WP SCCS 2018-11

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Technologies for meeting Clean Growth emissions reduction targets

SCCS evidence to Science & Technology Select Committee

October 2018

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Technologies for meeting Clean Growth emissions reduction targets

1 Key message

Just as timely Government decisions in the 1970s promoted highly effective oil and gas production in the North Sea, there is immediate opportunity for Government to achieve significant emissions reductions across the economy by promoting and supporting the proven technology of carbon capture and storage (CCS).

2 Scottish Carbon Capture & Storage

Scottish Carbon Capture & Storage (SCCS) is a research partnership of the British Geological Survey, Heriot-Watt University, 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 would be happy 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.[1] Please contact Rebecca Bell, SCCS Policy and Research Officer, on rebecca.bell@sccs.org.uk.

3 The Clean Growth Strategy

The Clean Growth Strategy states that it is a reaffirmation of the Government's commitment to deploying carbon capture, use and storage (CCUS) at scale in the UK in the 2030s, subject to cost reduction.

Carbon capture and storage (CCS) and, in some cases, CCUS, has a key role to play in meeting the UK's greenhouse gas emissions targets and in enabling the world to meet the ambition of the Paris Agreement.

Although it is explored in the *Improving business and industry efficiency and supporting clean growth* section of the Clean Growth Strategy, CCS has the potential to effect emissions reductions across the economy: by removing emissions from industrial processes and industrial fossil fuel use; by enabling efficient and reactive peaking power generation using natural gas; by enabling the bulk production of low-carbon hydrogen, which can displace fossil fuels in transport and heat; and by enabling bioenergy with CCS (BECCS), which provides 'negative emissions,'[2] which can offset emissions from parts of the economy where greenhouse gases cannot be eliminated.

[1] See http://www.sccs.org.uk/expertise/reports , http://www.sccs.org.uk/expertise/reports/working-papers , http://www.sccs.org.uk/expertise/publications

[2] BECCS is part of a suite of technologies and approaches referred to as greenhouse gas removal, carbon dioxide removal, or negative emissions technologies.

The Parliamentary Advisory Group on CCS found that CCS is essential for lowest cost decarbonisation; that it works and can be deployed quickly at scale; and that there is no justification for delay in enacting an effective CCS policy.[3] The Committee on Climate Change[4] and the Intergovernmental Panel on Climate Change[5] have both confirmed that CCS is crucial for meeting current greenhouse gas emissions targets and the ambitions of the Paris Agreement.

3.1 Progress on meeting carbon budget targets to date

The Committee on Climate Change made clear that, while there has been strong progress in decarbonising the power sector, this has masked by a lack of progress in other sectors, including industry, heat and transport. CCS has the potential to achieve significant emission reductions in these areas, and the Committee on Climate Change stated in its 2018 Progress Report to Parliament:

> "The Committee continues to stress the importance of CCS to achieving an 80% emissions reduction at lowest cost, as well as its crucial role in enabling deeper emissions reductions beyond that."
>
> "The clear evidence base shows that UK deployment of CCS is required to unlock the greatest opportunities for cost reduction (i.e. economies of scale for CO_2 infrastructure, and reductions in cost of capital by proving the technology and business model in a UK context)."[6]

There is a strong body of research and academic expertise in CCS in the UK which places us at the forefront of developing the technology. In SCCS partner institutions, this includes:

CO_2 capture and power plant engineering

- Evaluation and benchmarking of capture technologies, development of novel technologies
- Chemical modelling of capture plant and processes
- Capture-power plant integration modelling
- Performance, flexibility and power plant economics

Transport

- Impurities testing and modelling - physical properties and phase envelopes
- Dispersion modelling of leakage scenarios
- Evaluation of pipeline sensors and measurement systems
- Techno-economic modelling of capture and transport systems

Storage and injection

- Screening and ranking of CO_2 storage sites
- Full site appraisal, using a combination of field studies, monitoring and laboratory analysis
- Evaluation of monitoring technologies and techniques, baseline and ongoing monitoring
- Overburden leakage simulation

