Business models for CCUS

September 2019, SCCS

Scottish Carbon Capture and Storage (SCCS) welcomes the opportunity to comment on BEIS' proposals for business models for CCUS.

Whichever business models are chosen, it is imperative that carbon capture and storage (CCS) is deployed quickly across the UK, and should not be further delayed.

Consultation questions

Introduction – overarching questions

1. Have we identified the right parameters to guide the development of CCUS business models?

The consultation document[1] states that the models should "incentivise CCUS to provide value to the economy". This definition of 'value' needs to include the long-term value of decarbonisation to the economy, particularly in allowing industry to continue to operate sustainably.

We would suggest, in addition, a requirement to contribute to the Government's net-zero greenhouse gas emissions target. The House of Commons Business, Energy and Industrial Strategy Committee recommended that the Government "view CCUS primarily as a tool for decarbonisation,"[2] and the Committee on Climate Change described CCS as "a necessity, not an option."[3]

There may have to be trade-offs between the parameters set out here as business models are developed and refined, but the need to decarbonise must be paramount.

CO_2 capture rate is important: a commonly quoted figure is 90%, but research from IEAGHG suggests that capture rates close to 100% are feasible at little additional marginal cost[4]. With a net-zero target replacing the previous 80% greenhouse gas reduction target, it will be important to incentivise these higher capture rates, as the cost is likely to be lower than addressing residual CO_2 emissions by other means.

[1] https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-business-models
[2] Business, Energy and Industrial Strategy Committee (2018) *Carbon capture usage and storage: third time lucky?*, available at https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/1094/1094.pdf
[3] Committee on Climate Change (2019a) *Net Zero – the UK's contribution to stopping global warming*. Available at: https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/
[4] IEAGHG (2019) *Towards Zero Emissions CCS from Power Station using Higher Capture Rates or Biomass*. Feron et al (2019) *Towards Zero Emissions from Fossil Fuel Power Stations*, available at https://www.sciencedirect.com/science/article/pii/S1750583618308934

CCUS-specific risks

3. Do you have proposals to mitigate CCUS-specific risks?

Considering risks 1 and 2, cross-chain risks and stranded asset risks, the risks identified relate mostly to early stages of development of a CCS industry and infrastructure, when there will be only a limited number of capture and storage facilities and transport options. This would be the same for any other new, integrated supply chain with continuous production, delivery and consumption elements. Specific learning concerning commercial arrangements for managing these risks may be available from the history of other gaseous product supply chains such as acetylene or ammonia. However, given the commercial situation for CO_2, a degree of government acceptance and support for these risks will be needed initially. As the CCS industry develops, these risks will reduce as more operators enter the field.

More capture operations will help balance CO_2 "supply" if one fails. Clustering will help a larger number of capture operations make efficient use of transport infrastructure. Indeed, the CO_2 collection and trunk transport systems for a CCS cluster need to be designed to cope with variation in throughput to manage expected industry operational profiles. Clustering will also enable a larger number of smaller emitters to consider CCS, which will further help stabilise CO_2 supply.

In view of these two classes of risk, transport system design choices need to be considered carefully. The assumption, that seems to have been prevalent, of a pipeline based collection network for a CCS cluster and a (probably oversized) trunk pipeline to storage should be challenged, as it immediately accentuates these risks by removing flexibility and requiring high capital investment, which may well be underutilised. The alternative concept of modular transport of liquefied CO_2 may significantly reduce these risks. Modular transport, using road-tankers, rail tank-cars, barges (where inland waterways are available, perhaps not in UK), coastal and overseas shipping, as appropriate for the scale and location of CO_2 transport, may require lower initial capital investment and will certainly increase flexibility.

The use of liquid CO_2 shipping for trunk transport from a capture location CO_2 collection hub significantly reduces the "high impact" risk from potential outage at a storage site. If shipping routes to alternative storage sites, once developed, are available then if a storage site suffers an issue, the problem becomes one of capacity sharing rather complete shut down of a full CCS chain. The flexibility given by modular transport also allows for future competition in the provision of CO_2 transport and storage services once alternatives are available, which may help to bring costs down.

