CCUS: Market Engagement on Cluster Sequencing

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Scottish Carbon Capture & Storage (SCCS) is a research partnership between 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.

SCCS welcomes the Government's intention to deploy two carbon capture and storage (CCS) clusters by the mid-2020s and a further two clusters by 2030. CCS is safe, proven and effective technology, and it is right to accelerate its deployment to demonstrate the UK's commitment to net zero.

CCS has long been recognised as an essential set of technologies for decarbonising industry as part of a just transition; it also offers the opportunity to produce low-carbon hydrogen in bulk, and to capture and store CO_2 emissions from biogenic sources or directly from the air, providing greenhouse gas removals.

We consider that the aim of CCS deployment should be the decarbonisation of a range of industries, which would make a real reduction to the UK's greenhouse gas emissions by stopping emissions from existing sources reaching the atmosphere and by producing zero-carbon energy vectors, such as electricity or hydrogen, to decarbonise the UK's energy system. This means that the focus for cluster sequencing should be two-fold: a) clusters should decarbonise existing sources of CO_2 with a focus on retrofitting existing assets, b) clusters should focus on new capacity for zero-carbon energy vectors.

Historically, UK commercial projects focused on delivering CCS in the power sector. Clusters should be diverse in terms of the industry applications. Therefore, it is important that the first phase of clusters include at least one CO_2 capture project on existing industry.

Five UK industrial clusters are well understood, described in the CCUS Cost Reduction Task Force's report to Government[1], and have all received funding from UKRI under the Industrial Decarbonisation Challenge

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727040/CCUS_Cost_Challenge_Taskforce_Report.pdf

Terminology

The 2017 Clean Growth Strategy[2] committed the government to explore the potential for "CCUS industrial decarbonisation clusters"

We have tended to use the phrases "industrial cluster," "CCS cluster" and "carbon capture cluster" interchangeably, as we have understood these terms to describe locations where several high-emitting industries are grouped together, and therefore where CCS will be needed to enable those industries to continue operating in a net zero economy.

However, it appears now that BEIS may be trying to distinguish between the industrial clusters which are being funded to develop cluster plans under the UKRI Industrial Decarbonisation Challenge, and "carbon capture clusters" which are to be funded under this programme. This may explain why the timescale for the submission of carbon capture cluster plans suggested under this consultation (July 2021) is so different to the timescale for preparing UKRI-funded cluster plans (December 2022).

Such an approach – which pre-empts the strategic industry-led work being carried out in the roadmap projects – risks delivering CCS clusters which are sub-optimal; at the same time, speedy deployment of CCS to enable industrial decarbonisation is to be welcomed, as long as no opportunities for future build-out are cut off

Do you have any comments on the indicative timeline?

While we welcome the urge to deploy CCS quickly, we consider that the timeline may be too short for all UK industrial clusters to develop an application that meets the criteria set out in this consultation.

It is important that the location and size of CO_2 transport and storage networks built under this programme are suitable for long-term CCS deployment and sized according to the cluster they expect to serve, not just the projects that are ready to commit in Phase-1 or Phase-2.

Does the commitment to bring forward details of a process to select clusters for Track-2 mitigate the risks associated with not naming the second Track in 2021?

Government should give a firm commitment to see all five industrial CCS clusters developed in due course, and provide comfort to clusters that are unable to make an application that meets the criteria that they will still be eligible to apply for support in future. Furthermore, it would be helpful to have more information about the status that Track-2 would confer on CCS projects, and what support they can expect from government.

It is well known from previous BEIS competitions on CCS for Longannet or for Peterhead and White Rose, that Track 2 or "reserve" candidates disband their teams very quickly. There is not reason to suggest that this would be any different during this development of industrial decarbonisation clusters. That creates a risk for Government in not creating a pipeline of

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

projects and not creating a pipeline of developers or of supply chain service companies in the UK. How will BEIS provide substantial confidence to "reserve" candidates, and funding to reserve candidates, which enables them to continue employment of core staff expertise?

Furthermore, we understand that the OGA licensing process requires applicants that propose storage in deep aquifers to have a depleted hydrocarbon field as a back-up plan, because it is recognised that safe, permanent CO_2 storage in deep aquifers is not fully proven yet. This means even more players who need to be kept lined up 'just in case'.

Do you have any comments on the proposed requirement that an applicant has to meet the definition of a CCUS cluster to enter the process?

By definition, an industrial CCS cluster must include several emitters, and consequently several capture projects. However, at the first stage of deployment of CCS in the UK, it is more important to have the transport and storage infrastructure – including back-up plans for storage - in place and ready for connection. We suggest, therefore, that a 'cluster' under this process should include a full-chain CCS project – that is capture, transport and storage – and that the first phase should include at least one CO_2 capture project on existing industry.

