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Infrastructure Commission for Scotland

SCCS response to call for evidence

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Infrastructure Commission for Scotland: Call for evidence

1 A more resource efficient, lower carbon economy

The Infrastructure Commission for Scotland is tasked with providing advice on a 30-year infrastructure strategy for Scotland. This is the same timescale as Scotland's climate change targets (currently an 80% reduction in greenhouse gas emissions by 2050, but expected to become more stretching under the Climate Change (Emissions Reduction Targets) (Scotland) Bill). It makes sense, therefore, for the Infrastructure Commission to Scotland to consider the infrastructure that will be needed for Scotland to achieve its targets: that is, decarbonising heat, electricity, transport and industry; and enabling 'negative emissions' to offset emissions that cannot be eliminated.

Carbon capture and storage (CCS) will be essential for meeting the targets, and this implies the need for carbon dioxide (CO_2) transport and storage infrastructure. This will provide the opportunity to sequester CO_2 emissions from industry and thermal electricity generation before they can reach the atmosphere; it also provides the opportunity to make hydrogen from methane, sequestering the emissions from this process and providing a low-carbon fuel that can be used in heat and transport, enabling decarbonisation of those sectors. Biogenic CO_2 - for example from bioenergy, fermentation and anaerobic digestion – can be captured and stored, giving 'negative emissions', which can offset unavoidable emissions in other parts of the economy. In Scotland, there is potential for 2.1 Mt CO_2/year negative CO_2 emissions by applying CCS to existing biomass combustion, fermentation and anaerobic digestion operations.[1]

The urgency and importance of deploying CCS has been highlighted by the Committee on Climate Change's report on *Net Zero*, which states that "CCS is a necessity not an option," and proposes that Scotland sets an earlier target for achieving net-zero greenhouse gas emissions than the UK as a whole, in part because of its abundant CO_2 storage resource.[2] Now that the Scottish Government has lodged an amendment to the Climate Change (Emissions Reduction Targets) (Scotland) Bill to set a net-zero greenhouse gas emissions target for 2045[3], the necessity of deploying CCS in Scotland has been confirmed.

The role of CCS in decarbonising industry and enabling negative emissions was not included in the remit of the UK-wide National Infrastructure Commission, which means that the value and extent of CCS was not fully understood in the National Infrastructure Assessment. The Infrastructure Commission for Scotland has the opportunity to rectify that omission and carry out a more comprehensive assessment. A recent House of Commons Business, Energy and Industrial Strategy (BEIS) Committee report into carbon capture, usage and storage (CCUS) recommends that:

> "the Government tasks the National Instructure Commission— or a third party—to conduct a cost benefit analysis of the potential role of CCUS to decarbonise industrial emissions, taking account of how development of industrial CCUS would affect—and be affected by—the potential development of CCUS for other applications, notably hydrogen and power. The

[1] Brownsort, Peter (2018) *Negative Emission Technology in Scotland: carbon capture and storage for biogenic CO_2 emissions*, available at: http://www.sccs.org.uk/images/expertise/reports/working-papers/WP_SCCS_2018_08_Negative_Emission_Technology_in_Scotland.pdf
[2] Committee on Climate Change (2019) *Net Zero: the UK's contribution to stopping global warming*, available at: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf
[3] https://news.gov.scot/news/reaching-net-zero

> results of this assessment should be taken into account during decision-making on spending for national infrastructure."[4]

It is increasingly likely that hydrogen will be needed for domestic heating and in industrial uses.[5] At present, the most cost-effective way to produce hydrogen in bulk is through steam methane reforming (SMR), which has CO_2 as an off-gas that can be captured and stored.[6] Producing bulk hydrogen from methane in the 2020s will allow a market to develop that can later be served with hydrogen made with electrolysis from renewable sources, without CO_2 being produced, when this method of production becomes more cost effective.

Energy infrastructure will need to be different in 2050: as well as CO_2 infrastructure, Scotland will need improved electricity grid connections to allow increased renewable energy generation, and a repurposed gas transmission and distribution network that can carry hydrogen, or a blend of hydrogen and natural gas.

