



Scotland's 2030 ambitions for clean hydrogen

27th August 2020

Q&A

Q: Are there any ambitions to convert hydrogen produced in Scotland to other gases, such as methane?

A: We are certainly interested in the future of our heavy industries, particularly our chemicals industries largely based in Grangemouth. There are a number of key projects emerging through the Scotland Net Zero Roadmap (led by NECCUS) as well as the CCU Demonstrator project that will support the transition away from fossil fuels to "green" chemicals and products produced from captured CO2 and green hydrogen. (David Holman)

Q: We've heard about 'industrial' scale of H2 and policies to support this, but H2 has a place in micro-grids like Orkney as we saw early on. Where is the support for communities and non-industrial scale usage?

A: The Hydrogen Assessment was commissioned to consider the wealth and diversity of opportunity across our communities and geographies. This is based on the Scottish Energy Strategies key themes of an inclusive energy transition and smarter local energy model. The Action Plan that emerges will consider where Scotland has clear strengths and opportunities across our industries and communities and how we can support acceleration and growth. (David Holman)

Q: Matthew mentioned the benefit of a hydrogen economy attracting investment to Scotland and its local economies. What do you think is needed to ensure that investment and the associated benefits remain in the Scottish communities in which they're embedded?

A: The best opportunity for building a 'local' supply chain is to get started ahead of other places. Small companies that start in one place tend to grow in that place. That's why lots of the wind turbine supply chain is in Denmark. It was the first country to develop a regular market. Hence my point about working together to create a pipeline of projects big enough to attract a supply chain. The good news for Scotland is that places like Orkney and Aberdeen are ahead of the curve. That's why projects in the next couple of years are vital for a healthy future industry. The Westminster government focus on whisky as the first sector for hydrogen deployment is an opportunity to connect onshore wind in the highlands with local industry. (Matthew Knight)

Q: Matthew mentioned how important Scottish & UK government's collaboration in setting up a joint hydrogen strategy is. How can natural competition be outbalanced?





A: By making it clear that the UK needs to maximise the attractiveness of the whole UK market to compete with other countries around the world. Many countries now have hydrogen strategies, the UK needs to act quickly to create a market here that can build a local supply chain and attract inward investment. There is a short window of opportunity left to maximise our share of the future supply chain. 'Leading by doing' was the phrase used on the webinar. (Matthew Knight)

Q: Stuart and David, you mentioned export of hydrogen, do you see this excess of hydrogen for export to be produced from renewable sources or reformation of methane or both?

A: We see an opportunity for export of both blue and green hydrogen, depending on market demand and pricing. However, on the basis that hydrogen has a significant role to play in the decarbonisation of heat in the UK, from the mid-2020s onwards, we would anticipate much of the available blue hydrogen to be utilised in this space. From the 2030s onwards we would anticipate a significant increase in green hydrogen production from offshore wind and this would make use of our abundant wind resource in Scottish Territorial Waters. Depending on the pace of scale up, we could envisage a future where green hydrogen would ultimately replace blue hydrogen for both domestic use and export. (David Holman)

Q: It was mentioned by Siemens that they were trialling running gas turbines on Hydrogen. Is this the most efficient use of Hydrogen - are fuel cells not a better way of generating electricity, or is it simply a matter of trying to utilise existing hardware

A: Both are good. Fuel cells have an electrical efficiency of around 50% and produce low grade heat, ideal for, say, a caravan site with showers and a need to provide EV charging. Large scale power uses gas turbines today with efficiencies >60% combined cycle. (Matthew Knight)

Q: Hi Alexandra are there a list of German companies looking to invest in demonstration scale up projects, especially in the field of industrial decarbonisation i.e. whisky industry example. We are involved in an LCITP project which is almost a precursor.

[Low Carbon Infrastructure Transition Programme, launched March 2015 by SG with SE, HIE etc.]

A: There are a number of companies in Germany that are interested in these types of project. SDI Germany maintains an overview of companies looking to invest and is willing to discuss potential partners depending on the particular projects in question. It is always helpful to have details of the Scottish projects that are interested in finding partners so that we can identify companies that best match. (Alexandra Stein)

Q: What is the largest scale electrolyser currently available commercially, and what size are those being developed for the "GW scale" projects?





A: At Siemens Energy we make a Silyzer 300 PEM electrolyser - It uses 17MW and makes 8 tonnes of hydrogen a day but is designed to be put together in an array with others e.g. 3 of them is a 50MW plant that makes 25 tonnes of hydrogen a day. (Matthew Knight)

Q: Has there been a review of the multiple H2 strategies from Australia at both state/territory and federal level?

A: Scottish and Welsh governments are involved in the BEIS Hydrogen Expert Group. The Taskforce is an industry group. (Matthew Knight)

A: Yes, as part of the Hydrogen Assessment project we have reviewed a number of key government/state strategies from other countries to support our thinking and approach. Australia is included in this. (David Holman)

Q: Scotland has 5 GWs of onshore wind consented or planned. Offshore Blue and Green hydrogen at scale is 5-10 years off. Can we not start to create a market and a supply chain using onshore power?

