Draft Hydrogen Action plan

25 January 2022, SCCS

1 Introduction

In general SCCS supports this action plan and consider it to be a comprehensive set of actions to kick-start a low-carbon hydrogen economy in Scotland, although it could be more ambitious. Many of the actions in this plan could equally apply to carbon capture and storage (CCS), which is a fundamental part of Scotland's journey to net zero in its own right and will facilitate bulk production of low-carbon blue hydrogen from natural gas. **It is essential to realise that none of the actions on blue hydrogen proposed in this consultation can occur unless CCS is developed and accessible within Scotland**. In many cases, we consider it would be useful if the actions in this plan were expanded to cover CCS, particularly CO_2 transport and storage infrastructure, rather than hydrogen alone.

2 Responses to consultation questions

To what extent do you agree with the roles that hydrogen may play in our future energy mix and the pace of hydrogen uptake as set out in the Hydrogen Economy: route map to 2030 and 2045?

Hydrogen has an important role to play in our future energy mix, so we agree with the ambition of the action plan.

The terminology around hydrogen production definitions may need to be reconsidered: 'renewable hydrogen' should include biomass gasification for the production of hydrogen (with or without CCS), since biomass can be considered to be a renewable energy source, where the supply chain of biomass feedstock origins can be validated. If 'renewable hydrogen' is only intended to mean hydrogen produced by electrolysis using electricity from renewable sources then this should be made clearer.

Furthermore, one would expect 'renewable hydrogen' to be a subset of 'low carbon hydrogen', rather than a separate category. It would be more useful to use 'low-carbon hydrogen' to describe the range of hydrogen production methods that meet (or would be expected to meet) the Low Carbon Hydrogen Standard, which is currently being developed by BEIS[1], and to differentiate them from hydrogen produced, for example, through unabated steam methane reforming, or electrolysis using grid electricity.

[1] https://www.gov.uk/government/consultations/designing-a-uk-low-carbon-hydrogen-standard

For this reason, in this response we will use the terms ‘green hydrogen’ to mean hydrogen from electrolysis using renewable electricity; ‘blue hydrogen’ to mean hydrogen produced from natural gas with CCS; and ‘low-carbon hydrogen’ to mean either or both.

An indication of the lifecycle impacts of the various forms of hydrogen production would useful.

What are your views on the actions themes and key actions identified to support the development of the hydrogen economy over the next 5 years?

The themes are:

- Scaling up hydrogen production in Scotland
- Facilitating the development of a domestic market
- Maximising the benefits of integrating hydrogen into our energy system
- Enabling the growth and transition of Scotland’s supply chain and workforce
- Establishing and strengthening international partnerships and markets
- Strengthening innovation and research

These are very helpful ambitions, and such ambitions would be equally appropriate for a CCS action plan.

One element missing from these themes is the infrastructure needed to connect supply and meet demand: both the transport of hydrogen, and its large-scale storage. There appears to be more focus on infrastructure to connect Scotland to export markets than on domestic infrastructure.

In general, we support this action plan, and would like to see a similar action plan developed for CCS in Scotland.

One area missing here is an acknowledgement that hydrogen from natural gas is likely to come first, because it is at TRL9 – but it is dependent on the availability of a CO_2 takeaway service to make it blue hydrogen. It is also dependent on the availability of natural gas on the global market, which is very vulnerable to supply shortages driven by business and a buffer store of methane feedstock into SMR or ATR conversion plant is needed.

Green hydrogen is entirely dependent upon the abundant supply of very low-cost wholesale renewable electricity, which itself is dependent on the construction of the projects offered agreements in the ScotWind licensing round. Green hydrogen lags behind operating wind supply, and the consenting process for offshore wind can take several years; there is also a huge scaleup necessary to extend and strengthen the onshore electric transmission network from north and east Scotland to the central belt and England, and the risk of delay inherent in that, as was seen with the Beauly-Denny link.

We provide our detailed comments on some of the actions below:

Action 2: Ensure the regulatory, planning and consenting framework for renewable energy and hydrogen developments supports the scale-up of hydrogen production at pace.

The review proposed under this action should include the legislative, regulatory and standards landscape for CCS, since that will be essential for the deployment of low-carbon hydrogen. SCCS has identified a number of further areas for exploration. An output of the work proposed in this action plan should be an updated regulatory test toolkit, either for CCS and hydrogen separately, or for the two together. The 2011 CCS toolkit[2] is now out of date, both in terms of the legislative and policy framework and the potential applications of CCS, which would now include hydrogen, industry, energy from waste and greenhouse gas removals.