The number and diversity of emitters in the cluster, and quantity of CO_2 captured or abated should be part of the evaluation criteria for determining the sequencing of clusters, not the screening criteria for which clusters are evaluated.

Low carbon clusters must demonstrate from the outset clear steps to become net-zero clusters to avoid lock-in of unacceptable levels of residual emissions by, say, undersizing capacity. It is not clear how BEIS will encourage projects to operate to their design capacity with a focus on minimising residual emissions to levels of less than 1%, consistent with a net-zero society. CO_2 capture technology vendors are reporting performance and economics for near-zero emission technology with capture level of 99.5%[3]. Clusters must demonstrate an implementable plan to achieve net-zero, if they are unable to do so from the start of operation.

It is not clear either how this mixes with the expectation from several CCS projects globally that new capture equipment at industrial scale may experience commissioning problems which take 12-24 months to resolve. Will BEIS place penalties onto under-performing projects, as well as having to purchase UK-ETS certificates at market rates; and in addition to any lost income to transport and storage operators through being unpaid for storing CO_2? How does that balance with a BEIS interest in underwriting projects to ensure success? These questions are particularly apposite for (say) a new build gas power plant which operates its planned CCS equipment at reduced capacity or with an unplanned reduced availability during the first 12-24 months. The UK would have more gas fuelled electricity, but minimal control and influence to control the consequent increase of national emissions.

[3] Takuya Hirata, Tatsuya Tsujiuchi, Takashi Kamijo, Shinya Kishimoto, Masayuki Inui, Shimpei Kawasaki, Yu-Jeng Lin, Yasuhide Nakagami, Takashi Nojo, (2020) Near-zero emission coal-fired power plant using advanced KM CDR process™, International Journal of Greenhouse Gas Control, 92, 102847, ISSN 1750-5836, https://doi.org/10.1016/j.ijggc.2019.102847.

What should government be doing to facilitate remote sites and shipping and when should government be doing this?

Shipping of CO_2 should be given greater priority than currently, as it is the transport option that will open up the opportunity for the UK to store CO_2 from other countries, as well as providing greater resilience in the CCS system within the UK.

We note that Langskip Norway has already established a joint venture shipping company between Total, Shell, Equinor to work on constructing, delivering and operating CO_2 tanker shipping at North Sea size scale. How will the UK compete with this emerging industry?

We note that Scotland has access to abundant CO_2 storage in depleted gas fields, depleted oil fields and saline aquifers. These include fields that have already been decommissioned, and fields that are at, or approaching, cessation of production. Scotland's CO_2 storage potential has had the benefit of academic and commercial research and development studies on since 2005.

Consequently, the proposed stores are probably the world's best evaluated sites. **This provides multiple backup storage sites.** These include:

- The Goldeneye former gasfield - which Shell took to the stage of full licence application in 2015 for more than 30 $MtCO_2$.
- The adjacent Captain X site, which was appraised by Pale Blue Dot during PCI and ACT studies.
- The wider Captain sandstone, which was demonstrated to have up to 358 $MtCO_2$ capacity by the SCCS MultiStore projects and up to 1668 $MtCO_2$ storage capacity if water extraction boreholes are installed as a progressive development[4]; and very high quality mechanical containment with 99% secure retention simulated for 1,000 years.[5]
- The Mey sandstone further east, which is an entirely different reservoir storage system. This has been thoroughly appraised with detailed dynamic reservoir simulation and full risk appraisal , and published to academic standard showing about 1,000 $MtCO_2$ secure storage[6]

All these sites are accessible through the Goldeneye and Captain pipeline systems, and the Miller pipeline system.

[4] Jin, M., Mackay, E.J., Quinn, M., Hitchen, K. and Akhurst, M., 2012, January. Evaluation of the CO2 storage capacity of the Captain Sandstone Formation. In *SPE Europec/EAGE Annual Conference*. Society of Petroleum Engineers.
[5] McDermott, C., Williams, J., Tucker, O., Jin, M., Mackay, E., Edlmann, K., Haszeldine, R.S., Wang, W., Kolditz, O. and Akhurst, M., 2016. Screening the geomechanical stability (thermal and mechanical) of shared multi-user CO2 storage assets: a simple effective tool applied to the Captain Sandstone Aquifer. *International Journal of Greenhouse Gas Control*, *45*, pp.43-61.
[6] Worden, R.H., Allen, M.J., Faulkner, D.R., Utley, J.E., Bond, C.E., Alcalde, J., Heinemann, N., Haszeldine, R.S., Mackay, E. and Ghanbari, S., 2020. Lower Cretaceous Rodby and Palaeocene Lista Shales: Characterisation and Comparison of Top-Seal Mudstones at Two Planned CCS Sites, Offshore UK. *Minerals*, *10*(8), p.691.

Scottish Carbon Capture & Storage (SCCS) 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.[7]

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

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