrogen can decarbonise the UK's hard to reach sectors

The replacement of coal power with renewables has been the primary driver of UK emissions reduction so far, with power sector emissions down 70% on 1990 levels. With the Government's pledge to achieve net zero by 2050, all eyes are now focussed on how we decarbonise other areas of the economy.

Emissions in other sectors, such as the chemicals sector, heat – both in homes and industry – and transport, remain high. We can use electrification to decarbonise domestic cars and a good proportion of people's homes. But in other sectors, such as freight transport on land and sea, and for heat in the gas networks and industrial processes, electrification will be challenging. Reducing emissions from these sectors requires molecules not electrons. Renewable hydrogen is the zero-carbon molecule that can deliver decarbonisation in these sectors and, as such, it is vital that its development is supported and brought forward as soon as possible.

Figure 1: UK emissions 1990-2018[ii]



National Grid ESO estimates that by 2050 the UK will require 591TWh of hydrogen[iii], up from just 1TWh today. How this hydrogen is produced matters. Currently 99% of the UK's hydrogen supply is produced from methane gas (via a process called steam methane reformation or SMR), while coal and oil are also

used to make hydrogen elsewhere. The SMR method of hydrogen production is a highly carbon intensive process – for every ton of hydrogen, ten tonnes of carbon dioxide are produced. Using fossil fuels to create hydrogen therefore necessitates the use of carbon capture technologies (CCS) to reduce emissions. However, CCS is currently only around 80-90% efficient, meaning it still releases a significant portion of the carbon dioxide and will add significant cost.

Renewable hydrogen is a significant economic opportunity

Renewable hydrogen is at the forefront of innovation and on the verge of becoming a key component in the energy system. There are significant benefits to stimulating the economy by bringing forward the development of renewable hydrogen:

➔ Renewable hydrogen will support regional job creation

Renewable hydrogen has the potential to sustain thousands of high-skilled, green jobs across the country, mainly in regions outside of London and the South East. A report by the Offshore Renewable Energy (ORE) Catapult for the Offshore Wind Industry Council shows that, if the UK harnesses the opportunity of renewable hydrogen from offshore wind and its export potential, up to 120,000 jobs could be created across offshore wind generation, the manufacturing of electrolysers and logistics[iv].

➔ The UK can capitalise on its strengths to become a world leader

The UK already has a head start in the global race for renewable hydrogen. Firstly, we are home to world leading electrolyser manufacturers, ITM Power and Siemens, and have world-leading trials of renewable hydrogen, such as the Gigastack project in the Humber. Secondly, our world leading offshore wind industry is providing large volumes of clean, affordable power. And thirdly, our research institutions, combined with the expertise, knowledge and skills of our energy system engineers, provide a strong blueprint for cost reduction and innovation. The UK cannot let this opportunity pass and must start leveraging these strategic advantages so that the UK capitalises on renewable hydrogen right now, stealing a march on our nearest competitors who are already recognizing this opportunity. Across the European Union, traction is mounting for renewable hydrogen, with the EU Hydrogen Strategy[iv] setting a target of 40GW by 2030. In addition, individual countries are realising the hydrogen potential. Germany, for example, has committed €7 billion to renewable hydrogen up to 2050[v], and a target of 5GW by 2030; meanwhile Bloomberg New Energy Finance (BNEF) has identified $17 billion of hydrogen investment in China by 2030[vi].

➔ Renewable hydrogen is a global export opportunity

The global market for renewable hydrogen is expected to be $2.5 trillion by 2050[vii]. If the UK harnesses the innovation potential of renewable hydrogen, a major export industry could be created. Modelling by the ORE Catapult shows that exports of offshore renewable hydrogen from the UK could supply a growing import demand from Europe, with a value of up to £48bn by 2050, contributing to a cumulative GVA of £320bn by 2050, mainly from global electrolyser exports.

