Briefing for Citizen Participation and Public Petitions Committee for petition PE2159: Halt the production of hydrogen from freshwater.

Petition Summary

Calling on the Scottish Parliament to urge the Scottish Government to place a moratorium on the production of hydrogen from freshwater until scientific studies are undertaken to understand the impact on the environment, local economies and society.

Brief overview of issues raised by petition.

Hydrogen is currently used in the UK as a feedstock in the chemicals industry and as part of the crude oil refining process, with a very small amount of hydrogen as a fuel in transport. There are thought to be very limited natural sources of pure hydrogen (more on this below) and thus it has had to be manufactured. Almost all of this manufacture involves the use of fossil fuels; globally it is 47% from gas, 27% from coal and 22% from oil with a very small remainder made using electricity. Water is also necessary ingredient in many hydrogen production processes.

In Scotland, there is currently hydrogen produced via Steam Methane Reformation at the Grangemouth industrial site and also produced as a by-product in the production of ethylene at the Mossmorran industrial site.

Production via these means produces GHG emissions and is termed 'grey hydrogen'. While the production may be polluting the combustion of hydrogen as fuel does not release GHG emissions, and as a result, there is an increasing interest in hydrogen as a low carbon source of energy. There are a variety of different methods of production being considered, each with its own colour code.

The currently prominent and prospective methods of production are:

- **Grey hydrogen**: hydrogen produced using natural gas and from steam methane reformers (SMR), resulting in GHG emissions. This grouping sometimes also includes hydrogen produced as a by-product in oil refining. The Scottish Government use the term 'unabated hydrogen'.
- **Black / Brown hydrogen**: produced using coal, resulting in GHG emissions.
- **Blue hydrogen**: the same as grey hydrogen, but the carbon is captured and stored (CCS). CCS will likely not capture 100% emissions (see more

information below). Inputs include methane and water. The Scottish Government sometimes use the term ‘low-carbon hydrogen’.

- **Green hydrogen**: produced using electrolysis, where electricity is used to split water into hydrogen and oxygen. When using renewable electricity this is termed green hydrogen. Inputs include renewable electricity and water. The Scottish Government use the term ‘renewable hydrogen’.
- **Pink (or purple) hydrogen**: electrolysis to produce hydrogen but using electricity from nuclear power.

As Scotland moves to achieve it’s statutory net zero GHG emission, the Scottish Government and industry are focused predominantly on the blue and green methods of hydrogen production.

Water requirement for hydrogen production.

All hydrogen production technologies require water as an input. Green hydrogen production is the process of separating the hydrogen atoms from the oxygen atom in water, via electrolysis. While blue hydrogen production involves steam methane reformation, and thus also includes H_2O as a fundamental part of the process.

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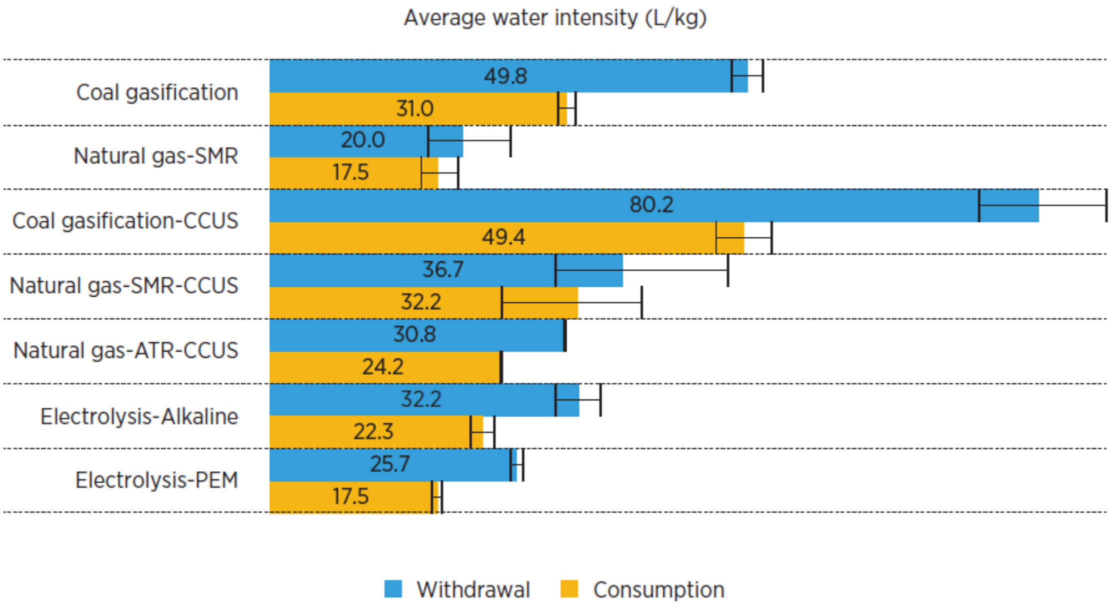
Within the general green and blue categories there are different methods that can be used. There are different forms of electrolysis, some involving alkaline methods and some involving a polymer electrolyte membrane (PEM). In blue hydrogen production, SMR can be used, or autothermal reforming (AMR). The International Renewable Energy Agency (IRENA) produced a report on Water for Hydrogen Production in 2023. They concluded that:

- It is found that on average, proton exchange membrane (PEM) electrolysis has the lowest water consumption intensity at about 17.5 litres per kilogramme of hydrogen (L/kg). Alkaline electrolysis follows PEM electrolysis, with a water consumption intensity of 22.3 L/kg. These may be compared with steam methane reforming–carbon capture, utilisation and storage (SMR-CCUS), at 32.2 L/kg, and autothermal reforming (ATR)-CCUS at 24.2 L/kg.

FIGURE S1 A comparison of average water withdrawal and consumption intensities by hydrogen production technology



In the above Graphic, taken from the IRENA report, there are figures for water Withdrawal and for Consumption. For each technology the Withdrawal figures are higher than the Consumption figures. The difference between the two figures is the amount of water that is returned to its source. The Consumption figure is the amount of water used in the production process, while the withdrawal figure includes water withdrawn but ultimately returned.

There are different sources of evidence on how much water is need for different hydrogen production techniques. A paper from Olaitan et al. (2024) finds that hydrogen production has a variable but generally high water footprint, and that hydrogen produced from water using renewable energy has a lower footprint than that produced using fossil fuels and carbon capture and storage (a similar finding to the IRENA study).

There are, however, sources which report higher water usage for green rather than blue hydrogen. A report from the engineering consultancy Arup from November 2023 on Water for Hydrogen has a different overall conclusion to the IRENA and Olaitan sources on which form of hydrogen production uses the most water, finding that:

- ‘water requirements are generally higher in the production of green hydrogen than blue, due to both feedstock water consumption and cooling water consumption and losses. There is also a higher water requirement when carrier conversion to liquid ammonia or liquid hydrogen is performed.’

The Clean Energy Group also report that more water is needed in the production of green hydrogen than there is for blue. The vast majority of the water required for blue hydrogen production is needed for cooling, with some amount of this able to be recycled.

Not all types of water are equally suitable for hydrogen production. Ordinarily, freshwater is used for electrolysis but seawater can be desalinated in order for it to be used; this adds to the overall cost of production. An article from the World Economic Forum, provides some useful background as to the type of water that is needed to produce hydrogen via electrolysis.

- ‘Traditionally, water used for electrolysis undergoes purification through a commercial reverse osmosis process and may require subsequent deionization to remove remaining ions. Water quality supplied to the majority of modern water electrolysis systems must comply with ASTM Type II standard — essentially a cleaner quality of water — although many producers recommended compliance with ASTM Type I, the cleanest standard of commercially useable water.’
- ‘ASTM Type I feedstock quality can easily be achieved by commercial reverse osmosis and deionisation plants. In essence, a vast number of large hydrogen projects announced globally will likely rely on seawater feedstock, however, they will require this extra processing step prior to feeding pure water into electrolyser to produce hydrogen.’