2 Securing Scotland's international competitiveness

CCS will be needed across the world: the Intergovernmental Panel on Climate Change found that CCS was needed in almost all its scenarios to keep global warming at below 1.5°C. Scotland's geology means that it is uniquely well placed to develop CCS, and to establish an industry to permanently store CO_2, preventing it reaching the atmosphere. If Scotland can move ahead with developing CCS, building on its existing academic expertise and the knowledge and skills built up in the oil and gas industry, it can establish a supply chain for CCS which can be exported globally.[7]

Estimates and ranges for Scotland's CO_2 storage potential can be found in the UK Storage Appraisal Project[8] and the Strategic UK CCS Storage Appraisal[9]. It is not possible to give a definitive figure for Scotland's CO_2 storage potential, but the total theoretical CO_2 storage capacity for the UK is 78 Gt with 50% confidence, with around 46 Gt of that in the offshore geology of Scotland. [10] The minimum capacity that could be expected to be developed in Scotland (that is, which is currently understood and categorised to a high level) is 5.7 Gt[11] – around 150 years of Scotland's greenhouse gas emissions at the current rate.[12]

Scotland's huge storage capacity is an asset which can be used decarbonise industry, heat and transport, and to provide negative emissions which can offset emissions that can not be reduced to zero. It can also form the basis of an international CO_2 storage industry, providing a service to countries that do not have their own storage capacity (for example, much of mainland Europe). The availability of storage capacity should not be seen as an excuse not to reduce emissions by other

[4] BEIS Committee (2019, *Carbon capture usage and storage: third time lucky?*, available at: https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/1094/1094.pdf
[5] BEIS (2018) *Clean growth: transforming heating – overview of current evidence*, available at https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base
[6] The Royal Society (2018) *Options for producing low-carbon hydrogen at scale*, available at: https://royalsociety.org/~/media/policy/projects/hydrogen-production/energy-briefing-green-hydrogen.pdf
[7] The UK Government's Departments of Business, Energy & Industrial Strategy (BEIS), and International Trade, are currently carrying out analysis of the economic opportunities of CCUS.
[8] https://www.eti.co.uk/programmes/carbon-capture-storage/uk-storage-appraisal-project; see also Bentham et al (2014) *CO_2 STORage Evaluation Database (CO_2 Stored). The UK's online storage atlas*, available at: https://www.sciencedirect.com/science/article/pii/S1876610214023558?via%3Dihub
[9] https://www.eti.co.uk/programmes/carbon-capture-storage/strategic-uk-ccs-storage-appraisal
[10] http://www.co2stored.co.uk/home/index
[11] 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
[12] Scottish Government (2018) *Scottish greenhouse gas emissions 2016*. Available at: https://www.gov.scot/publications/scottish-greenhouse-gas-emissions-2016/pages/3/

means, or to not take urgent and immediate action to tackle climate change: all measures will be necessary to reduce demand, generate low-carbon electricity and change behaviour.

Decarbonising industry using CCS means that high-emitting industries – either those that have a high heat demand that can only be met with fossil fuels, or those that have CO_2 emissions as a result of their chemical processes – can continue to produce goods and provide jobs in a zero-carbon economy. There is currently no other way of decarbonising industries with process emissions, such as cement manufacture, so without CCS those industries would, most likely, have to cease production in Scotland. Not only would this be disastrous for communities that rely on these employers, it is likely that production would move overseas to areas with less stringent controls on greenhouse gas emissions, increasing global emissions overall.

Research by the Centre for Energy Policy at the University of Strathclyde suggests that there is the potential for CCS to help to sustain approximately 44,000 direct and indirect Scottish jobs.[13] CCS has many roles in the just transition to a zero-carbon economy:

- CCS enables industry to keep producing, retaining jobs – around 7% of the working population in Scotland are employed in manufacturing.[14]
- CCS enables North Sea oil and gas to continue to be used for heat and transport.
- CCS jobs can directly replace offshore oil and gas jobs as North Sea production winds down.
- CCS supports the construction industry by providing low-carbon cement and steel.
- CCS makes best use of existing assets.

We recommend that the Infrastructure Commission for Scotland work closely with the Just Transition Commission, to ensure that the infrastructure needed to support the just transition to a low carbon economy is in place and to ensure that Scotland can build the supply chain and take full advantage of export opportunities associated with CCS.

3 The Scottish Government's definition of infrastructure

The Scottish Government's definition of infrastructure is:

> "The physical and technical facilities, and fundamental systems necessary for the economy to function and to enable, sustain or enhance societal living conditions.
>
> These include the networks, connections and storage relating to enabling infrastructure of transport, energy, water, telecoms, digital and internet, to permit the ready movement of people, goods and services... as well as the built environment of housing; public infrastructure such as education, health, justice and cultural facilities; safety enhancement such as waste management or flood prevention; and public services such as emergency services and resilience."[15]

This appears to be a comprehensive description of the current infrastructure landscape for Scotland; however, it does not sufficiently describe Scotland's infrastructure needs to 2050, as we transition to a low- or zero-carbon economy. Infrastructure to remove CO_2 from the economy will be necessary and will include pipelines, compressors, shipping, ports and secure geological storage. Although the

[13] Turner, Karen, Alabi Oluwafisayo, Low, Ragne and Race, Julia (2019) *Reframing the Value Case for CCUS: Evidence on the Economic Value Case for CCUS in Scotland and the UK (Technical Report)*, available at: https://strathprints.strath.ac.uk/67391/
[14] For more information, see SCCS (2018) *SCCS Briefing: The role of CCS in a just transition*, available at: http://www.sccs.org.uk/images/expertise/reports/working-papers/WP_SCCS_2019_01_Just_Transition.pdf
[15] As stated in the Infrastructure Commission for Scotland call for evidence: https://infrastructurecommission.scot/storage/15/InitialCallforEvidence.pdf

principles of CCS have much in common with those of waste management or sewerage infrastructure (removal and disposal of a pollutant), CO_2 transport and storage has a unique set of properties (not least, that the material to be transported is a gas under ambient conditions) that mean it should be considered an infrastructure category in its own right.

