Hydrogen and the net-zero carbon economy:

The need for hydrogen does not justify the expansion of the onshore oil and gas industry

Summary

- Some sectors of the economy will be difficult to decarbonise and using hydrogen as a clean fuel is one possible option.
- The production of hydrogen from gas or coal produces large amounts of polluting emissions and contributes to climate change.
- Progress towards developing commercial-scale carbon capture and storage has been very slow and there are serious doubts it will be a viable option for mitigating emissions from fossil fuel hydrogen production in the next few decades.
- Hydrogen produced from renewable electricity has very low CO_2 emissions and costs are falling rapidly.
- As renewable electricity will be needed in many sectors, it is important that hydrogen produced this way is reserved for those sectors where there is no alternative.
- The need for hydrogen in a zero-carbon economy cannot be used to justify an expansion of onshore fossil fuel production.

Introduction

We are in a climate emergency. There is a clear consensus, based on science, that we urgently need to reduce our emissions of greenhouse gases such as CO_2 if we are to have any hope of limiting the increase in global average temperatures to 1.5°C – and that means drastically reducing our reliance on fossil fuels such as oil and gas.

Electricity generation from renewable sources such as wind and sun is experiencing unprecedented growth, showing great potential for decarbonising transport and domestic heating, both large sources of CO_2 emissions. However, there are areas of the economy where electrification is not suitable and for which alternative solutions may be needed. These are the energy-intensive sectors (such as steel and chemicals), HGV transport, aviation and shipping.

One option for these difficult-to-decarbonise sectors is to use hydrogen as an alternative fuel. Some oil and gas companies are making the case that they could be part of the transition to a net-zero economy because they provide the feedstocks to produce hydrogen. For example, in June 2020, Stephen Sanderson, CEO of UK Oil & Gas told Surrey County Council's Planning Committee: "*We believe that well-regulated and safely produced indigenous gas, such as Loxley, represents a vital opportunity to help meet net zero targets by providing the most cost effective solution for the future UK production of clean hydrogen fuel*".

Such claims are misleading. At the point of use, hydrogen is a clean fuel. However, it is not freely available and has to be manufactured, either from fossil fuels or water – with very differing climate impacts.

Two methods of producing hydrogen are considered in this briefing.

1. **'Grey' hydrogen** is hydrogen 'produced from oil, gas or coal. Its production generates very large amounts of CO_2. The impact of this could be mitigated with carbon capture and storage (CCS) when the technology is fully commercially available. When CCS is involved the industry calls this **'blue' hydrogen**.
2. Hydrogen can also be produced by electrolysis, using electricity to split water into hydrogen and oxygen. When renewable electricity is used for this process it is known as **'green' hydrogen** – this has the lowest carbon emissions**.**

Hydrogen produced from fossil fuels will not help meet net zero targets, will contribute to climate change and may not be cost effective in the medium to long term if it is combined with CCS.

Fossil hydrogen: more carbon intensive than burning gas directly

At the point of use, hydrogen certainly burns more cleanly than either natural gas, oil or coal. However, producing hydrogen from these can generate huge amounts of CO_2 emissions and accelerate climate change.

A recent article in *Forbes Magazine* calculated that the production of 1kg of hydrogen produces as much as 9.3kg of CO_2. The article concluded that hydrogen produced from gas is likely to have a larger carbon footprint than when gas is burned directly in a gas-fired power station.

Hydrogen production is already a significant global business. At present fossil fuels are the main feedstocks. In 2017 as much as 6% of global gas supplies and 2% of global coal supplies were used in hydrogen production. According to the International Energy Agency, hydrogen production is responsible for around 830 million tonnes of CO_2 per year, equivalent to the emissions of the UK and Indonesia combined.

'Blue' hydrogen: still a pipe dream

Carbon capture and storage (CCS – capturing and storing the emissions safely for thousands of years) is widely touted as a solution to the emissions from hydrogen produced from fossil fuels. It could cut the carbon intensity of hydrogen if the technology were to prove effective. The Institution of Engineering and Technology has stated: "*Without the simultaneous deployment of a CCuS* (Carbon Capture use and Storage) *infrastructure hydrogen does not have a future for large-scale retrofit deployment to industry, homes and businesses*". The Committee on Climate Change has also declared that CCS is essential to any hope of meeting the Paris Agreement commitments and the UK's net-zero greenhouse gas target.

