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Developing CCUS Business Models in the UK: Key Issues Relating to Industrial Emitters

One of the key potential benefits of carbon capture (usage) and storage (CCS/CCUS) is enabling a range of heavy industries (other than power generation) to avoid CO_2 emissions. However, designing a regulatory system that will support such "industrial emitters" as they decarbonise their operations is a complex task that the UK government (HMG) has yet to complete. Potential beneficiaries and other stakeholders need to consider the issues and continue to engage with HMG on them.

Introduction

Background

1. UK CCUS is taking off. HMG says it is determined, over the next 10 years, to put the UK at the heart of the CCUS sector, as other governments also look to foster this technology. In a recent speech to a UN climate action roundtable, Boris Johnson said: "I want to lead on carbon capture and storage, a technology I barely believed was possible, but I am now a complete evangelist for".
2. A major change from the UK's previous efforts to commercialise CCS technology is that, rather than focusing on CCUS as a means of delivering low-carbon, despatchable electricity generation, the government is aiming to support CCUS clusters in which a range of non-power generating "industrial emitters" also play a central part. This is because CCUS is seen as playing a key role in decarbonising certain manufacturing industries.
3. HMG has already been providing, and is still offering, early-stage co-funding under its various innovation funding schemes. For example, UK registered organisations had a deadline of 7 October this year to apply for a share of up to £131 million to implement plans for decarbonising an industrial cluster.[1] However, this is in effect seed funding.
4. HMG's goal is for two CCUS clusters and at least one gas-fired power station with CCS, to be operational by 2030, with the first cluster by the mid-2020s. To achieve this, it will rapidly and coherently have to make foundational policy decisions about exactly what it wants to achieve and how it wants to achieve it; devise methods for selection of the projects to receive support; prepare the necessary legislation, institutional frameworks and template contractual arrangements; and do some deals.

1 The Zero Carbon Humber cluster was one of a number to apply for funds under this scheme. See here.

Current Position

5. In its July 2019 consultation Business Models for Carbon Capture, Usage and Storage (the BMC) the UK Department of Business, Energy and Industrial Strategy (BEIS) consulted on possible business models for each component of a CCUS cluster: transport and storage (T&S), power generation, industrial emitters and low-carbon hydrogen. Simultaneously, the CCUS Advisory Group (CAG) comprising CCUS industry participants published its paper Investment Frameworks for Development of CCUS in the UK (the CAG Report).

6. BEIS's response to the Business Models Consultation[2] (the BMC Response) includes some preliminary conclusions but says that BEIS is continuing to work with industry expert groups on developing CCUS business models, with major announcements due later in 2020 and anticipation that more funding has been sought in the current spending review. It is therefore timely for industry to be considering the issues and making representations to government, including on some fundamental legal and commercial issues, before the cement dries on business model design.

This paper

7. Dentons has already published a preliminary commentary on the BMC Response. See here.

8. This is the first in a series looking in more depth at each aspect of a possible CCUS cluster in light of the thoughts emerging from the BMC process. It looks at business models for industrial emitters. Other papers in the series will cover low carbon hydrogen business models; T&S business models; CCUS power business models; and CCUS cluster issues.

9. Our team has forensically analysed the current state of CCUS law and policy and previously advised HMG on CCS – please contact the authors for an in-depth discussion.

Foundational decisions and key underlying issues

Questions for government

1. HMG needs to address a number of foundational questions in defining a business model for an industrial emitter in a CCUS cluster. These include:

- What regulated financial support will those who own/operate CCUS on industrial plants receive?
- Will it work equally well for all categories of industrial emitter?
- Should there be separate support arrangements for capex and opex?
- Has HMG drawn a clear enough line between supporting capture of industrial CO_2 emissions and supporting hydrogen production (and the switch to hydrogen consumption) that allows industrial emitters to avoid emitting CO_2?
- Who should fund the regulated financial support payments?
- Is the relationship between the industrial CCUS support mechanism and post-Brexit UK carbon pricing clear and complementary?
- What steps is HMG prepared to take to increase specific demand for products produced by CCUS industrial plants (e.g. zero carbon steel) by taxation or procurement policy, rather than by susidising their supply?
- How are T&S risks and costs addressed and are they allocated in a way that works for industrial emitters and recognises the nature of the markets in which they operate in?[3]

2. The remainder of this note unpacks some issues that arise when looking at these questions.

Diversity of industrial emitter businesses

3. Industrial emitters come from a range of different (often highly globalised) industries. The origins, intensity and composition of their emissions vary. This is likely to affect how they wish to go about abating those emissions.

2 "A Government Response on potential business models for Carbon Capture, Usage and Storage – the Reponses to the Business Models Consultation" - see here).