CO_2 utilisation and enhanced oil recovery

- Core testing and high pressure flow visualisation

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[3] http://www.ccsassociation.org/news-and-events/reports-and-publications/parliamentary-advisory-group-on-ccs-report/
[4] https://www.theccc.org.uk/wp-content/uploads/2018/06/CCC-2018-Progress-Report-to-Parliament.pdf
[5] http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf
[6] https://www.theccc.org.uk/wp-content/uploads/2018/06/CCC-2018-Progress-Report-to-Parliament.pdf

- Reservoir simulation and modelling to assess enhanced oil recovery (EOR) potential
- New catalytic methods of conversion of CO_2 into value-added chemicals and fuels
- CO_2 mineralisation using mineral wastes

Policy, economics and environmental and societal impact

- Researching public perceptions of CO_2 storage
- Public engagement and understanding of CCS
- Assessment of terrestrial and marine environmental impacts
- Economic testing of CCS system scenarios

The UK is uniquely well placed to develop CCS with its high-volume and well-understood CO_2 storage resources, an established subsurface industry, existing infrastructure that can be reused to reduce initial costs, and the right skills and experience needed to develop this new industry serving our own, and potentially European, CO_2 storage needs. Skilled offshore and subsurface jobs are at risk as the oil and gas industry reduces production: the skills and experience from the industry will be crucial in developing CCS, and the growth of a CCS industry will enable a just transition from oil and gas. Likewise, the existing offshore infrastructure, including pipelines, boreholes and subsurface geological data is extremely valuable.

The UK CCS Storage Appraisal[7] found that the UK has offshore geological storage potential for over 78 gigatonnes of CO_2 (the equivalent of over two hundred years of the UK's 2017 CO_2 emissions)[8] and holds data for nearly 600 potential storage sites in the CO_2Stored database. The storage capacity and the knowledge about it are assets that very few countries have, and so give the UK a competitive advantage over the rest of the EU in deploying CCS. Furthermore, the leasing rights to offshore subsurface CO_2 storage and leasing for pipelines on the seabed are part of the Crown Estate and the Scottish Crown Estate, so there is the potential for significant additional public revenue from the development of CO_2 transport and storage.

Oil and gas pipelines are strategic national assets; they should be retained and preserved as a low-cost route to access CO_2 storage in the future for large industrial emitters. **In this way the value of large public investments already made in this infrastructure can continue to be realised through re-purposing.** It could be argued, therefore, that the UK Government has a responsibility to develop CO_2 storage in order to make the best use of the natural and other assets available to it.

3.2 The extent to which current and future technologies can help to meet the carbon budgets

The areas which CCS can help to decarbonise – power, industry, heat and transport – account for 83% of the UK's greenhouse gas emissions.[9]

[7] Energy Technologies Institute (2016) *UK CCS Storage Appraisal.* http://www.eti.co.uk/programmes/carbon-capture-storage/strategic-uk-ccs-storage-appraisal
[8] Department for Business, Energy & Industrial Strategy (2018) 2017 *UK greenhouse gas emissions, provisional figures*, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/695930/2017_Provisional_Emissions_statistics_2.pdf
[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

3.3 The uncertainty in future technologies' contribution to emissions reductions

Although the Committee on Climate Change and the Intergovernmental Panel on Climate Change have both recently stressed the importance of CCS to reducing greenhouse gas emissions and achieving the Paris Agreement ambition, there are uncertainties around its deployment. These uncertainties are not a result of technical or geographical barriers, but the result of a lack of certainty around government policy, and a lack of a business case to enable the private sector to invest in CCS.

Research is continually developing and improving CCS technologies; however, the basic techniques have been in existence for decades. Indeed, the St Fergus gas sweetening plant has been separating CO_2 from North Sea gas for 20 years[10], although in the absence of storage or utilisation markets, this CO_2 has then been emitted to the atmosphere. Similarly, Norway has been injecting and securely storing CO_2 offshore in the Sleipner field since 1996, with no leakage[11]. Other CCS projects are in existence across the world – see SCCS's global map for more information[12].