Hydrogen and renewable generation – perfect partners

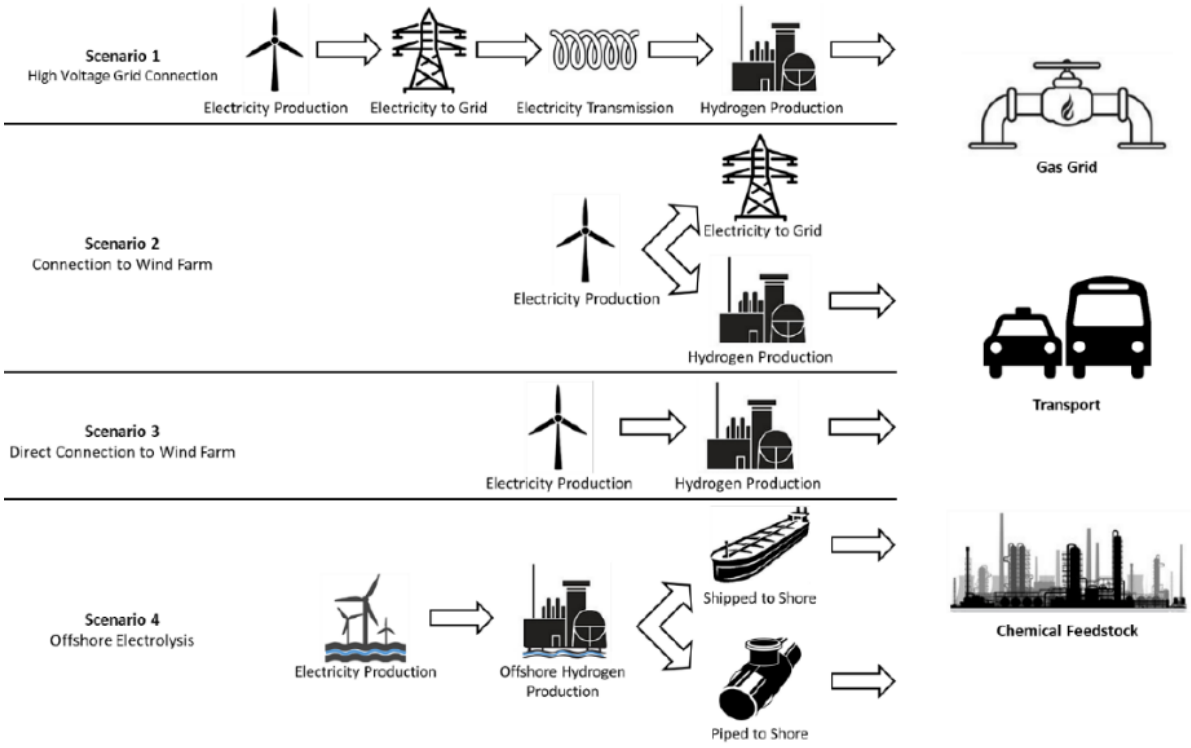
UK wind and solar are now the cheapest forms of new build electricity generation available and further cost reductions will come. As more renewable generation comes on to the system, and costs fall, renewable electricity becomes the best option for hydrogen production. The ORE Catapult has shown that renewable generation and hydrogen production are perfect partners. Hydrogen production is the logical next step to the increase in renewable generation; indeed, the National Renewable Energy Laboratory in the USA has shown that utilising hydrogen can double the volume of renewable

generation on the network[viii]. Renewable Hydrogen can make our energy system more flexible by offering alternative offtake for power production from renewables where grid capacity or oversupply creates constraints. Presently at times of high wind generation, and low demand, National Grid ESO "constrains off" wind generation to maintain system stability on some areas, particularly Scotland. With renewable hydrogen production coupled to the electricity system, this spare capacity can be used to produce hydrogen. This hydrogen can then be stored for long periods, and/or be delivered to the growing market of hydrogen demand cases in other sectors. Renewable hydrogen can produce renewable ammonia; ammonia unlocks more affordable transport of hydrogen and facilitates storage that can subsequently be converted back to hydrogen when demand increases. This hydrogen buffer will make the overall energy system more resilient and more efficient, lowering risk and costs for consumers.