3 Similar issues arise for power emitters and hydrogen emitters.

4. UK manufacturing industry emitted 72.4 $MtCO_2$ in 2018.[4] This was just under 20% of the UK's total CO_2 emissions,[5] but the sources and types of the industrial emissions vary significantly. This has implications for what HMG decides to support and how. Key distinctions are between:

- **Industry's existing models**: In a report for BEIS,[6] Element Energy identified the principal CO_2 emitting UK industries as iron and steel, refining (of both oil and natural gas),[7] cement and lime, ethylene/ammonia and other chemicals. Each of these has its own distinct business model and likely CO_2 capture processes and technology. For example, ammonia production emits high purity CO_2 that can readily be captured, whereas a typical refinery may have multiple flue gas vents containing low purity CO_2 presenting quite different capture challenges.[8]
- **Energy and process emissions:**
    - Energy-related emissions are those caused by the combustion of fossil fuels to produce heat and power. Process-related emissions are those where CO_2 is released as a by-product of the industrial process that the combustion process powers. For emitters with energy-related emissions, CCUS may not be the only way to decarbonise: electrification, or substituting low carbon hydrogen for fossil fuels, may be alternatives (see further below). By contrast, CCUS may be the only cost-effective way to get rid of some process emissions.
    - Some industries produce both types of emissions. For example, the production of cement involves heating limestone and other chemicals in a cement kiln to about 2,700 degrees Fahrenheit. This requires huge energy input, often involving combustion of fossil fuels, but it also drives off CO_2 from the raw materials, leaving a residue forming clinker (subsequently combined with gypsum to produce cement powder). Approximately 1/3 of CO_2 emissions from cement plants are energy-derived and the rest from process, whereas in other sectors the share of energy-related emissions is much higher (e.g. nearly 90% for iron and steel).
    - Different processes and machinery are needed to capture different sources of CO_2. For any two given industrial emitters, the levels of capex and opex involved in avoiding a tonne of CO_2 emissions will not always be the same, or even similar. This may drive different business models and needs for support and may make any "one-size-fits-all" HMG solution unattractive to some industries.
- **Value of end-product and emissions intensity:**
    - The proportional impact on manufacturing costs also needs to be considered. The cost impact of CO_2 capture from a high-value/low-carbon intensity product is proportionately lower than from a low-value/high-carbon intensity product.

4 This figure relates only to the manufacturing industry and does not include power generation or other industrial processes, such as mining and quarrying, or construction.

5 See the final UK greenhouse gas emissions national statistics published by BEIS on 20 July 2020.

6 See Element Energy "Industrial Carbon Capture Business Models" dated October 2018.

7 Acorn, one of the most advance clusters, envisages an initial phase of capturing CO_2 emissions from the natural gas processing plants at St Fergus in Scotland.

8 See page 10 of "Industrial carbon capture business models" by Element Energy dated October 2018.

- Many industrial emitters are also, individually, much smaller sources of CO_2 than a fossil-fuel power-generation plant. This is one reason they are best suited to participation in clusters where T&S infrastructure costs can be shared. The Acorn cluster is aiming to offer a low-cost industrial capture option by repurposing an existing pipeline network to carry CO_2 emissions captured directly from the gas processing units at the St Fergus gas terminal in Scotland.

5. How, then, should HMG allocate funding as between different industrial emitters, or between clusters made up of different combinations of emitters? This is partly a question of priorities: for example, do you want to avoid the greatest possible quantity of emissions today per £ of regulated support, or is the strategic value of reducing the costs of decarbonisation in particular industries, or of commercialising particular CCUS technologies, a greater priority?

6. There are analogies with renewables subsidies. The Renewables Obligation (RO) and Feed-in Tariff (FIT) regimes awarded different levels of support to different generating technologies, based on estimates of their relative installation costs. The renewables Contracts for Difference (CfD) regime awards subsidies on the basis of an auction process based around CfD strike price offers, but it has various features built in to it that allow some or all of the funding allocated to a given auction round towards particular technologies.[9]

7. The GB Capacity Market (CM) provides another point of comparison. Like the CfD regime, this uses a broadly technology-neutral auction to arrive at the lowest price in £/kW/year for a given total quantity of capacity. Unlike in the case of the CfD auctions, the CM pits new and existing plant against each other, and receives bids across a range of generation technologies (including storage) and demand-side flexibility providers. It does all this without segregating certain categories of bidders in the way that the CfD auctions do. Instead, new-build projects, those using existing equipment without major upgrades, and those using substantially refurbished equipment compete (or have at various stages during the CM's development competed) for subsidies of different durations, and technology-specific de-rating factors are applied which have the effect of making it easier or harder for them to compete.