A: Definitely – and the upcoming Whisky funding is an opportunity to put together schemes to use some of that consented wind that's delayed by grid constraints. (Matthew Knight)

A: We have recently commissioned a piece of work to look at supply chain and financial modelling of green hydrogen production from wind. Part of the study will start to explore incentives/mechanisms that might be required to unlock this market. However, future incentives to unlock hydrogen will be a national government decision. (David Holman)

Q: The RO made wind possible in the UK. What are the planned incentives to accelerate H2, RHI? Gen, RHI?

A: UK government is working on market models with the Hydrogen Expert Group, steered by the Hydrogen Advisory Council. Frontier Economics published its work on business models for BEIS this month. Expect announcements by Spring next year at the latest. There are also sector specific funding calls, such as the Whisky on recently announced. (Matthew Knight)

Q: The discussion around building out a Scottish hydrogen supply chain is interesting. How do we ensure that we do not replicate the offshore wind industry whereby Scotland has an abundance of offshore wind but has next to no supply chain here?

A: The energy transition is now becoming firmly embedded in our existing supply chains in Scotland. This was not necessarily the case when the offshore wind industry opportunity started emerging over 10 years ago. We need to ensure that we embed Scottish supply chain collaborations and innovation for hydrogen projects, demonstrator and pre-commercial, both within Scotland and internationally as these markets





begin to unlock. Projects also need to grow in scale rapidly through market demand certainty and stability so that commercial models can be unlocked that drive supply chain investment. (David Holman)

Q: Investors need sufficient scale of demand and longevity of agreements to invest with confidence. The devolved decision making across the 32 local authorities in Scotland is a challenge to getting that scale and commitment. How can Govt help?

A: Actually this could be perceived as an opportunity as we can more readily work together in Scotland to achieve the scale required to unlock projects. For example, there is an active project just now in the North East region looking at scaled demand through the transition of Local Authority and other public sector fleets to hydrogen vehicles. By growing the scale of demand across a region aims to unlock a near commercial model for the production of green hydrogen to service that demand. Such projects are supported by the Scottish Government and its agencies to help unlock scale and demand growth. (David Holman)

Q: To supply GW scale hydrogen, what kinds of hydrogen storage are needed?

A: GW scale needs geological storage or conversion to a chemical like ammonia that's easier to store than hydrogen.

See graphic below from Siemens Energy and also have a look at our Green Ammonia web site or Air Products announcement of the Neom project. (Matthew Knight)

Hydrogen Storage from MWh up to GWh range is possible

Some examples Cylinder tank - MWh range Spherical tank – GWh range Salt cavern - TWh range Typical size: ~ 2,000 m³ Typical size: 10 – 100 m³ Typical cavern size: 0.5 to 1 Mio m³ Typical pressure: 18 – 40 (100) bar Typical pressure: ≤100 bar Depth: 600 – 2.000 m Pressure range: Approx. 60 – 200 bar Pressure range: Approx. 60 – 200 bar Example Example Example 100 m³ H2 @ 35 bar ≈ 13 MWh th 2,000 m³ H2 @ 100 bar ≈ 700 MWh th 1 Mio m³ H2 @ 100 bar ≈ 0.4 TWh th New Energy Business July 2020 Intern © Siemens Energy, 2020

Q: Green h2 at scale require besides OW generation proximity of onshore sites. Standard industrial size unites require individually 40 to 50 hectares. What can a project developer expect in Scotland in order to find these sites?





A: At Siemens Energy we have done modelling suggesting hydrogen production footprint is comparable to the footprint of the grid connection substation for an offshore wind farm. (Matthew Knight)

A: There are a number of Energy Hubs emerging in Scotland in locations such as Shetland Islands, Cromarty Firth, Orkney, Aberdeen and Grangemouth. All are associated with ports. This is not an exhaustive list and Scotland has a wealth of infrastructure and sites that could support. Work is ongoing to rapidly consider how we properly articulate these opportunities. (David Holman)

Q: Are there plans for subsidies for green hydrogen producers to compete with blue and grey producers in the short term?

A: The UK government is working on this – see above answer. (Matthew Knight)

Q: Thanks for the international picture from Berlin. A question: the recent MoU with Morocco mentioned is at government to government level. What about getting an MoU between Scotland and one of the German regions?

We already have an economic agreement with Bavaria within the context of the Scottish-Bavaria MOU / Declaration of Intent, signed in 2027 and would like to explore further opportunities with other like-minded regions. (Alexandra Stein)

Q: When looking at the global green hydrogen pipeline for export markets. Some countries focus primarily on pure hydrogen, whereas other focus on hydrogen derived chemicals (ammonia, methanol etc...). What is Germany's preference for imports in the future?

A: In reality, the market will decide - it will depend on many factors such as the cost of transportation and on what the hydrogen is used for at its destination. Scotland is beginning work to explore the options open to the long distance shipping of hydrogen and happy to collaborate with others going forward on this issue. (Matthew Knight)

Q: Hi all, you briefly mentioned a Glasgow hydrogen facility in the introduction, can you confirm the details on this?