Scottish Water are promoting the use of treated waste water as a ‘viable, cost-effective, and environmentally responsible alternative to traditional water sources’ for hydrogen production. They believe that their Wastewater Asset Portfolio can provide good locations for hydrogen production. SEPA provide some guidance on the water abstraction and discharge involved with hydrogen production. They highlight that:

- ‘Under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) the abstraction of water is a controlled activity and will require authorisation from SEPA. As hydrogen production may need a significant amount of water, pre-application discussions are strongly advised to ensure sufficient water is available at all times of the year’

They also suggest a hierarchy of supply, prioritised as follows

- Treated effluent.
- Seawater
- Ground/surface water.
- Treated public supply should be the last option.

Scottish Government hydrogen policy

The Scottish Government published a Hydrogen Policy Statement in 2020, which had little to say on the water requirements of hydrogen production:

- ‘The key ingredients in green hydrogen production are renewable energy and water. Scotland has an abundance of wind, both on and offshore, tides, and reliable water resources within public control with which to support electrolysis.’

A Hydrogen Action Plan in 2022 included a commitment to:

- ‘Ensure hydrogen development is planned where it can be best supported by available water resources: Our Enterprise Agencies have completed the

Production Site Requirements Report that set out site requirements for large-scale renewable and low-carbon hydrogen production plants. Building on the production site requirements report, we will work with Scottish Water and industry to understand and map how water resources and infrastructure are distributed within Scotland and water availability for hydrogen production as part of our wider GIS-mapping activities.

The Scottish Enterprise commissioned 'Hydrogen Production and Export Locations: Site Requirements Study' was published in 2022.

The UK Government published a Hydrogen Strategy in 2021.

The UK Government have an explicitly 'twin-track approach' to hydrogen production policy, supporting green and blue. Although not so explicitly stated in policy documents, the Scottish Government has been thought to have similar approach. According to the UK's Scottish Affairs Committee report on Hydrogen in Scotland:

- 'The UK and Scottish Governments have taken a twin track approach to hydrogen… the dual approach supported "both electrolytic (green) and CCUS enabled (blue) hydrogen'

In Scotland, the Hydrogen Policy Statement in 2020, committed to £100m funding towards the development of a hydrogen economy over the next five years. The Hydrogen Action Plan, set out that the £100m would come from the Emerging Energy Technologies Fund (EETF) and would be made available to support renewable (green) hydrogen production. As of April 2025, a total of £10.1m from the EETF has been pledged to hydrogen, with £8.6m of this disbursed.

The Hydrogen Innovation Scheme (part of the EETF) has offered grants totalling over £7m to 31 projects. A Hydrogen Business Development Service is also funded and delivered through the Energy Technology Partnership.

In September 2024, a new support fund for green hydrogen was announced with up to £7m available. Applications were open until the end of September with a maximum of £2m in match funding on offer.

In addition to this in August 2024, the Scottish Government announced £3.1m in support for the Speyside Hydrogen Project, operated by Storegga, who will match the funding.

£6.2m has been given to the Hydroglen project which is a 'green hydrogen powered farming community pilot project in north east Scotland' being run by the James Hutton institute.

At the UK level, the Hydrogen Production Business Model (HPBM) scheme, awarded its first contracts in July 2022 to solely green hydrogen projects (including two in Scotland), in Hydrogen
Allocation Round 1 (HAR1)

- ‘The 11 projects have been agreed at a weighted average [footnote 1] strike price of £241/MWh (£175/MWh in 2012 prices). This compares well to the strike prices of other nascent technologies such as floating offshore wind and tidal stream.’

There is an HAR2 shortlist with 27 electrolytic projects, including various Scottish projects, hoping for a contract.

There is also the Net Zero Hydrogen Fund (NZHF) which aims to support the commercial deployment of new low carbon hydrogen production projects during the 2020s. Strand 1 of the NZHF provides development expenditure (DEVEX) for front end engineering design (FEED) and post-FEED activities, while Strand 2 provides capital expenditure (CAPEX) for projects that ‘do not require revenue support’ from the HPBM scheme. The first round of funding resulted in 15 successful applicants, four of which are based in Scotland. The second round of funding resulted in 7 successful projects, two of which are in Scotland. While all of these projects involve the production, storage or distribution of green hydrogen, the NZHF is open to blue hydrogen projects.

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Published by the Scottish Parliament Information Centre (SPICe), an office of the Scottish Parliamentary Corporate Body, The Scottish Parliament, Edinburgh, EH99 1SP