8. There is useful experience (positive and negative) to draw on from both the renewables and CM regimes when framing support for industrial emitters. One key difference is that the electricity-related regimes were and are dealing with much greater volumes of projects. As a result, particularly in competitive allocation processes, there is more competition for funding and a greater likelihood of its being efficiently allocated. A large number of auctions, or regular allocation of subsidy, against rapidly developing supply chains (as particularly in the case of renewables) also allows for an element of trial and error in developing a funding system. There will be fewer opportunities to experiment in "getting it right" in the early stages of commercialising CCUS. Another difference is that, with renewables, you are only looking at one output market (electricity) rather than two (avoided CO_2 emissions plus whatever the industrial emitter's product is).

Boundary between industrial emitters and hydrogen support

9. CCUS is not the only way to decarbonise industrial processes. Some can be decarbonised by being powered by zero carbon electricity; and some by being fuelled with hydrogen (although not those where there are process, as well as energy, emissions). There is thus a fundamental question about the boundaries between CCUS support and other decarbonisation funding mechanisms.[10]

10. If its purpose is only to subsidise the addition of CCUS to existing processes, rather than the substitution of hydrogen for natural gas, would that include adding CCUS to a steam methane reforming plant, so as to create a "blue hydrogen" facility? And, if that plant were then to supply adjacent industrial emitters, enabling them to reduce their emissions by switching from fossil fuels, would they also be supported by the CCUS regime?

9 These include separate auction "pots", "maxima and minima", and the ability to exclude a given eligible technology from an individual auction. A BEIS consultation on possible changes to the CfD regime published in March 2020 suggested the possibility of a new, separate pot for floating offshore wind projects.

10 We are not dealing here with cases where decarbonisation is achieved by using fuels that combine hydrogen feedstock with captured CO_2, although these may well become important in non-stationary applications.

11. Ultimately, a line has to be drawn somewhere that either distinguishes, or in some way co-ordinates, industrial CCUS support in the narrow sense from support for the production of blue hydrogen and/or the industrial consumption of zero carbon hydrogen.

12. The importance of this distinction becomes apparent when you consider the varying models of the emerging UK clusters. To take three examples:

- **Hynet** envisages creation of a central low-carbon hydrogen production plant that distributes low-carbon hydrogen by pipeline to a range of industrial users. Here, CO_2 is removed centrally at the hydrogen generation station and piped offshore.
- **The Acorn Cluster** proposes an initial phase of capturing CO_2 from gas processing plants at St Fergus in Scotland. Subsequent phases will involve production of blue hydrogen from natural gas at St Fergus, and the capture of CO_2 from industrial emitters in the central belt of Scotland. Thus, this project combines capture from industrial emitters and production of hydrogen.
- **The Teesside cluster**, in contrast, is focused on a more classic full-chain model. There will be a CCGT power station using a post-combustion capture plant to remove CO_2 from flue gases. This will connect into a central CO_2 gathering network. Industrial emitters will also build CO_2 capture facilities at their respective sites and connect into the CO_2 gathering network by pipeline.

13. Thus, CO_2 capture in some models is centralised and in others is disaggregated, and it is likely that the nature and mechanics of the incentives for each of them will be different, if HMG designs its support mechanisms to respond to these structures, rather than expecting industry to structure itself to meet government's business models.

14. It is also conceivable that a cluster may combine elements of each of these models, and possible to envisage a single industrial premises receiving low-carbon hydrogen for its energy needs, while needing equipment to capture and transport its own process-related CO_2 emissions. HMG will presumably not want the support system to require separate bids for two different support contracts for different parts of the same operations if that can be avoided, at least for the initial projects to be supported – it may be an inevitable consequence of disaggregating the physical CCUS chain.

15. The BMC approached this by distinguishing:

- **hydrogen produced for fuel-switching from fossil fuels** – described as in scope of the low-carbon hydrogen business model; and
- **post-combustion capture on hydrogen production for industrial feedstock** –described as in scope of the industrial emitter model.

Regulated financial support options for industrial emitters

Business model options

1. The BMC identified three possible options:

- **Industrial CfD**: a new industrial CfD, under which there would be an agreed strike price per tonne of CO_2 abated. Difference payments would represent the gap between the market price of CO_2 (or the UK ETS equivalent) certificates and this agreed strike price, and would flow to the industrial emitter for as long as the strike price exceeds the market price of CO_2;
- **CO_2 obligation**: industrial emitters have a CO_2 capture obligation that can be met by means of certificates. In this model, rather than representing the right to emit a given quantity of CO_2 (as in the EU and UK ETS and the industrial CfD model), certificates would be awarded for a given quantity of CO_2 emissions verified as having been avoided through the application of CCUS processes. However, as well as earning certificates through its own efforts, an emitter could purchase them from another emitter that had acquired more certificates than it needed. Thus:
    - there is a choice of investing in CCS or buying CCS certificates; and
    - in principle, the abating emitter is compensated by the market price for sale of excess CCS certificates.