A: Details are beginning to emerge around this. Today's announcement by ULEMCo regarding 20 hydrogen fuelled gritters to be deployed in Glasgow. This will be supported by a supply of green hydrogen to support these vehicles. (David Holman)

Q: Shouldn't we look at Blue as a transition technology. Green needs to compete with electricity generation for the grid in the short / mid-term.





A: Yes. In Scotland we see blue hydrogen having a significant role to play in the transition. But ultimately, green hydrogen will be the longer term solution, given the significant renewable resource we have available in Scotland. (David Holman)

Q: Given Germany have a need to import H2 would they also consider blue hydrogen from Scotland in the mix given the resource and skills of the Scottish oil & gas sector.

A: The Germany strategy is very clear in its emphasis on importing green hydrogen, and the Economy Minister has reiterated that only green hydrogen will be sustainable in the long run. The government acknowledges that blue hydrogen or 'Co2-neutral' hydrogen with CCS will be used in Germany over the next 10 years, in line with international market developments to meet Germany's demand – and businesses such as the Heide refinery are working on this basis. (Alexandra Stein)

Q: Supply chain strengthening was identified as one of the important to do's. In which field do you see an specific need for foreign investment?

A: We have commissioned a project called the Wind to Green Hydrogen Supply Chain study. This will undertake a deep dive into our existing supply chain capability for green hydrogen production and supply at scale. It will also help to identify where there are gaps that need to either be filled by indigenous R&I activity and/or inward investment.

Any programme of activity that will develop will look to maximising economic impact in Scotland but also support collaboration opportunities between our supply chain and other complementary global supply chains where this can add value. (David Holman)

Q: As an operator of district heating networks what is the most likely way we would be able to move to a hydrogen model for reducing carbon emissions? Blended through gas network? Delivered by lorry? Any cost / emissions predictions available to 2040 /2060?

A: Ideally blended (and eventually 100% hydrogen) through the gas network where this is possible but in many cases this will be dependent on regulatory changes and UK government decision making around the future of the gas grid. (David Holman)

Q: How important is communications and public perception for Hydrogen in terms of delivering on strategic ambitions towards net zero world?

A: Very important. The SGN H100 project is looking at building a global first 100% hydrogen network supplying c. 300 homes in Levenmouth, Fife. Whilst this will be much about demonstrating a full system of green hydrogen production into a domestic network, it will also give the local community the opportunity to try out hydrogen boilers and other hydrogen ready equipment in the home to socialise the transition. (David Holman)

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Q: Are steps being taken now to develop the same sort of networks and schemes for ammonia?

A: Yes, there is. (David Holman)

Q: Does Germany anticipate having direct hydrogen import/export links to the UK?

A: It is too early to say. However, it is clear that Germany will need to import hydrogen in future and has a clear strategy to collaborate with other nations in research and innovation to this end – an area Scotland is strong in. (Alexandra Stein)

Q: As Matthew, Dave said, driving factor is market. Looking at Nat Grid FES scenarios 2020 : WIDE divergence in scen. for heat decarbonisation. ((100% H2 vs 100 % elec ??). Can a Scottish Policy progress any longer without a big UK govt decision (strategy)?

A: There are a number of projects and market opportunities that we can progress in Scotland based on our resources, skills, supply chain and geographies. In certain areas, national (UK) strategies and national policy decisions will be required (for example, heat). But certainly we all need to work together to ensure that our emerging strategies and thinking are joined up. (David Holman)

Q: With the ability to supply green h2 to vehicles at diesel parity prices 5-7£/kg-how are the panellists with SE, SG, HIE engaging with the demand side of hydrogen (ie vehicle manufacturers) to make sure Scotland is seen as a viable place to deploy fleets?

A: Yes, we are actively pursuing these opportunities working closely also with Transport Scotland. (David Holman)

Q: A colleague at ENU has a tool for modelling hydrogen storage in deep saline aquifers or depleted gas fields. It's ready to be applied and he now wants to collaborate with industry to conduct a feasibility study of potential sites. Any interest out there?

A: Interested to find out more. (David Holman)

Q: Energy conversion efficiencies for power-to-X and finally x-to-power are not particularly high and hence lots of renewable energy will be key to make this work. How commercially sustainable does the panel believe a CfD price of, and lower, £39.65 is?





A: Efficiency only matters in terms of cost and environmental impact. Low efficiency can be tolerated if it doesn't cost too much - we are quite happy with efficiencies of <20% with fossil fuelled internal combustion engines in our cars today. Actually hydrogen, or hydrogen carriers like ammonia, is one of the most efficient ways to store energy in bulk for longer periods. Where we have to manage energy seasonally chemical storage is the most cost effective and practical option. Electrolyser systems are around 70% efficient, compression / conversion to ammonia for storage might knock off another 5-10%, conversion back to power is then around 50% in a fuel cell or 60% in a combined cycle gas turbine – so overall around 30% end to end. (Matthew Knight)