In addition to CO_2 transport and storage infrastructure, it is likely that Scotland will need infrastructure to transport and store hydrogen, for use in heat and transport. Hydrogen does not emit CO_2 when it is burned, meaning that it is zero-carbon at the point of use, and consequently a contender to displace fossil fuels. Hydrogen has potential for use in domestic heat and transport, and in industrial applications.

In the context of the Scottish Government's definition of infrastructure, hydrogen would come under the 'energy' category. However, because it is an energy vector that is not yet in widespread use in Scotland, we consider that it is necessary to highlight it as an emerging infrastructure need.

CO_2 transport and storage infrastructure will be a brand-new undertaking for Scotland. Currently no such infrastructure exits in the UK at large scale, but this does not mean we will be developing from a standing start:

- We can draw on international knowledge:
    - CO_2 transport and storage infrastructure exists elsewhere in the world, including CO_2 transport pipelines in the USA, CO_2 storage in Norway, CO_2 transport by ship;[16]
    - International standards and codes have been agreed.[17]
- Scotland has workers with the skills and experience that will be essential to developing this infrastructure: these include geology, engineering, chemistry and offshore expertise.
- We have existing infrastructure that can be repurposed: on-and offshore pipelines, and ports such as Peterhead.[18]
- A wealth of knowledge and understanding has been built up, through projects such as ACT Acorn[19], ALIGN-CCUS[20], Caledonia Clean Energy Project[21], East Coast[22]; the cancelled CCS commercialisation competition projects at Peterhead and White Rose[23]; and the cancelled commercialisation programme project at Longannet.[24]
- SCCS partners carry out world-leading research.[25]

4 Carbon capture and storage infrastructure

CCS is a set of technologies that tackles emissions of CO_2 at source to prevent them reaching the atmosphere.

[16] See the SCCS Global Map for more information: http://www.sccs.org.uk/expertise/global-ccs-map
[17] See https://hub.globalccsinstitute.com/publications/good-plant-design-and-operation-onshore-carbon-capture-installations-and-onshore-30
[18] See SCCS's evidence to Scottish Affairs Committee: http://www.sccs.org.uk/images/expertise/reports/working-papers/WP_SCCS_2018_04_evidence_to_Scottish_Affairs_Committee_inquiry_on_future_of_oil_gas_industry.pdf; the outputs of the ACT Acorn project https://www.actacorn.eu/about-act-acorn/infrastructure-reuse-and-decommissioning
[19] https://www.actacorn.eu
[20] https://www.alignccus.eu
[21] http://www.ccsassociation.org/news-and-events/reports-and-publications/caledonia-clean-energy-project-feasibility-report/
[22] http://www.sccs.org.uk/news/441-new-study-east-coast-ccs-can-boost-uk-economy-by-160bn
[23] https://www.gov.uk/government/collections/carbon-capture-and-storage-knowledge-sharing
[24] https://webarchive.nationalarchives.gov.uk/20121217153246/http://www.decc.gov.uk/en/content/cms/emissions/ccs/ukccscomm_prog/feed/scottish_power/scottish_power.aspx
[25] http://www.sccs.org.uk/expertise

The CCS process has three distinct parts: capture, transport and storage. In some industries, a pure stream of CO_2 is a by-product of the process and needs little additional treatment. However, in most cases, CO_2 is mixed with other gases when emitted and must be separated out by the capture process. Once captured, cleaned and compressed, the CO_2 is transported to a geological storage site to be permanently stored deep below ground.

Captured CO_2 is most commonly transported to a storage site by pipeline, but it can also be transported by road, rail or ship if smaller volumes are involved. The UK has a number of onshore and offshore pipelines that are currently used to transport gas from the North Sea; these could be repurposed to transport CO_2 in the opposite direction, from onshore sources to offshore storage sites. There will also be a need for new pipelines to complement this existing infrastructure.

Geological storage of CO_2 takes place offshore, in sites 1-2 km below the seabed, in layers of rock that are highly permeable and highly porous, such as depleted oil and gas fields and saline aquifers. CO_2 is able to move through the rock and fill the pore spaces within it, but is prevented from escaping to the surface by several layers of impermeable rock above.