      However, because certificates in this system are only generated as a result of CCUS activity, rather than being a feature of the wider carbon markets, the level of the capture obligation would need to be set carefully by reference to the development of CCUS chains including industrial emitters. The liquidity of the certificate market may need to be supported in the early stages, and it may be necessary to set a floor price for certificates and employ a range of additional regulatory devices similar to those found in the RO regime, with which the obligation plus certificates approach has a number of similarities; and
- **Reimbursement**: HMG pays the CCUS opex plus CCUS capex and an agreed return, with costs determined on an open-book basis. Efficiency might be supported by painshare/gainshare.

2. These consultation options represented a shortlist from a much longer candidate list mooted by industry and policy groups – the CCUS Advisory Group (CAG) had suggested using a tax credit system akin to the 45Q regime used to support projects in the US, for example. Use of a RAB model has also been suggested, and the CAG Report talks about the potential for HMG to fund a centralised **decarbonisation service company** that would provide a decarbonisation service to industrial emitters.
3. CAG's idea of a **decarbonisation service company** is that a regulated RAB model entity would raise private sector finance to invest in CO_2 capture projects on industrial sites and provide a "decarbonisation service" to industrial emitters. This company could operate the capture plant, or it could be run by their customers (i.e. industrial emitters) on the company's behalf. Revenue support would flow from government to the service company, which eliminates the need for industrial producers to invest directly in the capture plant. Key points envisaged by CAG include that:

- the decarbonisation service company would enter into an industrial CCUS contract with the industrial producer; and
- the industrial producer would pay an amount equal to their savings on carbon taxes, leaving the industrial service company economically neutral.

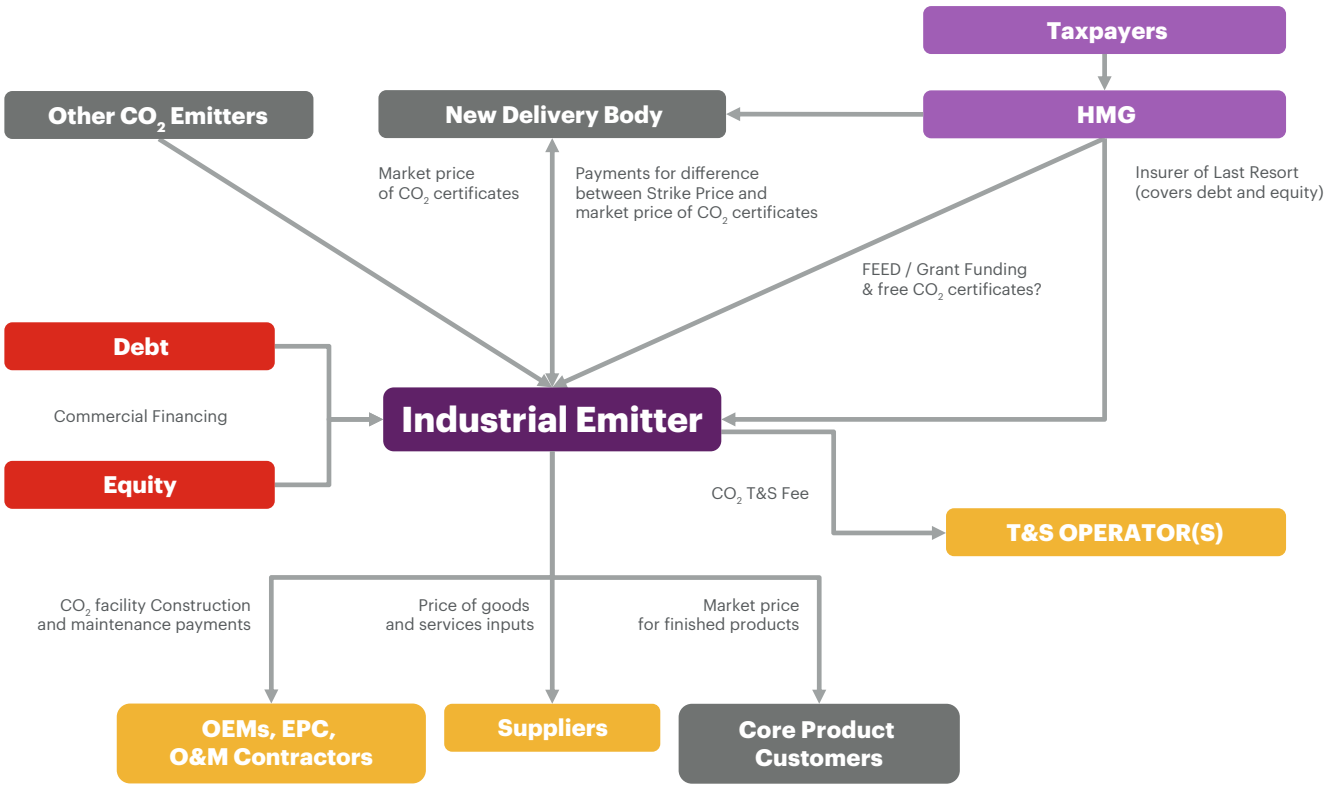
Who is to fund support for industrial emitters?