Although modular CO_2 transport has different investment needs and brings different risks, studies have shown that, for shipping at least, it can have lower costs than pipeline transport in a number of circumstances that may well occur in the development of a CCS industry, particularly in early stages.[5] We would suggest that further studies of integrated modular CO_2

[5] E.g. Element Energy (2018). *Shipping CO2 – UK Cost Estimation Study*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/761762/BEIS_Shipping_CO2.pdf

transport, both for onshore collection and offshore trunk transport, are needed and that business models for CO_2 transport do not pre-judge technology choices, but allow the most cost-effective and lowest-risk solution for the industry as a whole to surface.

4. Are there any other CCUS-specific risks that need to be considered? If so, what are your proposals for mitigating them?

The CCUS Cost Challenge Task Force identified a further irreducible risk: **political risk**. The significance of this risk should not be underestimated: the entire rationale for deploying CCS, particularly for the UK being a first-mover developing the supply chain and cross-border storage offer, depends on governments being serious about their climate change targets.

Without a serious international commitment to the ambitions of the Paris Agreement, the post-subsidy business case for CCS in the 2030s and beyond collapses. Since there is no value to CO_2[6], storage can only be driven by subsidy, regulatory requirement, or by a carbon price that makes CCS more attractive than emitting. These last two, applied unilaterally by the UK, would run the risk of 'carbon leakage' as high-emitting industries choose to move production abroad rather than decarbonise in the UK.

Although the Government reacted quickly to the Committee on Climate Change's recommendation to set a target for net zero greenhouse gas emissions by 2050[7], the CCC's 2019 progress report to Parliament highlighted a lack of action to support the ambition: "Overall, actions to date have fallen short of what is needed for the previous targets and well short of those required for the net-zero target."[8] This assessment, and the finding of the House of Commons Public Accounts Committee that the Government's cancellation of the 2015 CCS commercialisation competition had damaged the industry's trust in the government, and that Treasury had unduly influenced energy policy[9] combine to mean that the political risk is increased.

Furthermore, the Prime Minister's recent letter to Donald Tusk, in which he stated that having the opportunity to diverge from EU environmental standards "is the point of our exit"[10] only adds to the uncertainty around the Government's commitment to climate change action.

One way the Government could demonstrate its commitment, and attempt to re-build trust and provide businesses with some long-term policy certainty, is to commit to targets for quantities of CO_2 stored, as recommended by the CCC[11], in line with their advice to Parliament that the UK would need to store 75-175MtCO_2 per year by 2050[12]. We

[6] Apart from in very limited circumstances where there is a market for CO_2 utilisation
[7] Committee on Climate Change (2019a)
[8] Committee on Climate Change (2019b) *Reducing UK emissions: 2019 Progress report to Parliament*. Available at: https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/
[9] Public Accounts Committee (2017) *Carbon Capture and Storage*. Available at: https://publications.parliament.uk/pa/cm201617/cmselect/cmpubacc/1036/1036.pdf
[10] HM Government (2019), *PM letter to Donald Tusk: 19 August 2019*, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/826166/20190819_PM_letter_to_His_Excellency_Mr_Donald_Tusk.pdf
[11] Committee on Climate Change (2018) *Reducing UK emissions: 2018 Progress Report to Parliament*. Available at: https://www.theccc.org.uk/publication/reducing-uk-emissions-2018-progress-report-to-parliament/
[12] CCC (2019a): "We previously recommended that the first CCS cluster should be operational by 2026, with two clusters, capturing at least 10MtCO_2 operating by 2030. For a net-zero target it is very likely that more will be needed."

understand that the forthcoming National Infrastructure Strategy is intended to build on the Clean Growth Strategy, and we urge the Government to bring forward actions on CCS in line with the CCC's recommendations.

However, UK commitment to climate change targets will not be enough on its own. The Government should use its influence to ensure that the EU and G7 similarly commit to the deep decarbonisation that will be necessary for a fair and ambitious contribution to the Paris Agreement.

In addition to the uncertainty around the Government's commitment to deep decarbonisation, the Government's policy of the UK leaving the European Union in 2019, with or without a deal, creates a significant risk around future policy. At minimum, the legislative process of leaving the EU and subsequent years of negotiations threaten the parliamentary time available to discuss the legislative changes that are likely to be needed to implement the business models proposed in this consultation.