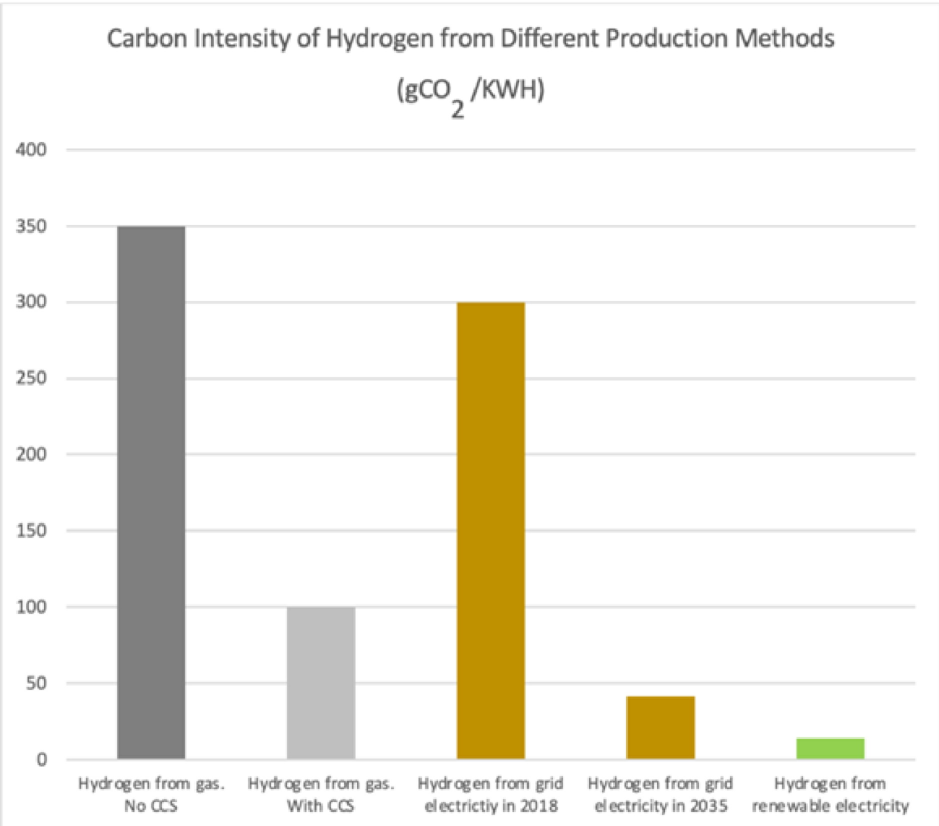
However, progress towards developing commercial scale CCS has been painfully slow and there are serious doubts that it will be a viable option in the next few decades, let alone a 'simultaneous deployment'. In March 2020 a House of Commons briefing complained that there were still no operational carbon capture usage and storage sites in the UK and concluded that: "*Key barriers to the deployment of CCUS include high infrastructure costs, lack of commercial viability, and concerns around safety*".

In the March 2020 budget, the Chancellor of the Exchequer did commit £800 million towards a CCS fund. This is intended to develop one CCS site in the mid-2020s and another as far in the future as 2030. This is too little too late. The Committee on Climate Change's net-zero scenarios estimate we will need to store between 75 and 175 million tonnes of CO_2 per year in 2050 to reach the goal of net-zero greenhouse gas emissions. The upper value is equivalent to around half the country's emissions in 2019. At present it seems unlikely that the UK will have working CCS capacity for these levels of CO_2 storage in the coming decades.

Carbon capture and storage does not reduce emissions to zero

Another significant problem is the limited effectiveness of CCS. Two flagship power plant CCS projects in the US and in Canada currently remove a little over 30% of CO_2 emissions. A study published in the journal *Energy Procedia* comparing different systems of hydrogen production found that the plants studied captured between 53–90% of CO_2, meaning that between 10-47% still escaped into the atmosphere.

Moreover, carbon capture and storage is itself a carbon intensive process requiring additional energy. The higher the CO_2 capture rate the greater the cost as more energy is required. The additional fossil fuels required for the capture process will, when burned, also produce other pollutants such as sulphur dioxide (SO_2) and particulates.



1. Hydrogen from gas with no CCS. This is estimated to have a carbon intensity of 285 gCO_2/kWh. However, if fugitive emissions from gas extraction are included then the carbon intensity increases by 15–70 gCO_2/kWh.
2. Hydrogen gas with CCS. This assumes a 95% capture rate. Lower and cheaper carbon capture rates would increase carbon intensity.

3. Hydrogen using grid electricity. This is based on 2018 figures when the carbon intensity was 288-388 gCO2/kWh. This is falling steadily as more renewable electricity enters.
4. By 2035 the carbon intensity is predicted to fall to 70 gCO_2/kWh.