4. Hitherto, the government has avoided models involving direct taxpayer payments to incentivise decarbonisation, beyond limited capex grant funding and insurer of last resort (Hinkley Point C and Thames Tideway Tunnel). Under EMR frameworks, for example, the electricity consumer bears the ultimate burden of subsidy for renewable electricity, via the electricity suppliers' obligations to fund the public sector counterparty to electricity CfDs and capacity market contracts.

5. However, the electricity market deals in a single commodity, and is so structured that, by imposing a levy on licensed suppliers, it is possible to ensure that all consumers (apart from some energy-intensive industries, exempted on grounds of the damage it would do to their competitiveness) pay a share, proportionate to their own consumption, of the additional CfD costs of "green electricity" or the security of supply enhancement provided by the Capacity Market. Moreover, a CfD for electricity generators operates by reference to a price which is their main or only source of revenue. By contrast, the price of CO_2 emissions (or CO_2 emissions avoided) is only one element in the costs of industrial emitters, and they sell their products in markets that are subject to many more (and unrelated) influences and forms of volatility.
6. There would be no way of replicating such a framework (of consumer funding) for an industrial CfD in diverse, unregulated industrial markets whose ultimate customers are not necessarily UK-based or end-user consumers. In any case, increasing industrial consumer prices in the way that EMR increases electricity consumer prices would simply cause "carbon leakage" (whereby industry's non-end-user customers switch to unabated non-UK competitors not subject to the same cost) leaving UK industry uncompetitive unless some form of carbon border tax was also introduced to ensure that imported products had the same cost of carbon added to their cost base as those in the domestic market. The EU is considering this approach in the context of its main carbon pricing instrument, the EU ETS, as part of its Green New Deal, although it is not mentioned in the HMG's recent consultations on possible UK replacements for the EU ETS.[11]
7. There is no immediately obvious non-governmental/taxpayer constituency to look to as a funder. An early decision is therefore needed about whether government (as seems likely) or some other source will fund industrial capture, because it has a significant effect on what the business models will ultimately look like.

Emerging HMG Policy: favoured model indicated in the BMC Response

The picture emerging from the BMC Response is that BEIS currently favours an industrial contract for difference (by reference to a carbon price) coupled with government co-funding of capital costs.[12] The value chain under this model may look like this:



11 See the consultation and response on the Future of UK Carbon Pricing, here, and "Carbon Emission Tax Consultation" published 21 July 2020, here.
12 Energy Minister, Kwasi Kwarteng has also given this much emphasis in a range of speeches, including in the CBI's Net Zero conference on 14-15 September 2020.

8. This diagram includes among other things a reference to HMG acting as insurer of last resort, a role the CAG Report stated would be required if the project is to attract investment. It spoke of HMG taking this role when the emitter is not at fault and there is no prospect of a CO_2 transport and storage system being built to store captured CO_2 or where a CO_2 transport and storage system is permanently closed. It is not yet clear if HMG will agree or see this as an unnecessarily industry-friendly risk allocation, because it is not addressed in the BMC or the BMC Response.

Implementation of the favoured model

9. The BMC Response suggests that, while industrial CfDs are likely to be competitively awarded, this may not be the case for initial projects. BEIS envisages a phased approach:

- *Phase 1*: emitters would be awarded a negotiated industrial CfD with upfront payment of capital costs (albeit that BEIS is considering the balance between HMG support and private finance). From HMG's point of view, there is an obvious value for money risk in letting this kind of contract on the basis of bilateral negotiations without an element of competitive tension;[13]
- *Phase 2*: emitters would be allocated an industrial CfD competitively; and
- *Phase 3*: a market-based approach would apply, relying on cost of carbon to incentivise emitters.

10. BEIS is considering the appropriate counterparty for the industrial CfD.

11. Going beyond current core T&S policy, it is interesting to see that, alongside the consultation response, BEIS has published a report looking at some of the practical questions facing the deployment of CCUS at industrial sites that are not located in one of what are perceived as being the main "clusters" of emitters.[4] This emphasises that the policy is to facilitate decarbonisation of all British industry.