International policy risks

A potential business model for the UK is to store CO_2 from other countries in UK geology. There is a strong need for international policy to set a stable framework for this cross-border handling of CO_2 - in addition to the well-understood issues around the London Protocol, there need to be more practical measures and standards to cover the physical transport of CO_2 across borders – either by pipeline, ship or other means.

It is imperative that BEIS consider scenarios around cross-border CO_2 transport and storage in light of a potential exit deal with the EU, or no-deal exit.

Competitiveness

A number of the high-emitting industries that SCCS has engaged with have raised issues of competitiveness that could arise from the implementation of business for industrial CCS. They raise concerns about the need for UK businesses to be able to compete with imports elsewhere – this could be addressed by imposing a border tariff on goods with high embedded CO_2. In addition the business models also need to ensure fairness between industries in the UK.

Carbon dioxide transport and storage (T&S)

We strongly support the separation of business models for CO_2 transport and storage infrastructure from business models for CO_2 capture, in line with the recommendations of the Oxburgh report[13].

A general comment, which applies to all business models discussed in this consultation, is that there is not enough detail to enable businesses and investors to understand the costs, structures, risks and opportunities of what is proposed.

[13] Parliamentary Advisory Group on Carbon Capture and Storage (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/

5. Have we identified the most important challenges in considering the development of CO_2 networks?

In addition to the challenges identified in the consultation document, there are issues around data handling. Regulations are needed around preserving, and making available, data and information from oil and gas operators after fields go into abandonment. As well as specifying the platform through which these assets are made available, regulation should consider a specific format for preserving and documenting information.

8. Are there any models that we have not considered in this consultation which you think should be taken forward for CO_2 T&S, and why?

The Oxburgh report recommended that a publicly owned company be established to deliver CO_2 transport and storage infrastructure. Given the urgency of tackling climate change, we recommend that the Government take the approach that will enable the deployment of CCS most quickly.

The Committee on Climate Change implied that the Government should following the advice of the Oxburgh report:

> "[the Government] has not yet proposed concrete approaches to tackle the challenges in deploying CCS in the UK. Many of these have been well understood for some time and should progress more quickly than proposed in the Action Plan – for example the model for developing infrastructure for CO_2 transport and storage could have been agreed already, rather than by the end of 2019. Urgent progress is required to ensure that CO_2 transport and storage infrastructure is operational at multiple industrial clusters by the mid-2020s."

This is echoed by the Climate Emergency Response Group, a group of civic and business leaders, which recommended that the Scottish Government establish a public-interest company to invest in and operate CCS infrastructure.[14]

We also support the Oxburgh report's recommendation of CO_2 storage certificates and a storage obligation on companies extracting oil and gas, to drive a market for CCS.

Many of the issues of business model for CO_2 T&S are predicated on the choice of transport technology being pipeline. Many of these issues would be avoided if a modular CO_2 transport system were adopted, as outlined at Question 3. Trunk transport of CO_2 by ship to offshore storage (either direct, or by a hybrid port-to-port plus offshore pipeline system as proposed by Northern Lights and Acorn CCS projects) has been shown to be cost-competitive in a number of likely circumstances.[15] If trunk transport of liquefied CO_2 by ship were the chosen technology, liquefaction facilities would be best considered as part of the capture process with

[14] Climate Emergency Response Group (2019) *12 immediate actions for Scotland's response to the Climate Emergency*, available at: https://www.wwf.org.uk/sites/default/files/2019-08/Climate%20Emergency%20Statement.pdf

[15] Element Energy (2018). *Shipping CO2 – UK Cost Estimation Study*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/761762/BEIS_Shipping_CO2.pdf

investment by emitters. The business model for modular CO_2 transport, onshore or offshore, could follow established models for bulk liquid transport. The only multi-user, CO_2-specific systems would be at collection hubs, ports, the trunk shipping service and any trunk pipeline sections of a hybrid system. These could be operated under a much simpler business model than a pipeline network, based on throughput, as all CO_2 "suppliers" would be using the same equipment.