The barriers to deployment of CCS are financial and political. The Environmental Audit Committee found that "the decision to cancel the [2015 CCS commercialisation] competition has had a negative impact on investors' confidence to engage with government."[13], and that "the negative impacts on CCS investors' confidence could increase costs or risk for taxpayers or consumers in deployments of the technology."[14] The Energy and Climate Change Committee found "six factors that in combination were damaging investors' confidence, including a lack of transparency or a long-term vision, inconsistency of approach and sudden changes to policies" and this conclusion is echoed by the Committee on Climate Change, which urged government to "end the chopping and changing of policy" around CCS.[15]

4 How the development and deployment of technology can best be supported

The CCUS Cost Challenge Taskforce makes sixteen recommendations for supporting the development and deployment of technology. We ask the Science and Technology Committee to urge the Government to accept and implement these recommendations in full.

It is crucial that Government supports CCS, but within that blanket term are a number of different technologies and approaches, for capture, transport and storage, which will each be more or less appropriate in different situations and at different stages in the roll-out of CCS across the UK. Support should therefore be technology-neutral to ensure that the best approach can be used in a particular circumstance. It should include support for research and give a clear signal to students and institutions that CCS is a growing opportunity. Access to EU research will be crucial, so preparations for the UK to leave the EU should ensure that they do not threaten current and future collaborations.

One of the UK's unique strengths in relation to CCS is the availability of secure, well-characterised CO_2 storage. We ask the Committee to urge the Government to accelerate the development of CO_2

10 https://actacorn.eu/sites/default/files/ACT%20Acorn%20Basis%20of%20Design%20for%20St%20Fergus%20Facilities%201.0.pdf
11 https://www.bgs.ac.uk/science/CO2/home.html
12 http://www.sccs.org.uk/expertise/global-ccs-map
13 https://publications.parliament.uk/pa/cm201617/cmselect/cmpubacc/1036/103607.htm#_idTextAnchor012
14 https://publications.parliament.uk/pa/cm201617/cmselect/cmpubacc/1036/103607.htm#_idTextAnchor012
15 https://www.theccc.org.uk/wp-content/uploads/2018/06/CCC-2018-Progress-Report-to-Parliament.pdf

transport and storage infrastructure, including taking steps to prevent the premature decommissioning of on- and offshore pipelines that have the potential for re-use for CCS.

There is also the potential to accelerate deployment of bioenergy with CCS using existing sources of biogenic emissions[16], as explored in the forthcoming SCCS working paper *Negative Emission Technology in Scotland: Carbon capture and storage for biogenic CO_2 emissions*[17]. The report recommends that Government should:

- Improve consistency and coverage of reporting of biogenic CO_2 emissions to allow better quantification of the opportunity for negative emissions.
- Consider incentives and/or policies specifically to encourage capture of biogenic CO_2 emissions.
- Support early project development to demonstrate CO_2 capture from biogenic sources at appropriate scales (smaller than previous CO_2 capture proposals).
- Initiate and/or support further work to define better the options for smaller-scale CO_2 transport modes, both technically and commercially, including the integration of such modes with trunk transport of CO_2.
- Maintain support for existing proposals that aim towards development of CO_2 transport and storage infrastructure in Scotland; such infrastructure is clearly a pre-requisite for achieving significant negative CO_2 emissions.

5 The relative priority that should be attached to developing new technologies

Priority should be placed on technologies – whether new or existing – that can decarbonise the parts of the economy where emissions reductions have so far proved hard to achieve. CCS meets this requirement, and while CCS technologies have been deployed for decades across the world, new techniques and technologies are constantly emerging and improving.

CO_2 storage makes use of depleted oil and gas fields, and its costs can be reduced by reusing existing oil and gas pipelines – this defers the cost of decommissioning and enables maximum advantage to be taken of existing infrastructure, as well as enabling a just transition for offshore workers from oil and gas extraction to CO_2 injection.

Deployment of hydrogen for heating can use existing pipework and appliances, meaning that investment in natural gas infrastructure can continue to bring value as heat is decarbonised.

We support the argument that it would be better to deploy available climate mitigation technologies now, than to defer deployment until improvements in the technology deliver improved efficiency. These efficiency benefits are likely to be marginal and outweighed by the damage caused by delaying emissions reductions.[18]

[16] Emissions from biomass combustion, anaerobic digestion, and the fermentation industry.
[17] This is due to be published on 30 October 2018 and will be available at: http://sccs.org.uk/expertise/reports/working-papers
[18] See slides: https://ukccsrc.ac.uk/sites/default/files/documents/event/Mac%20Dowell%20UKCCSRC%20Sept%202018.pdf

6 Examples of specific technologies whose development and deployment have been effectively supported so far

In providing support for CCS, government can learn from its success with offshore wind, but must take a different approach to provide an incentive for public sector investment.