Data source. policy.friendsoftheearth.uk/insight/role-hydrogen-our-low-carbon-transition

Electrolysis and the role of 'green' hydrogen

An alternative route to generating hydrogen is electrolysis, with oxygen as the only by-product, and no direct CO_2 emissions. However, this must be powered by electricity from renewable sources. Hydrogen produced from grid electricity currently has considerably higher emissions than 'green' hydrogen because of the amount of gas-fired generation still in the system. it is worth noting though that the carbon intensity of the grid is forecast to drop significantly over the next 15 years.

However, using renewable electricity (or any form of electricity) to produce hydrogen of course incurs an efficiency loss. The most efficient way to use electricity is to use it directly.

The UK produces about 34 gigawatts (GW) of renewable electricity at present and will need to increase this to up to 237 GW by 2050. Given this dramatic increase in demand, it will be important to reserve 'green' hydrogen for those sectors where the direct use of renewable electricity will not suffice, such as the steel, cement and chemicals industries. In the transport sector, shipping could be decarbonised with ammonia produced with hydrogen and long-haul HGVs with hydrogen fuel cells.

Other sectors would be better served by prioritising the direct use of renewable electricity. For domestic heating and small vehicles, two large sources of CO_2 emissions, it will be more efficient to use renewable electricity directly. For example, hydrogen is often presented as an alternative for domestic heating fuel. However, Friends of the Earth have shown that the amount of 'green' hydrogen required for the North of England alone by 2050 would require more than six times the amount of renewable electricity to generate it than we produce at present. The International Renewable Energy Agency calculated that electric heat pumps for domestic heating would provide 270% more heat than the equivalent hydrogen boilers. Similarly, electric vehicles would provide 75% more power than hydrogen fuel cell vehicles.

Organisations such as WWF advocate that zero-carbon hydrogen should only be produced with excess renewable electricity. The technology for this is developing rapidly. Plans to build the first commercial-scale 'green' hydrogen plant to use only excess renewable electricity were announced in Belgium in January 2020. This will be the world's largest electrolyser, and the Belgium consortium plans an even larger one for 2025.

The financial costs of hydrogen production

Hydrogen production from fossil gas is cheaper in monetary terms than electrolysis at present but comes with enormous environmental costs. However, current prices do not include the costs of CCS.

Both 'green' hydrogen and 'blue' fossil hydrogen with CCS will require considerable investment in developing technologies and infrastructure in the coming years. A report from Bloomberg NEF (BNEF) suggests that when CCS is taken into account, the costs of the two technologies could be similar by 2030 and 'green' hydrogen could be the cheaper option by 2050. (Some predictions go further and argue that this could happen more quickly if the industry develops quickly enough and at scale.) BNEF make two important provisos: "*this will only be possible if policies are put in place to* *help scale up technology, and drive down costs*" and "*for its use to have net environmental benefits**, it must be produced from clean sources, rather than from unabated fossil fuel processes***" (our emphasis).

Renewable electricity is getting cheaper all the time while gas prices fluctuate. Investment in renewable energy is increasing globally, not least in China especially in the offshore wind sector. Recent projections show that electricity from offshore wind could even be cheaper than electricity from gas-fired power stations as soon as 2023 in the UK. A further consideration is the pace at which the technology is developing. The costs of electrolysers have fallen by 40% in the last five years and they are scaling up quickly, from megawatt (MW) to gigawatt (GW). There are now numerous 'green' hydrogen projects at various stages of development throughout Europe, China, the US and Canada.

Choices need to be made whether to invest in 'green' hydrogen or fossil hydrogen. 'Green' hydrogen, with its greater certainty of carbon reductions and its long-term cost effectiveness is the better option.

Conclusions

Hydrogen is likely to be a key piece of the jigsaw for decarbonising hard to abate sectors of the economy, thereby helping to achieving net-zero carbon emissions, but only if it is produced from sustainable renewable energy sources.

Global hydrogen production from fossil fuels is already responsible for large amounts of CO_2 and any increase in production from gas or coal would only increase global emissions further. It would need to be produced simultaneously with reliable CCS to avoid increases in CO_2 emissions, but commercial scale CCS is not developed sufficiently to deliver this. Even with CCS a proportion of CO_2 escapes into the atmosphere.

Conversely 'green' hydrogen, produced from water using renewable electricity, would be very low carbon and the technology could rapidly become cheaper than the technology for fossil hydrogen with CCS.

Crucially though, for most purposes, using renewable electricity directly is more efficient than a hydrogen alternative and consequently hydrogen should be limited to those sectors of the economy for which electrification is not an option.

The need for hydrogen in a zero-carbon economy cannot be used to justify an expansion of onshore fossil fuel production.

This briefing was written on behalf of the Weald Action Group, an umbrella group for local groups campaigning against all forms of extreme extraction of oil and gas across the Weald and Isle of Wight in the South East of England.

wealdactiongroup.org.uk