Emerging HMG Policy: other factors

12. HMG's apparent commitment to an industrial CfD is, however, at odds with the emerging approach to pricing and taxing carbon. The option of the UK remaining formally part of the EU-ETS scheme after the scheduled end of the Brexit transition period on 31 December 2020 appears to have gone, but it remains possible that a replacement UK-ETS scheme could enjoy some degree of interoperability with the EU-ETS (perhaps on the Swiss model).[14]

13. However, the government has also published a consultation paper on a new carbon emissions tax,[15] and has already made some legislative provision for it. Chancellor Rishi Sunak recently stated that he is considering implementing such a tax and, while details remain high level, key points in the consultation included confirmation that while tax-free allowances of emissions would equate to what is currently available to businesses under the EU-ETS scheme, the allowances would not be tradable. This would appear to mean that the scheme (as envisaged by the consultation at least) would not work with the model of industrial CfD so far proposed, which relies on the ability of an emitter to sell excess free carbon allowances.

14. If HMG does decide to use some form or ETS or other carbon pricing mechanism to work with an industrial CfD, it will be a tricky balancing act to avoid, on the one hand, setting the effective carbon price too low (for example, by over-generous allocation of free allowances) and under-incentivising emitters and, on the other hand, causing the price for carbon to go up quicker than anticipated, with adverse impacts on those outside CCS clusters.

13 See the NAO reports on the Final Investment Decision for Renewables scheme, here, and Hinkley Point C, here.
14 See European Commission press release of 9 December 2019, "Agreement on linking the emissions trading systems of the EU and Switzerland", here.
15 See "Carbon Emission Tax Consultation" published 21 July 2020, here.

Legal and regulatory frameworks for industrial emitters

1. There is no existing regulatory framework that could be used to introduce any of the business models for industrial CCS. As a result, whichever is chosen will require new law and regulation. The nature of the new law and regulation will depend on the model chosen, and will vary considerably between them.

Industrial CfD – key legal framework changes

2. Key changes to the legal and regulatory framework would include:

- **Enabling legislation**: The government's focus is on *"deployment of post-process capture on industrial processes"*. The aim seems to be to encourage capture of CO_2 from industrial processes, and to disconnect the model from energy generation (and, in particular, generation of electricity). If so, the CfD regime in Chapter 2 of the Energy Act 2013 will not be used. New primary legislation would be needed to:
    - establish the carbon market necessary to establish contracts for difference, presumably by creating a link between the new scheme for industrial emitters and the proposed UK replacement for the EU ETS so that it generates a market reference price for CO_2 against which to calculate subsidy payments;
    - impose any requirements for emitters to participate;
    - create the powers needed to devise, fund, allocate and administer an industrial CfD, and to create the necessary secondary legislation to implement the model in detail;
    - provide for establishment of any new institutions (e.g. a funding body to pay out subsidy – see below); and
    - create powers for the Secretary of State to transact with industry before the enduring regime which will eventually be implemented is fully established and for the later transfer of those contracts and functions to any new institutions.
- **Secondary legislation**: A panoply of secondary legislation will be needed covering issues such as:
    - rules to determine eligibility for support;
    - a process for allocation of support contracts, likely to be by means of auctions or other competitions;
    - promulgation of standard terms of support for different types of emitter; and
    - institutional arrangements.
- **Tax frameworks**: The industrial CfD as so far conceived seeks to use markets for carbon to help incentivise and facilitate carbon reduction. Legislation would therefore be needed either to establish a carbon market in which industrial emitter CfDs would operate, or to adapt the proposed post-2020 UK-ETS/carbon emissions tax (CET) regime to interact effectively with the proposed industrial regime. For example, it would need to create an effective market reference price for the CfDs, and potentially a carbon border tax to prevent emitters exporting their CO_2 output.
- **Counterparty body**: Even if government is a funder of industrial capture, it is likely to prefer to create a separate body or bodies to administer the allocation and contractual arrangements for

delivering support. This could be a new body or an option would be to use the Low Carbon Contracts Company (LCCC) that administers electricity CfDs. This is not a foregone conclusion, given the different circumstances and purposes of the regimes. The statutory underpinning of this will need to deal with:

  - the statutory functions, duties and powers that the body has generally;
  - what its source of funds is, how it collects them, how assurance of continued funding is given (equivalent to the electricity supplier levy arrangements) and (from a taxpayer perspective) a control framework to limit the maximum cost to taxpayers;
  - the process for determining which emitters receive support and the new body's role in that process (perhaps a process similar to the CfD allocation process where auctions are not administered by LCCC, so, perhaps necessitating two delivery bodies);
  - the nature of the instrument to be used to provide the support (e.g. a CfD equivalent); and
  - the relationship of the body with the Secretary of State.