The offshore wind industry has grown rapidly in the UK and technology costs have plummeted, providing a blueprint for how low-carbon industries can (with Government support) create jobs and export opportunities over the course of a single Parliament.

The UK could replicate this success by supporting CCS and go even further – by ensuring that the CCS supply chain (and associated jobs) are kept in the UK. Whilst the offshore wind sector has been a success, only 30% of supply chain is domestic.[19]

However, a clear difference between CCS and offshore wind is the lack of a product, and therefore lack of profit. In future, a CO_2 storage service is likely to be profitable, but at present there is no guarantee of a customer for this. However, other countries have seen the potential future market for CO_2 storage – for example, Norway is offering to store other countries' CO_2 in its offshore geology[20] – and the UK should do the same. The UK's storage capacity is comparable to Norway's, and much greater than that of any other EU country.[21]

In addition, there is some potential to use captured CO_2. However, the market for this is currently extremely small (estimated to be less than 1% of emissions in 2015)[22] and most of the uses of CO_2 merely delay rather than prevent the gas from reaching the atmosphere. The largest potential market for CO_2 would be for enhanced oil recovery (CO_2-EOR) which, if properly managed, can permanently store more CO_2 than it emits (including through the use of the oil produced) and can drive the development of a CCS industry.[23]

7 The role of the Industrial Strategy 'Clean Growth Grand Challenge'

The Clean Growth Grand Challenge states that:

> "We will make the UK a world leader in the development, manufacture and use of low carbon technologies, systems and services that are cheaper than high carbon alternatives."[24]

Carbon capture and storage has a twin role to play in this: both as a low-carbon technology (or, more accurately, a suite of low-carbon technologies and services) in itself, and as an enabler of the production of low carbon goods, when it is applied to manufacturing processes.

It is important to recognise that CCS will have a key role in clean growth in the low-carbon economy of the future – but it needs to be started now, in order for it to be deployed at scale in the 2030s. At

19 https://ore.catapult.org.uk/app/uploads/2017/12/SP-0012-The-Economic-Value-of-Offshore-Wind-1.pdf
20 https://www.euractiv.com/section/energy/news/norways-latest-ccs-revival-attempt-meets-lukewarm-eu-response/?ct=t(CCSA_Daily_Bulletin_Tuesday_25_April_2014_25_2017_), https://www.telegraph.co.uk/business/2017/08/19/norway-embarks-mission-improbable/
21 Global CCS Institute (2016) Global Storage Portfolio, available at: https://www.globalccsinstitute.com/publications/global-storage-portfolio-global-assessment-geological-co2-storage-resource-potential
22 Carbon Capture and Storage Association briefing paper: Carbon Capture and Utilisation, not available online
23 http://www.sccs.org.uk/images/expertise/reports/co2-eor-jip/SCCS-CO2-EOR-JIP-Report-SUMMARY.pdf
24 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

the moment, policy and legislation provide no incentives or requirements for industry to use CCS to decarbonise, so there is no market to drive its deployment, and to consequently enable cost reductions through experience and economies of scale.

Since there is currently no business case for using CCS, but a clear public interest justification in doing so, it falls on government to support its deployment. This could be by direct funding; or by driving changes to markets, such as through a suitably high carbon price, or through tradeable certificates for permanent CO_2 storage accompanied by a CCS obligation system.[25]

In addition, the CCUS Cost Challenge Task Force recommended that industry should "lead the creation of the decarbonised product mark, a clean industrial products certification system, to certify the low-carbon USP of decarbonised industrial products"[26] and that government should encourage its use through public procurement, in order to create a market.

[25] http://www.ccsassociation.org/news-and-events/reports-and-publications/parliamentary-advisory-group-on-ccs-report/
[26] Recommendation 16, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727040/CCUS_Cost_Challenge_Taskforce_Report.pdf