Work to ensure the marine planning processes support the delivery of hydrogen electrolysis at sea should also ensure that the marine planning process supports the delivery of CO_2 transport and storage infrastructure, and consequently blue hydrogen.

Action 3: Ensure our ambitions for onshore and offshore wind development in Scotland support our 5GW by 2030 hydrogen ambition.

It would be useful to set an interim target for low-carbon hydrogen production, and for demand. The easiest way to create a market is through hydrogen blending in the gas grid, creating a guaranteed purchaser and encouraging investment, driving cost reductions.

Action 4: We will build on our evidence base to understand the extent of the role renewable hydrogen is likely to play in a domestic and global market.

It would be helpful to expand this action to include all forms of low-carbon hydrogen production.

The key advantage of hydrogen is as energy storage in the system: hydrogen storage is likely to be significantly lower cost, and more resource efficient, than electric batteries.

It would also be helpful to identify where hydrogen offers monetizable advantage over green electricity.

In terms of export opportunities, it would be useful to understand the hydrogen production potential of the countries that could be Scotland's competitors, and the cost of transporting hydrogen by ship or other means.

Action 5: Support spatial planning in enabling the establishment of hydrogen projects.

This action should cover marine planning, as well as land-use planning, and the interfaces between the two.

[2] https://www.sccs.org.uk/images/expertise/reports/toolkit/CCS-Toolkit-Full.pdf

There should also be detailed guidance and training for planners on how to incorporate hydrogen and CCS requirements in their development plans, and how to assess applications for hydrogen, CCS and supporting infrastructure developments.

We will provide more comments on our views on NPF4 in relation to CCS and hydrogen in due course, but for our initial thoughts, please see the evidence we submitted to the Scottish Parliament.[3]

Action 6: Support the Scottish Cluster to deliver on its ambition to produce low-carbon hydrogen at scale.

We strongly welcome this action. The delivery of the Scottish Cluster is essential for Scotland to be able to produce blue hydrogen. Estimates of the relative price of blue and green hydrogen vary, but blue hydrogen is currently significantly cheaper per tonne than green.

Action 7: Ensure low- carbon hydrogen produced and used in Scotland is compatible with our climate ambitions.

The methodology and thresholds for emissions associated with low-carbon hydrogen production should cover all forms of hydrogen production (i.e. electrolysis and methane reforming), and should be expressed in terms of the carbon intensity of the hydrogen produced. For reformed methane this should include the carbon intensity of production of the methane (which will differ from country to country) and for electrolysis this should include embedded emissions in the electricity generation assets. Both production processes also require the use of water, which should also be taken into account.

We agree that the highest possible CO_2 capture rates should be sought. Johnson Matthey, part of the HyNet project, have said that the auto-thermal reformer that is part of the HyNet project in Ellesmere Port will have a >95% capture rate.[4]

Action 8: We will not support new hydrogen production where CO_2 is unabated.

We strongly support this action, and the intention to integrate the UK low-carbon hydrogen standard into funding schemes. These criteria should also be incorporated into planning policy and guidance.

Action 11: We will support Scottish industries to use hydrogen in their decarbonisation plans.

We note that Net Zero Transition Managers will be embedded on high-emitting manufacturing sites. For these to add value to existing environmental management roles, they would need to work between companies to develop shared approaches to deep decarbonisation. This then leads to the question of who will employ them, and how to navigate issues such as commercial confidentiality.

[3] https://www.sccs.org.uk/images/expertise/reports/working-papers/NPF4_evidence_to_Scottish_Parliament.pdf
[4] https://matthey.com/en/news/2020/world-first-low-carbon-hydrogen-projects-in-the-north-west-win-13m-government-backing

We welcome the commitment to take action on the recommendations of the Scotland's Net Zero Roadmap project.

Action 12: No support for new unabated hydrogen production.

This appears to be a repeat of action 8.

Action 18: We will continue to work with SGN and National Grid Gas Transmission to provide evidence on the role gas decarbonisation can play in meeting our targets, and a timeline for resolving uncertainties.

The fifth sub-action here - We will identify ways to support projects which seek to demonstrate renewable hydrogen production and blending in the gas network - should be technology agnostic (as long as the source of hydrogen is low-carbon).

Action 21: Explore the use of hydrogen as an energy storage and balancing asset to the national electricity grid and the national gas grid including the repurposing of existing national grid pipelines for hydrogen use, transportation and storage.

Energy storage is likely to be the area where hydrogen out-competes electricity.

Sub action: Reflecting the critical role that hydrogen can play as a low-carbon energy source providing flexibility, resilience and balancing to the wider energy system, we will develop a vision for the role of hydrogen storage as an integrated part of the hydrogen and wider energy systems.