- **Other changes**: Necessary to implement the regime(s) for the other, complementary parts of the cluster-based CCUS ecosystem, particularly T&S.

CO_2 obligation model

3. If this model is chosen, the underlying capture obligation and compensation mechanism (including funding) would need to be legislated for; as with CfD model, there would also be a need for a new CO_2 certificate trading system or modifications to the UK ETS.

Key issues for investors

1. We look at the key issues for investors below from two perspectives: first, that of the individual industrial emitter; second, that of the cluster as a whole.

Drivers for individual emitters

2. *Global competitiveness*: Many potential industrial participants operate in globally competitive industries. It will not be possible for them to pass any costs of CCUS participation through to customers. Thus, any additional costs imposed at the UK level could have a significant impact on competitiveness,[16] and investors and government will be keen to design the model carefully to avoid any damaging impact.

3. *Investment time horizons*: Another consequence of the highly competitive environment in which industrial emitters typically operate is that investment horizons are relatively short. This is recognised in the CAG Report, which proposes repayment of all or some of the capital investment in industrial capture facilities over a five-year time horizon. However, given that the operating life of the capture facilities and of the T&S investment will be far longer, this will affect the required form of revenue support. There may need to be longer-term support for operating expenses and shorter-term support for capital expenditure, which of itself would drive differences in the form of the CfD (and potentially also a clawback if the future evolution of carbon prices provides windfalls after the five years).

4. *Carbon markets:*

a. As stated above, the government's favoured model for industrial emitters is apparently to build a support model around the ability of the industrial emitter to sell "free" CO_2 certificates (whether UK ETS or other tradable CO_2 certificate). Indeed, if the purpose of CCUS power support is to make the investment case for new CCS CCGT plants, the ultimate rationale of industrial emitter support is to finance a hedge against higher future carbon prices. The success of any such approach therefore depends in part on the effectiveness, as a carbon market, of the new arrangements put in place to replace the EU ETS with a new UK ETS.

b. Although the regime is to take effect from 2021, it seems likely to continue to evolve over the 2020s, in parallel with the development of cluster plans and bids for support. The link to carbon markets introduces complexities that need to be worked through in the design of the industrial capture mode, including:

- **Design of the tradable CO_2 certificate system**: There will be some uncertainty around the proposed UK ETS until the legislative process for it

16 Unless carbon border adjustments are introduced around the world.

has been completed and until it is clear whether it will be linked to the EU ETS.

- **Reliance on "free" certificates**: Industrial participants receive free allowances up to a declining benchmark related to the best performing installations producing the product concerned. A decision will be needed about whether the industrial CfD would respond to any change to the relevant benchmark level of certificates over time.

More generally, respondents to the BMC emphasised that the model should not overly expose industry to fluctuations in ETC certificate prices.

5. *T&S risks and fees:* The handling of the risk of T&S failure or non-performance will be a key issue for industrial emitters, and the role for HMG as insurer of last resort proposed by CAG (see diagram above) is one proposal to address this. HMG will need to carefully examine what risks it is willing to stand behind.
6. *T&S fees:* On the one hand, transport and storage networks will need to be sized to accommodate the growth of an industry over time but, on the other, the initial cluster projects may not be sufficient to use all capacity in those facilities. There will therefore be an early phase during which either T&S fees will need to be supplemented by HMG, or projects will need to pay oversized (but gradually reducing) T&S fees while T&S capacity is filled. See also further below regarding cluster issues.
7. *Operating uncertainties*: CO_2 flows, both in terms of absolute volume and flow rates, are inherently less certain, and more vulnerable to external forces (such as markets other than power), in the context of an industrial emitter. The uncertainties this creates for the whole CCS value chain will need to be addressed. One of the proposed CCUS clusters has, for example, mooted an arrangement whereby capacity payments for storage flow directly from the CfD funders to the T&S Co.
8. *Lock in risks*: Respondents to the BMC also highlighted the risk that an industrial CfD would commit an emitter to supply CO_2 to a T&S network after substitute decarbonisation options such as CO_2 usage had become preferable.

Industrial emitters: cluster perspective

9. A CCUS cluster can be defined in more than one way. Most straightforwardly, it is a group of emitters, all or most of whose emissions will be shipped or transported via the same offshore pipelines to storage. Any pipeline has a finite capacity. That capacity, and fees for using the pipeline, will be based on assumptions about the number of emitters and their emission volumes. From an emitter perspective, it would be desirable to be able to enter and exit the cluster (i.e. start and stop using the pipeline/store) at more or less any time, but such flexibility would have to be paid for (reflecting the costs of providing initially surplus capacity to cover demand from new entrants, and the risk to the T&S operator of being left with

too little revenue, and the risk to other emitters of facing sharply increased fees if the same costs have to be covered by fees levied on a significantly reduced volume of emissions).

