Climate Change Plan update

January 2021, Scottish Carbon Capture & Storage

1 Introduction

We welcome the opportunity to provide evidence on the Scottish Government's Climate Change Plan update (CCPu), which represents a ramping-up of efforts to tackle climate change in line with the 2045 net-zero target.

The move from a target of 80% emissions reduction in 2050 to net-zero emissions in 2045 means that decarbonisation activities that were previously considered optional now become a necessity. We are pleased, therefore, to see that the Scottish Government has made a commitment to deploying carbon capture and storage (CCS); that it has recognised the importance of low-carbon hydrogen; and that it has understood the need for greenhouse gas removals, or "negative emissions" to balance residual emissions and enable Scotland to reach net zero.

We consider CCS to be crucial to the achievement of net zero, not least because it underpins the bulk production of low-carbon hydrogen from methane, and the ability to use either direct air capture or biomass to permanently remove carbon dioxide (CO_2) from the atmosphere. We would stress that this does not mean other climate mitigation activities are unnecessary: CCS is a set of technologies that prevents CO_2 reaching the atmosphere, but it must be developed alongside measures to reduce consumption and improve efficiency in line with the waste, energy and travel hierarchies. We support an approach to emissions reduction that uses "all the tools in the box" and keeps options open for early stage technologies to be developed and deployed.

We have seen with the Covid-19 pandemic that governments can take swift and decisive action in an unprecedented situation, and can deploy public resources for activities that might previously have been considered politically difficult, if not impossible. We have also seen – for example with hydrogen – that technology can emerge and develop quickly, and move from the fringes to the centre of policy given the right support.

We welcome the Scottish Government's intention to take a cross-government approach to reaching net zero, and in a way that enables a just transition and a green recovery from the Cover-19 pandemic. Such a joined-up approach is crucial to decarbonise efficiently and to maximise the co-benefits of climate action.

2 Industrial decarbonisation

We strongly welcome the intention to take a sequenced and strategic approach to industrial decarbonisation. This is vital to achieving a just transition for workers in high-emitting industries.[1]

SCCS is a partner in the NECCUS-led Scotland's Net Zero Roadmap project, and we are keen that the findings of this project make a real impact on Scotland's industrial emissions. We welcome support for the Acorn project as the crucial first step for industrial decarbonisation in Scotland, but consider the build-out to all industries to be just as vital.

A strategic approach to industrial decarbonisation will require the provision of new infrastructure, both to provide the CO_2-takeaway service and to allow the use of hydrogen. This is not currently addressed in the Scottish Government's draft Infrastructure Investment Plan (see section 6.1), so a revision will be needed.

3 Carbon capture and storage

We strongly welcome the CCPu's recognition that deploying CCS will bring employment opportunities, both in building and operating the infrastructure and in the new and existing low-carbon industries that it will support. We would also like to emphasise that CO_2 storage in the offshore geological subsurface has the opportunity to bring revenue to the Scottish Government, through Crown Estate Scotland's rights to leasing the porespace.

Scotland has the capacity to store **at least** 5.7 gigatonnes CO_2 and potentially 70 Gt CO_2[2]. The ALIGN-CCUS[3] project has developed a Storage Readiness Level approach, which can be used to characterise this resource in more detail[4].

For context, Scotland's annual greenhouse gas emissions in 2016 were 41.6 million tonnes (Mt) CO_2e[5], so 5.7Gt CO_2 is over 130 years' of Scotland's emissions at current rates. This means that, while Scotland reduces its emissions through means such as increased efficiency and reduced resource use, this storage capacity can be used to provide CO_2 storage for other countries that have industrial emissions but lack the geological resources. This approach is already being taken forward by Norway as part of its Longship project[6].