SCCS members have undertaken surveys of geological hydrogen storage on land and offshore in Scotland and the rest of the UK. There is massive opportunity for hydrogen storage, many times more than annual need. This needs research support to continue evaluation, in partnership with UK industries and gas distribution companies

Massive hydrogen storage is an inevitable need and a no-regrets action for the gas network in Scotland, the rest of the UK and Ireland. Scottish companies are exceptionally well positioned to evaluate and design this, due to hydrocarbon legacy skills, and to develop the infrastructure and sales.

Work at Edinburgh University[5] indicates that we will need around 100TWH of annual hydrogen energy storage and that scale of storage can only be delivered by geological storage in depleted gas fields. As permitting a site for storage can take many years, we need to get a demonstration project for hydrogen storage in porous rocks underground operational as soon as possible.

[5] https://blogs.ed.ac.uk/hystorpor/

Storage of hydrogen is envisaged as 30% of UK annual methane consumption. Such storage has not previously been needed, due to the ability to produce more methane, but for a manufactured energy vector such as hydrogen, big stores are essential.

Action 22: Support the establishment of a Hydrogen Transportation and Distribution infrastructure to support our ambition to export hydrogen to the rest of the UK and Europe.

This action should also cover transport, storage and distribution infrastructure within Scotland, and should include the potential for hydrogen transport by ship. Studies on re-purposing and optimising existing pipeline infrastructure should also consider their potential use for CO_2 transport.

Action 23: We will work with the Enterprise Agencies to build support for the Scottish Hydrogen Supply Chain through the development of a Hydrogen Economy Cluster.

We support this action. CCS will play a crucial role in the development of Scotland's hydrogen economy, so should have support through this project.

Action 26: We will fund a Hydrogen Business Development service, delivered through the Energy Technology Partnership, to accelerate knowledge exchange between academia and enterprises to stimulate innovation in the hydrogen sector

It would be helpful to fund a similar role for CCS.

Action 27: We will work with industry to produce a Hydrogen Export Plan.

This plan should cover all low-carbon hydrogen, not just renewable.

Action 28: We will work to ensure our ports and terminal infrastructure matches our ambitions for a hydrogen economy.

The review of ports and infrastructure preparedness should cover CO_2 transport and storage as well as hydrogen export: Scotland has the opportunity to build an industry around storing CO_2 from other countries, as well as its own captured CO_2, and ship transport is expected to be part of that.

It is possible that hydrogen will be transported in the form of ammonia, as this is a globally established industry and likely to be lower cost, so the review should also take ammonia transport – both pipelines and ships – into account.

International standards for equipment connectivity should also be considered.

Action 29: We will support the development of hydrogen transport options and international supply chains from Scotland to European customers.

This work should cover all low-carbon hydrogen, not just renewable.

Action 30: We will press the UK Government to take the action necessary at a UK-level to facilitate the smooth international trade of hydrogen, in line with Scottish export ambitions

A key part of this will be ensuring that the UK low carbon hydrogen standard aligns with EU and international standards.

Action 31: We will work with our overseas offices and Scottish Development International (SDI) to boost inbound and outbound trade and investment missions to secure opportunities for Scottish companies in the international hydrogen market.

There will also be similar opportunities for Scotland to support other countries' decarbonisation by storing the CO_2 and providing CCS expertise and technology: this should also be part of trade and investment missions.

Action 32: We will develop a Hydrogen Outreach Programme.

CCS is a vital part of industrial decarbonisation, as well as essential to the production of blue hydrogen. The work under this action should include Scotland's CO_2 storage offer to countries that do not have their own CO_2 storage resource.

Action 33: We will work to strengthen existing relationships and develop new bilateral partnerships.

See response to Action 32. The work on this action should cover all forms of low carbon hydrogen, not just renewable.

Action 34: We will launch a Scottish Hydrogen Innovation Fund to drive technological progress and advance innovation in Scotland.

The Hydrogen Innovation fund should cover all forms of low carbon hydrogen, not just renewable. Innovation work should not be limited to hydrogen production, but should also include transport, storage and building demand and developing markets.

Action 35: We will, in partnership with our Enterprise Agencies, establish a Scottish Hydrogen Innovation Network to provide support to the growing hydrogen research and innovation ecosystem in Scotland.

We welcome the development of this network. There will also be crossover with research and innovation on CCS.

Action 36: We will support multi-national collaboration on research and innovation challenges & Action 37: We will support the Scottish academic and research community to further hydrogen research.

We welcome these commitments.

Further funding for research and development partnerships into Europe and with green hydrogen producers in emerging economies such as Namibia, Taiwan and, Oman, would be useful.