10. To some extent, these issues can be dealt with in the way that the T&S industry is supported by government. However, these structural issues that need to be addressed for offshore pipelines and storage systems will also arise for any shared infrastructure that will link the emitters to the pipeline, and it may not be that all of that infrastructure will be owned/operated by the same entity as the offshore T&S. As such, they may well become issues for emitters to resolve amongst themselves, along with any investors who may wish to invest in the in-cluster infrastructure without themselves being emitters.

11. Some light is thrown on the likely future for industrial emitters in a cluster by the emerging plans for the Net Zero Teesside cluster (follow this link). In its early development, this cluster was branded as the Teesside Collective and described itself as "...a cluster of leading industries with a shared vision: to establish Teesside in Tees Valley as the go-to location for future clean industrial development by creating the UK's first Carbon Capture and Storage (CCS) equipped industrial zone".

12. More recently, however, there is an emphasis on power generation as the anchor emitter for this cluster. Documents submitted to the Planning Inspectorate[17] suggest that the project will commence with a twin turbine CCGT from which up to 6 million t/CO_2 per annum will be captured, transported and stored. A CO_2 gathering network will be added with a design capacity of up to 4 million t/CO_2 per annum, and to which industrial participants will be added in future.

13. This may reflect the features of industrial emitters set out above: they are smaller, more diverse and less durable long term. In this context, it is obviously attractive to have as at least one of its initial participants, a power emitter, whose long-term use of the T&S infrastructure is underpinned/enforced by a CfD and any other regulatory requirements it has over its lifetime to operate in CCS mode. Yet, there would still need to be flexibility for industrial emitters to be added over time, with the necessary modifications being made to the physical infrastructure and any associated financial arrangements (whether regulated T&S fees or in-cluster deals between emitter participants).

14. The existing statutory rules on third party access to CO_2 infrastructure made under the Energy Act 2008, and commercial practice in the oil and gas sector, which relies heavily on shared upstream and midstream infrastructure, provide a starting point for investors tackling these issues. However, those oil and gas sector arrangements

17 See "Teesside Cluster Carbon Capture & Usage Project, Application for a Scoping Opinion" by Aecom dated February 2019 and linked here.

involve partners who are all in the same industry operating the same kind of assets and, historically at least, with less exposure to major shifts in the regulatory framework. And even the statutory CO_2 regime, which was put in place when HMG's CCS policy was based around full-chain projects rather than the current, functionally disaggregated model with a T&S operations separately funded on a utility-style RAB model, will arguably need to be developed further.

15. It is very likely that government will want to ensure industrial emitters in CCUS clusters benefit and are subject to the full regime for the long-term future of the sector. However, there may not be enough time to devise and pass the primary and secondary legislation, and build the institutions and regulatory arrangements needed to enable industrial emitter participation in a cluster when it is first operational in the 2020s, supported by a fully-fledged industrial CfD, and related enduring institutional arrangements.

16. However, what may be feasible is:

- for government to devise bespoke contractual arrangements between government and industrial emitter participants that wholly or partially replicate the expected long-term framework. These interim arrangements could then either be transitioned or simply folded into the long-term arrangements when the enduring regime is fully established – this is what happened with the early "investment contracts" in the electricity market; or
- for an initial cluster to start with its anchor emitter being a power station, but with T&S infrastructure capable of handling, or being cost-effectively upgraded to deal with, rapid addition of industrial emitters. This may explain why Teesside has emphasised power generation, if it is keen to be the first supported cluster.

Conclusion

1. Developing a robust CCUS business model for industrial emitters is really important. CCUS is likely to be the quickest or most cost-effective way to decarbonise some heavy industries and the only way to deal with some categories of industrial CO_2 emissions.
2. Yet, if developing a model for industrial emitters is the most essential task for HMG as it frames its CCUS policy, it is also uniquely complex. In particular, the diversity of industrial emitters and their end product markets, their exposure (in many cases) to global competition, and the inevitable interaction between any industrial emitters CCUS business model and the uncertainties surrounding wider UK carbon pricing policy, all present significant challenges.
3. Once a detailed policy has been developed, new legislation (including primary legislation) will be required to articulate and implement it. If HMG wants to meet its ambition of establishing a CCUS cluster by the mid-2020s, contractual arrangements to support the first industrial emitters with CCUS may need to be made before the full regulatory framework is in place.
4. Experience of past subsidy schemes suggests that the first implementation of any regime tends to have a disproportionately large impact on its subsequent development. Those emitters and industries represented in the first cluster may therefore enjoy an additional first mover advantage (and enjoy higher first-mover returns). Others will need to be vigilant and engage with HMG and with the legislative process when it comes to ensure that they are not correspondingly disadvantaged.