HYDROGEN AND CARBON CAPTURE IN SCOTLAND – VISIT NOTE

The Scottish Affairs Committee visited Cologne as part of the hydrogen and carbon capture in Scotland inquiry on Wednesday 8 June 2022.

The German Government published a hydrogen strategy in 2020.[1] The document states that: "The Federal Government considers only hydrogen that has been produced using renewable energy (green hydrogen) to be sustainable in the long term".[2] There was a Federal Election in January 2021 and a new government was formed who, in 2022, outlined that they would not fund fossil gas-based hydrogen (blue hydrogen).[3] This is in contrast with the UK Government twin track approach where it will be funding both green and blue hydrogen.[4]

Members who attended:

- Deidre Brock MP
- Wendy Chamberlain MP
- Sally-Ann Hart MP

Wednesday 8 June

The Committee was hosted by the REFHYNE green hydrogen electrolyser in Cologne. The website explains:

> Launched in January 2018, the pan-European REFHYNE project aims to supply clean, green hydrogen for refineries. Running until December 2022, it is funded by the European Commission's Fuel Cells and Hydrogen Joint Undertaking (FCH JU), and receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe, and Hydrogen Europe Research. Together with ITM Power, the project partners include Shell Deutschland Oil GmbH, SINTEF, Element Energy, and Sphera.[5]

In July 2021 the €16 million 10MW REFHYNE PEM electrolyser built by ITM Power started to work. Using renewable electricity, this electrolyser can produce 1,300 tonnes of green hydrogen a year, making it the largest of its kind in Europe, and the largest of

[1] Federal Ministry for Economic Affairs and Climate Action, The National Hydrogen Strategy (English version) 10 June 2020
[2] Federal Ministry for Economic Affairs and Climate Action, The National Hydrogen Strategy (English version) 10 June 2020, page 3
[3] Euraciv, German government disavows blue hydrogen, 17 January 2022
[4] UK Government, UK Hydrogen Strategy, 17 August 2021, page 10
[5] ITM power, REFHYNE, accessed 25 May 2022

its kind to be deployed on a major scale.[6] The REFHYNE project began in January 2018 and will run for 5 years to December 2022.[7]

The Committee visited the REFHYNE electrolyser site and saw the PEM electrolyser and the vital supporting infrastructure including electricity management, water purification and delivery into the industrial process.

The Committee heard from:

- Wolfgang Krüper, Teamlead Project Execution, Shell Energy and Chemicals Park Rhineland
- Marco Richrath, General Manager of the Shell Energy and Chemicals Park Rheinland
- Sebastian Köpp, Corporate Relations Advisor External Communications & Marketing, Shell Deutschland
- Isobel Kaul, Consultant Project Manager, element energy
- James Collins, Head of Investor Relations, ITM Power
- Dr John Newton, REFHYNE Project Manager, ITM Power

[6] ITM power, REFHYNE, accessed 25 May 2022
[7] REFHYNE, Clean Refinery Hydrogen for Europe, accessed 25 May 2022

Discussions included

The REFHYNE project

The initial request for this funding came from ITM Power who put together the consortium of companies who are involved in the REFHYNE project. ITM Power are based in Sheffield and initially approached Shell UK but were directed to Shell Germany for a more appropriate partnership as the electrolyser needed to be based in an industrial setting.

The REFHYNE project is an EU Fuel Cells and Hydrogen Joint Undertaking (FCH JU)[8] funded project. The funding EU was €20 million,[9] with Shell contributing €12 million. The Shell board approved this funding in record time against normal procedures of approval.

REFHYNE is a 10MW capacity electrolyser and produces 160kg hydrogen per hour and has been in successful operation since July 2021. The project is due to finish in 2023. Timeline for the project:

- July 2017 bid successful;
- January 2018 project started;
- June 2019 building construction starts and permit approval;
- January 2021 ITM stacks installed; and
- July 2021 commissioning and start of operations.

Companies from across the EU were involved: ITM power is based in Sheffield, SINTEF is based in Norway. Units for the REFHYNE project came from Spain and Italy and the UK.

This project is helping to see if green hydrogen is scalable and safe. Most of the piping involved is plastics.