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[1] See our briefing on the role of CCS in a just transition for more information: https://www.sccs.org.uk/images/expertise/reports/working-papers/WP_SCCS_2019_01_Just_Transition.pdf

[2] SCCS (2009) Opportunities for CO_2 storage around Scotland – an integrated strategic research study. Available at: http://www.sccs.org.uk/images/expertise/reports/opportunities-for-co2/CO2-JointStudy-Full.pdf

[3] www.alignccus.eu

[4] Akhurst, Maxine et al (2018) *Steps to achieve storage readiness for European industrial CO_2 source clusters*. Available at https://www.alignccus.eu/sites/default/files/Steps%20to%20achieve%20storage%20readiness%20for%20European%20industrial%20CO₂%20source%20clusters.pdf

[5] Scottish Government (2020) *Scottish greenhouse gas emissions 2018*. Available at: https://www.gov.scot/news/scottish-greenhouse-gas-emissions-2018/

[6] https://ccsnorway.com

Research carried out by SINTEF to support the Norwegian CCS projects suggests that the market for CO_2 storage in Europe would be between 50-390 $MtCO_2$/yr in 2030 and between 170-1087 $MtCO_2$/yr in 2050, which they translate to revenue of 65-400 billion Norwegian Krone (NOK) (£5-34 bn) in 2030, and 190-900bn NOK (£16-77 bn) in 2050[7].

The Centre for Energy Policy assumes that Scotland could take 40% of the European CO_2 storage market (in line with the UK having about 40% of Europe's geological storage resource), and estimate that this would support between 22,000 and 105,000 UK jobs by 2050[8]. Based on SINTEF's assumptions, this suggests revenue of between £2 billion and £13 bn in 2030, and £6 bn to £30 bn in 2050. Even at the lowest estimate, the revenue would be considerable.

3.1 New funding

We welcome the funding streams for industrial decarbonisation proposed in the CCPu.

We recommend that the Carbon Capture and Utilisation (CCU) Challenge Fund is designed in a way that maximises CO_2 emissions reduction and incentivises carbon capture. While some potential uses of CO_2 – such as making building materials – can keep the CO_2 out of the atmosphere in the long term, others (for example, its use in the food and drink industry) only delay its release to the atmosphere by days or weeks. The CCU Challenge fund must, therefore, ensure that it does not support uses that are in conflict with climate change goals, and must ensure that the CO_2 used is captured from a waste gas stream in Scotland and not produced intentionally for the project.

It is not clear what the proposed Emerging Energy Technologies Fund is expected to cover so we look forward to receiving more detail.

3.2 Supply chain

We welcome the intention to learn from the past and capture supply chain and jobs opportunities as well as private investment.

We consider that the proposed requirement for wind energy developers to include supply chain commitments should also apply to the development of CCS and hydrogen projects.

A study[9] by the Energy Industries Council and the CCSA found that there is an urgent need to understand and, where needed, upscale and enhance fabrication yard capabilities so that equipment can be produced domestically.

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[7] Størset et al (2018), *Industrial opportunities and employment prospects in large-scale CO_2 management in Norway*. Available at: https://www.nho.no/contentassets/e41282b08ceb49f18b63d0f4cc9c5270/industrial-opportunities-ccs_english.pdf

[8] Turner et al (2019) *The economic opportunity for a large scale CO_2 management industry in Scotland.* Available at: http://www.evaluationsonline.org.uk/evaluations/Search.do?ui=basic&action=show&id=689

[9] Energy Industries Council (2020) *CCUS – UK Supply Chain Capabilities*. Powerpoint slide pack available on request

Domestic production would also benefit from an element of standardisation of the basic design of equipment in order to reduce costs, and programme- rather than project-length contracts to give yard operators the confidence to invest in upgrades.

4 Negative emissions technologies

We strongly welcome the inclusion of negative emissions technologies (NETs) as a separate chapter in the CCPu. This reflects the role that NETs will need to play in balancing residual emissions from parts of the economy where complete decarbonisation is not possible.

There are opportunities for "quick wins" in negative emissions (once CO_2 transport and storage infrastructure is in place), which are not explored in the CCPu but that should be considered as a priority: SCCS research[10] has found that there is the potential to **capture 2.1 $MtCO_2$ per year from existing biogenic sources** at 29 sites across Scotland.