While coupling the electricity system and hydrogen markets presents an attractive business model and whole system approach, some developers are looking at solely producing hydrogen from their wind farms. Developers are also considering producing hydrogen on site and exporting this onshore via gas pipelines to take advantage of the efficiencies in this system.

The wide range of business models for hydrogen means that renewable hydrogen has a diversity of applications and scales; RenewableUK's Project Intelligence highlights the range of applications for renewable hydrogen in the UK from already operational electrolyser capacity. These electrolysers are producing hydrogen across the UK, including facilities for ferries in Orkney, and buses in Aberdeen. The advantage of electrolysers is that they are modular and can be stacked, meaning that as the market grows, we can build larger facilities to meet demand, without laying out high upfront costs. This steady growth means we can learn by doing, bringing down project costs over time. It is welcome that the Government is supporting some of this growth with funding for the Gigastack project, which is helping ITM Power to build the world's largest polymer electrolyte membrane (PEM) electrolyser factory with the capacity to produce 1GW of electrolysers per year by 2025 as demand grows, employing hundreds of people.

Figure 2: business models for renewable hydrogen[ix]



Driving renewable hydrogen growth and cost reduction

To maximise the benefits of renewable hydrogen to the UK's decarbonisation efforts and economic recovery, we need to start now. Research shows that most of the cost reduction can take place by 2030, though this requires the UK to get the right framework in place to drive down costs and upscale production now.

New research from the Offshore Renewable Energy Catapult shows that, by 2030, renewable hydrogen can be competitive, or even cost less to produce than hydrogen produced from natural gas, with carbon capture and storage (CCS), typically referred to as 'blue' hydrogen[x]. The cost reduction in renewable hydrogen will be achieved through accelerated deployment of electrolysis, coupled with targeted research and development (R&D), and demonstration projects and technology validation at large-scale. UK academia has world-leading strengths in the research areas required to develop improved electrolyser technologies to help drive cost reduction and efficiency gains. The cost reduction that will take place by 2030 will also be driven in part by the continued cost reduction of offshore wind itself.

The period from 2020-2030 is therefore critical, both for ensuring steady growth of a hydrogen economy that can integrate increasing amounts of offshore wind, on the path to 2050, and for securing the substantial economic benefit that can flow from renewable hydrogen.

The current costs of renewable hydrogen electrolysers are estimated to be around £800/kW at 10MW capacity. The Gigastack project from ITM Power and Orsted will deliver cost reductions of around 50% on this[xi]. Further innovation in the energy efficiency of electrolysers and innovation means that overall costs will fall from £8 per kilogram of renewable hydrogen today to £2/kg by 2030 and less than £1.50/kg by 2050.

Realising renewable hydrogen's potential

To realise these goals, government must give confidence to the sector and support its development. Cost reductions are driven by three components: (1) improvements in the stack design and manufacturing of electrolysers; (2) economies of scale; and (3) lower input electricity costs. The last of these will continue as the costs of renewables continue to fall. In order to deliver the first two, the Government will need to undertake several approaches.

First, a commitment to support R&D spending that will drive innovation in design and manufacturing of electrolyser systems. This will not only reduce costs, but reinforce the UK's as the world's leading location for electrolyser manufacturing.

Second, a clear commitment to volume of hydrogen to be produced. Economies of scale and learning by doing are critical factors in cost reduction of new technologies. As we have learnt from the wind sector, establishing a commitment to a pipeline of projects and investment in the sector pays dividends in cost reduction.