The REFHYNE system is powered from electricity taken from the grid and produced 2% of the annual hydrogen demand for the refinery site. As the hydrogen is all used onsite there is no storage other than into the standard refinery holding tanks.

Obtaining permits for the project was a relatively smooth process as there was a lot of engagement and support from the local community.

There are five stacks which each house three electrolysers. Every stack can produce 2MW of hydrogen.

[8] Fuel Cells and Hydrogen Joint Undertaking (FCH JU), About us, accessed 9 June 2022
[9] European Commission: Cordis, Clean Refinery Hydrogen for Europe, accessed 9 June 2022

The REFHYNE project building

The building that hosts the electrolysers needs significant ventilation but a relatively humid environment as electrolysers run at 55°C for the most efficient operation. The venturi roof provides natural ventilation. The roof was expensive, but is effective with cooling and would be used on future projects.

Water quality is essential: the water conductivity must be zero and with no bubbles. The water used is recycled from water used in the refining process at another point on the site. The use deionised water from their process plant but still require water management before it enters the electrolyser. If this was not in place the stacks would need to be replaced more quickly, which would raise costs.

Electricity current management is essential. Around two thirds of the total footprint of the electrolyser system is for the electricity management to ensure controlled even delivery to the electrolysers and the other components.

Electrolysers can be damaged if they are switched on and off frequently. The project is testing how this could affect the life of an electrolyser. The results may be relevant to Scotland when it is looking at using curtailed energy (from excess renewables) for producing hydrogen.

After the electrolyser the hydrogen is wet and still needs processing to remove the water vapour and get the required standard of dry hydrogen for use in the rest of the site.

Future plans

The Committee were told they need three things to make hydrogen work: to incentivise industry, have hydrogen accepted by society and make sure hydrogen is acceptable to the government. These three things will allow industry to meet net zero.

The war in Ukraine has made decisions be taken more swiftly in Germany about green hydrogen and trying to reduce the reliance on natural gas imported from Russia.

The demand for hydrogen in Germany is not high and so government support for the demand side of hydrogen would be useful for industry as it would provide certainty for producers of green hydrogen that they could sell it.

There are plans to build REFHYNE II at a cost of €200 million - which will be a 100MW capacity electrolyser. This is estimated to provide 10% of the total hydrogen demand on the site, which is currently from grey hydrogen. It is likely some of the produced hydrogen will be used for mobility applications, such as sustainable aviation fuel and fuel for HGVs and buses. Projects are looking into how this could work. Shell are looking into building a loading facility at the site so they can use the hydrogen produced away from the site.

As Germany remains an industrial centre, and there are ambitions to move industry closer to being emission free (or at least significantly reduced carbon emissions) – the Committee were told that hydrogen will have a key role in this.

Shell refinery current focus on REFHYNE II is sustainable aviation fuels and biofuels. Shell are focusing on energy parks with refineries to use hydrogen.

The investment for REFHYNE II will be made later this year but they are awaiting news on the Renewable Energy Directive II, hydrogen legislation from Europe.

Legislative support

Shell described how legislative support needs to be from the EU, the Federal German Government and local Government. These need to work together to make hydrogen projects take place.

The German Government have a legislative requirement to substitute grey hydrogen for green hydrogen, this is along similar lines as the renewable energy obligation in the UK.

Dr Katriona Edleman, Specialist adviser, did some calculations about how this would be possible in the UK:

- UK used 0.7 million tonnes (Mt) (700 million kg) of hydrogen in 2020. Bearing in mind REFHYNE produces 160kg per hour which is 3,840kg per day. If it runs 24 hours a day. 7 days a week, in a year it could produce 1,401,600 kg hydrogen. This would equate to 700 REFHYNE projects.[10] This could be expensive.