In your view, is there any further action that we, or other key organisations (please specify), can take to maximise the positive impacts and minimise negative ones on people, communities and businesses in Scotland in support of a just transition to net zero?

We suggest the following further areas for action:

Ensure alignment between land-use planning, marine planning and infrastructure investment, for both hydrogen and CCS infrastructure, and undertake capacity building for planners, regulators and other decision-makers.

Ensure that the locational study for hydrogen includes the infrastructure needed to support blue hydrogen, that is CO_2 transport and storage infrastructure, such as storage sites, port facilities and pipelines that may be suitable for re-use. Include relevant data from the OGA's National Data Repository (and their other data sources) and the CO_2Stored database.

Call on the UK government to deliver a carbon border adjustment mechanism that takes into account the greenhouse emissions from the production of natural gas, in line with the industry's commitments in the North Sea Transition Deal, to reduce the embodied emissions in the feedstock of blue hydrogen produced in the UK.

Carry out further work to understand how CCS can further reduce the carbon footprint of hydrogen, for example in conjunction with biogas reforming.

Consider opportunities – perhaps through SEPA's sustainable growth agreements – to maximise synergies between technologies: for example using the oxygen given off from electrolysis (green hydrogen production) in auto-thermal reforming (blue hydrogen production).

Consider the potential for a Project of Common Interest in the form of a pipeline to link Scotland's hydrogen production with users in the European Union.

For a just transition, policy needs to enable the growth and transition of Scotland's supply chain and workforce through technical and safety standards, ensuring that people with skills and experiences developed over many years are retained within Scotland. Projects, such as SGN's H100, that support the development of installation standards and training specifications for the repurposing of existing natural gas systems for use with hydrogen is very welcome. Hydrogen storage in depleted gas fields is envisaged to retain vital skills, jobs and infrastructure.

The energy transition will be expensive, with significant upfront capital costs. Policy must address who pays for this transition and export revenues could play a significant part. Ultimately costs will pass to the consumers, but this will not impact everyone equally. Cost recovery exclusively through utility bills will impact the poorest households and struggling

companies the most unless there is government support to ensure a fair, equitable and inclusive energy transition.

Are there further actions that could be taken by government or industry that you think would drive a reduction in the cost of hydrogen? Please provide evidence to support any suggestions.

Green hydrogen requires a significant reduction in production costs and this can be supported through the focus on innovation. Continued focus on research will result in falling renewable power costs and reductions in electrolyser costs with innovations in design, materials, efficiency and flexibility that occur with increasing economies of scale. In addition, policy can provide dedicated support such as reduced tax on electrolysers and grants to decrease investment costs.

What are your views on the funding principles and scope of the Emerging Energy Technologies Fund? In your view, are there any eligibility and project assessment criteria we should consider as part of the Emerging Energy Technologies Fund?

The scope of the EETF should be all forms of low carbon hydrogen, not just renewable. We suggest that the purpose of the fund should be "to support the development of a *low-carbon* hydrogen economy in Scotland [etc]".

The £100M EETF is a good start but needs to be implemented in a strategic manner with innovation towards production, distribution and demand in parallel and in unison with knowledge exchange between academia and industry to maximise impact.

In your view, what should be the priority areas of focus for the Hydrogen Innovation Fund over the next 5 years?

Infrastructure is a crucial area for investment – both to transport and store hydrogen, and to transport and store CO_2 from low-carbon steam methane reforming. Without this infrastructure in place, it will hard to scale up supply and demand for hydrogen. A pilot project for the geological storage of hydrogen would be valuable.

3 Scottish Carbon Capture & Storage

Scottish Carbon Capture & Storage (SCCS) is the largest CCS research group in the UK, providing a single point of coordination for CCS research, from capture engineering and geoscience to social perceptions and environmental impact through to law and petroleum economics.

Our internationally renowned researchers provide connected strength across the full CCS chain. With our unique position SCCS is able to act as the conduit between academia, industry and government.

SCCS has access to cutting-edge experimental and analytical facilities, expertise in field studies, modelling and simulation, key academic and research personnel to accelerate the

development of CO2transportation, capture and subsurface storage. We undertake strategic fundamental research and are also available for consultancy. In addition, we perform a key role in providing impartial advice to industry, the public sector, government agencies, and policy makers.

Founded in 2005, SCCS is a partnership of the British Geological Survey, Heriot-Watt University, the University of Aberdeen, the University of Edinburgh, the University of Glasgow and the University of Strathclyde working together with universities across Scotland.

This submission does not necessarily represent the views of the individual members of the SCCS Directorate nor of the SCCS consortium partner institutes.