While the approach to CO_2 capture will differ depending on the industrial process it is applied to, the infrastructure to transport and store CO_2 can be shared by any number of CO_2 producers. This CO_2 transport and storage infrastructure provides a CO_2 removal service in a way that is comparable to a solid waste management or sewerage service.

4.1 Current and future infrastructure stock

There is currently no CCS infrastructure in Scotland, and no demand.

However, UK and Scottish Government aspirations mean that this should change in the 2020s, and IPCC analysis suggests that there will be a substantial global need for CCS in order to meet the ambitions of the Paris climate change agreement. The Committee on Climate Change has found that the UK needs annual carbon capture and storage of 75-175 Mt CO_2 / year by 2050.

Although there is no dedicated CCS infrastructure at present, there are elements of existing infrastructure that could be repurposed for CO_2 transport and storage. These include onshore gas pipelines such as Feeder 10; offshore gas pipelines such as Goldeneye, Miller and Atlantic & Cromarty; ports such as Peterhead and Grangemouth; and depleted oil and gas fields.

It is likely that Scotland's first storage site will be in the Captain Sandstone Formation, with CO_2 transported to the storage site through the repurposed Atlantic pipeline from St Fergus.[26] About 80% of Scotland's high emitters are within 40 km of the onshore Feeder 10 pipeline[27], which runs from the Central Belt to St Fergus, making it a valuable potential asset for transporting CO_2 from source to storage site. CO_2 can also be transported by ship, meaning that ports at Peterhead and Grangemouth are also likely to be part of the CO_2 network. The presence of CCS infrastructure should make Scotland a more attractive place for high-emitting industries to locate, since they have the assurance that their CO_2 can be taken away and permanently stored.

CO_2 transport and storage infrastructure needs to be included in spatial planning. Current Scottish Planning Policy addresses CCS in relation to electricity generation, so this needs to be updated to cover the role of CCS in decarbonising industry, heat and transport. Likewise, the CCS national

[26] For more information on the Acorn project, which aims to be the first full-chain CCS project in the UK, and its plans for building out, see https://www.actacorn.eu

[27] Brownsort et al (2016) *Reducing costs of carbon capture and storage by shared reuse of existing pipeline – Case study of a CO_2 capture cluster for industry and power in Scotland*, available at: https://www.sciencedirect.com/science/article/pii/S1750583616302948?via%3Dihub

development in National Planning Framework 4 should be updated to reflect the current CCS project landscape. There will also need to be alignment between onshore spatial planning and marine planning, and between Scotland and England, to allow for onshore CO_2 transport from sources in the rest of Great Britain, ensuring that this national infrastructure is developed efficiently.

Various options have been proposed for funding CO_2 transport and storage infrastructure, including a publicly owned company[28], and a regulated asset base model[29]. BEIS is carrying out work to explore the options for business models for CCUS, including CO_2 transport and storage as a separate category to carbon capture. The Committee on Climate Change found that "Government will need to take a lead on infrastructure development, with long-term contracts to reward carbon capture plants and encourage investment."[30]

It is also likely that there will need to be an operator of last resort to take on ownership and liabilities for pipelines that are to be repurposed for CO_2, between cessation of oil and gas production, and the start of CO_2 storage activity.[31]

Public procurement of new infrastructure should require the use of low-carbon materials such as steel and cement produced using CCS. This would stimulate a market for these products and reduce the lifecycle emissions of new infrastructure.

5 Scottish Carbon Capture & Storage

Scottish Carbon Capture & Storage (SCCS) is a research partnership of the British Geological Survey, Heriot-Watt University, the University of Aberdeen, the University of Edinburgh 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.

Scottish Carbon Capture & Storage is keen to work with the Infrastructure Commission for Scotland and would be happy to meet to answer any questions or provide further information. We have a wealth of research – produced by our partner research institutions and by the SCCS team – that we would be happy to share.[32]

[28] Parliamentary Advisory Group on CCS (2016) *Lowest Cost Decarbonisation for the UK: The Critical Role of CCS*, available at: http://www.ccsassociation.org/news-and-events/reports-and-publications/parliamentary-advisory-group-on-ccs-report/
[29] CCUS Cost Challenge Task Force (2018) Delivering clean growth: CCUS Cost Challenge Taskforce report, available at: https://www.gov.uk/government/publications/delivering-clean-growth-ccus-cost-challenge-taskforce-report
[30] Committee on Climate Change (2019) *Net Zero: the UK's contribution to stopping global warming*, available at: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf
[31] ALIGN CCUS / University of Groningen presentation to stakeholder workshop on re-use of hydrocarbon infrastructure for CCS, 9 April 2019.
[32] See http://www.sccs.org.uk/expertise/reports , http://www.sccs.org.uk/expertise/reports/working-papers , http://www.sccs.org.uk/expertise/publications