[10] Statistics from: H2FC SuperGen, Opportunities for hydrogen and fuel cell technologies to contribute to clean growth in the UK, May 2020

Today, about 10 million tons of hydrogen is already used in the EU industry, mainly as feedstock for the production of ammonia and in the refining industry

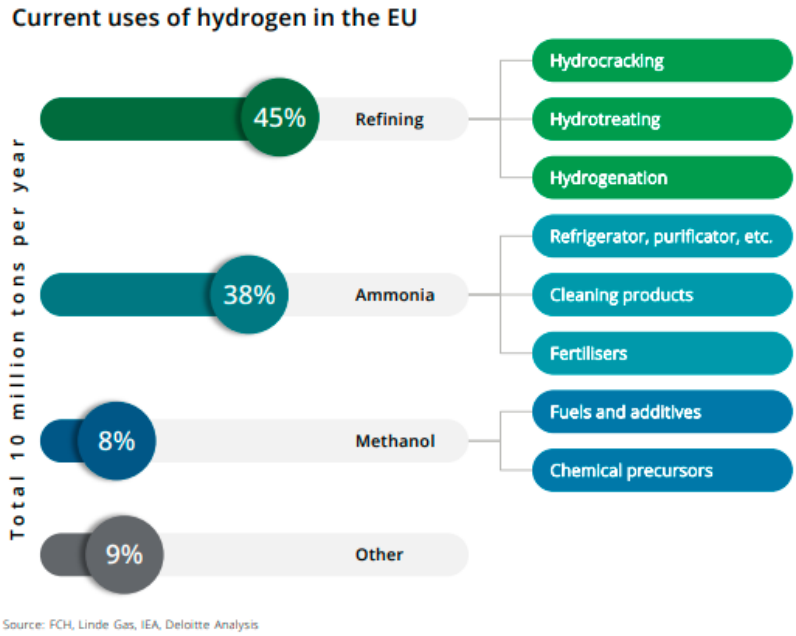
About 10 million tons of hydrogen is used in the European industry on a yearly basis, primarily as feedstock in the chemical and refining industries.

In the chemical industry, hydrogen is mostly used as feedstock to produce ammonia. Ammonia is mainly used as a fertiliser but it is also a key component of various household cleaning products under the form of ammonium hydroxide. In industrial processes, ammonia serves as a refrigerator, purificator and chemical stabilizer.

In addition to ammonia, hydrogen is involved in the production of methanol, which is mainly used as a chemical building block to produce other chemical compounds, fuels and additives.

In the refining industry, hydrogen is used in the conversion of crude oil for:

- Breaking large molecules into smaller molecules with higher added value (Hydrocracking)
- Removing contaminants such as sulfur, nitrogen and metals from crude oil fractions (Hydrotreating)
- Stabilizing some chemical products (Hydrogenation)



https://www2.deloitte.com/content/dam/Deloitte/xe/Documents/energy-resources/me_pov-hydrogen-chemical-industry.pdf

Shell's requests of Government were to remove all additionality clauses in existing relevant legislation, for example the timeframes in which things need to be produced to be able to be used in a single project – even in the short term. e.g. this has already been suggested as an action with the renewable transport fuel obligation to encourage hydrogen vehicles and production, but the additionality clauses currently prevent it helping hydrogen.

Germany has formed a National Hydrogen Council with representatives from industry and government and Shell have found this extremely positive and that industry opinions and experience are being listened to.

There should be a requirement for new import facilities in Germany to be hydrogen ready – primarily for LPG to support the switch from Russian supplies. Germany estimate 50-80% of hydrogen will need to be imported. Germany already has a Memorandum of Understanding with Saudi Arabia for hydrogen and are developing hydrogen production facilities in Chile.

Even within Europe, cross border agreements for hydrogen, CO_2 and pipelines are complex. The London protocol 2007 amendment for the geological storage of CO_2 in sub-seabed geological formations. But this might need to be amended for hydrogen.

Workforce

There are currently 1,500 permanent Shell staff and 1,500 contractors across the refining site. The REFHYNE site is expecting that numbers working on the site will reduce due to the digitisation of tasks. The digitisation of tasks is happening across the industry and is not related to hydrogen specifically. The Committee were told that the numbers of staff might reduce but in the future there will be different challenges from what Shell are facing now and so staff will be performing different roles.

There is a lot of competitions for jobs in the local area, if people think another company has better facilities they will move there. Shell are designing and building a new energy campus to help with skills training, whether for new recruits or for retraining existing staff. There are graduate programmes but there aren't enough graduates coming through to fill the roles that are needed.