This research estimated current (2017) biogenic emissions from anaerobic digestion (including biogas, landfill, sewage gas and biomethane upgrading), biomass combustion and fermentation industries (beer and whisky). Total biogenic emissions from these sources in Scotland were estimated to be 3.35 $MtCO_2$/yr.

These include six major sites where biomass is burned for power generation, heat or both, accounting for around 1.4 $MtCO_2$/yr. Scotland also has seven industrial-scale grain whisky distilleries, which account for around 0.25 $MtCO_2$/yr. The fermentation process gives off a concentrated stream of CO_2 as yeast turns sugar to alcohol, and CO_2 capture (for use in the food and drink industry) has previously been deployed at the North British Distillery, in Edinburgh.

We welcome the proposal to carry out a detailed feasibility study of opportunities for developing NETs in Scotland and recommend that existing emitters of biogenic CO_2 should be included in the scope of the study.

5 Hydrogen

We welcome the recognition of the important role that hydrogen can play in decarbonisation, particularly in terms of dispersed emissions, such as from domestic heating. Hydrogen can be produced in bulk through steam methane reforming, with the CO_2 off-gas captured and stored in the subsurface.

It is important to consider how and where hydrogen will be stored, particularly as interseasonal differences in demand are likely to be substantial: it is well

[10] Brownsort, Peter (2018) *Negative Emission Technology in Scotland: Carbon capture and storage for biogenic CO_2 emissions*: https://www.sccs.org.uk/images/expertise/reports/working-papers/WP_SCCS_2018_08_Negative_Emission_Technology_in_Scotland.pdf

established that methane use in winter (mostly for heating) is about six times that of summer, and that the demand for gas on a winter's day can more than double within three hours[11].

The EPSRC-funded HyStorPor[12] project at the University of Edinburgh is the UK's first practical project aiming to establish the feasibility of storing hydrogen in underground porous reservoirs. HyStorPor is developing fundamental understanding of hydrogen flow and reactivity in the subsurface, upscaled to the storage reservoir, coupled with public engagement to set the scientific foundations for hydrogen storage in porous rocks.

Retaining hydrogen within a porous sandstone requires a no-flow caprock layer above the gas. Calculations indicate that caprocks sealing methane into known gasfields will provide increased caprock sealing capacity to hydrogen.

North Sea depleted gas fields have greater salinities and hotter temperatures that inhibit bacterial growth – which can prevent the storage of hydrogen – thereby reducing the risk of hydrogen loss and contamination. These criteria identify suitable candidates for hydrogen stores as 7 from 42 fields examined by the project[13]. Not all sites are suitable for hydrogen storage, so government planning is needed to protect those most suitable sites and allocate them to hydrogen storage.

HyStorPor is identifying potential sites for hydrogen storage onshore in the UK, which could integrate with demonstration projects[14], such as SGN's H100 Levenmouth project for replacing natural gas in the gas grid with 100% hydrogen, where potential storage sites lie within 10km of the project.

Studies[15] using criteria for hydrogen storage, and data from CO_2 storage databases have shown that the UK has some of the world's largest storage capacity - between 2,660- 6,900Twh, which is at least 17 times the UK's expected storage requirement of 150KWh[16]. The next step is to undertake field tests to verify these calculations and bring the technology closer to commercialisation. This can be achieved through the implementation of a pilot site for the storage of hydrogen in an underground porous reservoir, ensuring Scotland and the UK take a world leading position.

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[11] Wilson, Taylor, Rowley (2018) '*Challenges for the decarbonisation of heat: local gas demand vs electricity supply Winter 2017/2018'* UKERC Briefing Note. https://ukerc.ac.uk/publications/local-gas-demand-vs-electricity-supply/

[12] HyStorPor (2021) project website, University of Edinburgh https://blogs.ed.ac.uk/hystorpor/

13 Thaysen etal (2021) Microbial hydrogen consumption in hydrogen storage as a basis for site selection https://eartharxiv.org/repository/view/1799/

14 Heinemann et al (2018) Hydrogen storage in porous geological formations onshore play opportunities in the midland valley. Int J Hydrogen Energy, 43, 20861-20874.