Third, the Government must establish how demand for hydrogen will develop. Hydrogen is already emerging as a solution to decarbonizing long-distance transport, either directly or as a feedstock for other fuels. Hydrogen fuel cells, for transport applications in particular, are already a well-established technology with refueling stations already in place. Transport is a good place to start for implanting a renewable hydrogen economy. Hydrogen Europe estimates that at €5/kg (roughly £4.50), hydrogen is competitive with diesel[xii]; a price achievable in the near term. Therefore, hydrogen for transport can be rapidly deployed as a source of demand for an expanding hydrogen supply, while other sectors, especially industrial processes and gas networks, ready themselves for the transition.

Learning the lessons from offshore wind: long-term partnership between industry and government
The UK has the world's largest offshore wind fleet and we have seen costs fall from £119/MWh in the 2015 CfD auction to £39.65/MWh in 2019. There is much that the Government and the renewable hydrogen industry can learn from this experience. The Government demonstrated a long-term commitment to the sector with a stable procurement mechanism that gave companies the confidence to invest. The Offshore Wind Sector Deal further reinforced this partnership with industry and government and has been highlighted as something to emulate in other sectors.[xiii]

Recommendations

To capture all the benefits outlined above, we recommend that:

1) The Government must publish by the end of 2020 its hydrogen strategy and roadmap to 2050, setting out how renewable hydrogen will be transformed from a niche discipline to the central pillar of decarbonisation strategy. This strategy must bring together all government departments, especially BEIS, DfT, MHCLG, to bring forward demand, as well as supply.

2) The Strategy should include a clear plan to deliver the first gigawatt of electrolyser capacity in the UK, identifying potential projects and funding where appropriate to drive innovation and investment, including "at scale" demonstrations for production and storage.

3) In addition to a strong carbon price, the UK Government should set a target for electrolyser capacity to signal to industry and provide a framework for policy development. RenewableUK supports a target of 5GW by 2030, 10GW of renewable electrolyser capacity by 2035. This should be supported by a target price of £2/kg by 2030.

4) Take the lessons from the wind industry to develop a revenue support mechanism for hydrogen production which takes carbon costs into account to drive investment and cost reduction via a hydrogen CfD or Hydrogen Obligation Certificate.

5) The Government should look holistically at the decarbonisation of industry and heat, including the direct injection of renewable hydrogen to the gas grid, as well as private pipelines and behind-the-meter applications. This should include outlining specific measures for the deployment of renewable hydrogen in the forthcoming Industrial Decarbonisation Strategy.

6) Focus on transport as a growth sector for hydrogen in the short term. This should mean levelling the playing field for hydrogen with other low carbon fuels through tax treatment and Road Transport Fuel Obligation.

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[i] National Grid ESO, July 2020, "Future Energy Scenarios" https://www.nationalgrideso.com/document/173821/download
[ii] Committee on Climate Change, 2019, "Reducing UK emissions – 2019 Progress Report to Parliament"
[iii] National Grid ESO, July 2020, "Future Energy Scenarios"
[iv] Offshore Renewable Energy Catapult/OWIC, 2020, Solving the Integration Challenge Workstream B – Final Report, https://www.owic.org.uk/documents
[v] EURACTIV "Germany plans to promote 'green' hydrogen with €7 billion" https://www.euractiv.com/section/energy/news/germany-plans-to-promote-green-hydrogen-with-e7-billion/ (accessed 11/6/20)

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[vii] Hydrogen Council, 2017, “Hydrogen Scaling Up”
[viii] Mark Ruth, NREL, January 2020 “H2@Scale: Hydrogen Integrating Energy Systems”
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[xii] Hydrogen Europe 2018, “Hydrogen, Enabling a zero emission Europe” https://hydrogeneurope.eu/sites/default/files/2018-10/Public_HE%20Tech%20Roadmaps_full%20pack_0.pdf
[xiii] House of Commons Business, Energy and Industrial Strategy Committee, 19 March 2019, “Industrial Strategy: Sector Deals”, paragraph 29. https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/663/66307.htm#_idTextAnchor026