1.1.1 Power CCUS

We are concerned that, because business models for power CCUS build on contracts for difference and are therefore easier to develop, government's focus will be on bringing them forward, to the detriment of developing business models for the areas where CCS has the most potential for value to the economy (because it is the only, or most cost-effective way, of achieving emissions reductions) - industry, negative emissions and hydrogen, which are more difficult to incentivise.

The consultation fails to fully address several CCS applications, for example:

Negative emissions: biogenic CO_2 capture and storage and direct air CO_2 capture and storage. Any business models developed as a result of this consultation must be set up in a way that enables, or at least does not preclude, the deployment of negative emissions technologies.

The potential for negative emissions from biogenic sources will not just be from dedicated biomass-to-energy plants: for example, there is the potential to use biomass as a feedstock in refineries, or in blast furnaces in steel plants. Business models will need to be flexible to address the proportion of CO_2 captured in such situations that is from biogenic sources, and therefore contributes to greenhouse gas removals.

Waste to energy: as in the examples above, waste-to-energy with CCS will deliver a proportion of negative emissions. This is a sector that is becoming increasingly important in Norway and the Netherlands, and should be given consideration in the UK.

Waste-to-energy plants provide two services: electricity production and waste management, so it is not clear whether they should be categorised as industry or power CCS. Because of their waste management function, these plants to operate continuously, so need a business model that enables them to operate as base load power generation. In addition, business models should recognise that the CO_2 from the biogenic component of the waste handled in these plants, when captured and stored, will contribute to negative emissions.

1.1.2 Industry CCUS

13. Have we considered the most important challenges in considering the development of CCUS for industry?

Industry is not a single sector – different companies, different industries, different regions will have circumstances that affect the business model that will be needed.

Different businesses will want a different rate of return on investment; and a business that is prepared to accept a lower rate of return is likely to feel unfairly treated if they see another business getting support at a higher rate of return.

One suggestion that has been made by industry in Scotland is for the Government to provide a grant for capex, so businesses don't have to consider the rate of return, accompanied by support for opex.

Support for carbon capture should be contingent on the final destination of the CO_2 - that is, it should only be provided where the CO_2 will be permanently stored. Where CO_2 will not be geologically stored, lifecycle analysis should be used to establish whether the method of storage can be considered permanent or sufficiently long-term.

17. What actions should Government and industry take to help establish demand for low-carbon industrial products?

We understand that the Government intends to set out actions towards meeting its net-zero greenhouse gas emissions target through the National Infrastructure Strategy.

As well as direct actions around CCS infrastructure deployment, the infrastructure strategy should set a requirement that all new projects use low-carbon steel and cement: this would drive the development of a market for low-carbon products manufactured using CCS. This requirement should also apply in all public sector procurement over a certain threshold. It will require upskilling and capacity-building for procurement staff, and that they be empowered to specify and assess contracts for their contribution to wider objectives, including decarbonisation.

In addition, a tax on high carbon products could be introduced and hypothecated to support the deployment of CCS in delivering low-carbon products.

CCUS for hydrogen production

19. Do you have views on whether the model should seek to support both CCUS-enabled hydrogen production and renewable production methods? If so, how might this work?

The model needs to allow different sources of low-carbon hydrogen to access the market depending on their competitiveness. Support should allow the market to develop, but should not favour one technology over another – so support should be generally independent of technology. However, a modifier to this should be the carbon intensity of the low-carbon hydrogen supply, measured by lifecycle analysis of the supply with the broadest boundaries.

1.1.3 Delivery capability

23. What capabilities are needed for the delivery of CCUS in the UK?

We agree with the Parliamentary Advisory Group and the CAG that a dedicated co-ordinating or delivery body for CCUS in the UK is needed, and we agree with the benefits set out in the

consultation document. A dedicated delivery body would also need to work with the devolved governments of the UK and provide advice to them as well as to central Government.

The consultation document suggests that the example of the USA and Canada implies that a dedicated delivery body is not necessary. However, in those countries CO_2-enhanced oil recovery has had a strong role to play in creating a market – this has not so far been the case in the UK, so greater intervention from government is needed.

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.[16]

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