15 Scafidi et al (2021) quantitative assessment of the hydrogen storage capacity of the UK continental shelf. Int J Hydrogen Energy https://doi.org/10.1016/j.ijhydene.2020.12.106, Mouli Castillo et al (2021) Mapping geological hydrogen storage capacity and regional heating demands, Applied Energy https://doi.org/10.1016/j.apenergy.2020.116348

[16] Scafidi et al (2021) quantitative assessment of the hydrogen storage capacity of the UK continental shelf. Int J Hydrogen Energy https://doi.org/10.1016/j.ijhydene.2020.12.106

5.1 Hydrogen policy statement

We welcome the publication of the Scottish Government's Hydrogen Policy Statement[17] at around the same time as the CCPu. However, we question why there is no similar document for CCS.

Both CCS and hydrogen deployment entail the establishment of a new sector and share many of the same issues, such as: the need to develop the supply chain; the potential to re-use existing infrastructure (and the risks associated with not planning for that); and the need for funding and legislative decisions from the UK Government. Hydrogen deployment in Scotland depends on the availability of CCS and we consider that a policy statement and action plan for CCS would be beneficial to the development of both sectors.

6 Other policy areas

6.1 Infrastructure

The CCPu refers to the Scottish Government's draft Infrastructure Investment Plan. We have significant concerns that this plan as it stands is not fit for purpose and will fail to deliver the infrastructure needed for net zero emissions in Scotland.

Our main concern is that industrial decarbonisation is not considered in the Infrastructure Investment Plan, despite the Scottish Government's ambitions in the CCPu to have CCS operational in the mid-2020s. Consequently, the plan does not adequately consider infrastructure needs relating to CCS and hydrogen, and risks hampering their deployment.

We prepared a detailed response on the inadequacies of the Infrastructure Commission for Scotland's key findings report[18] yet, despite this, these inadequacies were carried through to the Infrastructure Investment Plan. We urge the Scottish Parliament to ensure that infrastructure investment in Scotland aligns fully with Scotland's climate change targets. This includes:

- Recognising that the size of Scotland's industrial emissions is comparable to the size of its emissions from heat and transport
- Recognising that industrial emissions are not just about heat – there are also unavoidable process CO_2 emissions
- Ensuring that the Scottish Government's definition of infrastructure explicitly includes infrastructure to enable industrial decarbonisation

CCS infrastructure – or more accurately, infrastructure to transport and store CO_2 – does not exist yet in Scotland. This is perhaps why it was not picked up by the Infrastructure Commission for Scotland or in the draft Infrastructure Investment Plan. At minimum Scotland will need on- and offshore CO_2 pipelines, between the central belt and the North East and out to the offshore

[17] https://www.gov.scot/publications/scottish-government-hydrogen-policy-statement/
[18] https://www.sccs.org.uk/images/expertise/reports/working-papers/EV_SCCS_2020-01_Industrial_decarbonisation_position.pdf

storage sites, as well as potential upgrades to port and harbour facilities to enable the transport of CO_2 by ship for storage in Scottish sites.

6.2 Waste

We welcome the consideration of CCS technology for waste-to-energy plants. We recommend that the post-2025 route map for waste should consider the potential for negative emissions, where the waste includes biogenic material.

This is being explored as part of the cross-Europe NEWEST-CCUS[19] project, which aims to de-risk and accelerate the development and deployment of CO_2 capture technologies tailored specifically for waste-to-energy plants.

6.3 Public procurement

We welcome the commitment to use public procurement to support net zero. We suggest that this should include requirements for low-carbon products to be used in major public contracts after 2026 to drive industry uptake of CCS infrastructure.

7 Scottish Carbon Capture & Storage

Scottish Carbon Capture & Storage (SCCS) is a research partnership of the British Geological Survey (BGS), Heriot-Watt University, the University of Aberdeen, the University of Edinburgh, the University of Glasgow and the University of Strathclyde with associate member the University of St Andrews. SCCS researchers are engaged in innovative applied research and joint projects with industry and government to support the development and commercialisation of carbon capture and storage as a climate change mitigation technology.

[19] https://www.newestccus.eu