Department for
Business, Energy
& Industrial Strategy

Power with Carbon Capture, Usage and Storage

Call for evidence on the future policy framework for the delivery of power with Carbon Capture, Usage and Storage

Closing date: 17 October 2022

July 2022

Any enquiries regarding this publication should be sent to us at: powerCCUS@beis.gov.uk

Executive Summary

The Net Zero Strategy (NZS) and the British Energy Security Strategy (BESS) set out the critical role of carbon capture, usage and storage (CCUS) in delivering net zero by 2050, and the government's commitment to a fully decarbonised electricity system by 2035 subject to security of supply. Power CCUS will be vital to both objectives.

Given the long-term nature of these objectives, it is important that we put in place a policy framework that meets these ambitions. The Dispatchable Power Agreement (DPA) is being introduced to incentivise the deployment of the first power CCUS project(s) as part of Track-1 of the Cluster Sequencing process. This call for evidence however is focussed on how we can best develop our future policy framework to support the continued deployment of power CCUS projects beyond these first Track-1 project(s). The term power CCUS covers any form of electricity generation with CCUS technology attached, but for the purposes of this document when using the term 'power CCUS' we are just referring to dispatchable gas-fired power generation with CCUS. The government will be engaging separately on bioenergy power generation with CCUS (power BECCS).

This call for evidence seeks views and evidence on several topics that will help with the development of our future policy framework. Each topic begins with a short introduction to the policy area followed by a series of questions which specify where we are seeking views and evidence. These topics include:

Chapter 1 - How the power CCUS business model (the DPA) should be evolved over time

Chapter 2 - How we can introduce competitive allocation in the 2020s

Chapter 3 - The removal of barriers to deployment

Chapter 4 - How we can maximise economic benefits through our future policies

Chapter 5 - How the power CCUS sector is expected to develop

Chapter 6 - How power CCUS could work with wider electricity markets, taking particular note of the recently launched Review of the Electricity Market Arrangements (REMA) consultation[1]

The information that we receive will help us develop our future policy framework for delivering power CCUS and will also feed into the development of our wider policy initiatives including the Review of the Electricity Market Arrangements (REMA).

[1] Review of Electricity Market Arrangements

Contents

General information

Why we are issuing a call for evidence

We are seeking evidence on how we can best develop our future policy framework to support the continued deployment of power CCUS projects beyond Track-1 of the Cluster Sequencing process[2]. We are engaging now to ensure the policy framework facilitates the development of a long-term pipeline of projects. We have chosen to engage formally, to collect views and evidence from people, organisations, and stakeholders, to allow Government to make more effective policy decisions in an open and transparent way.

The continued rollout of power CCUS is important for the development of our future energy system and the CCUS programme. We will ensure future policy development on power CCUS, the CCUS programme and the energy system is well integrated. In particular, we would encourage stakeholders to note, and consider responding to, the recently launched Review of the Electricity Market Arrangements (REMA) consultation[3].

This call for evidence will not be used to inform the business model design for the current Track-1 Cluster Sequencing process. Responses will inform the design of competitive allocation for power CCUS projects, which we aim to begin in the 2020s, and will inform how the future policy framework for power CCUS will fit with wider energy markets developments and the CCUS programme. This call for evidence focusses on power CCUS, but we also aim to move to a more competitive allocation process for industrial carbon capture and hydrogen business model contracts. Government will continue to co-ordinate efforts in this space, particularly in relation to the buildout of the CO2 transport and storage network.

[2] Cluster sequencing for CCUS deployment: Phase-1 - guidance
[3] Review of Electricity Market Arrangements

Call for Evidence details

Issued: 25 July 2022

Respond by: 17 October 2022

Enquiries to:

Power Carbon Capture Usage and Storage Policy Team
Department for Business, Energy and Industrial Strategy

3rd Floor,
1 Victoria Street
London
SW1H 0ET

Email: powerCCUS@beis.gov.uk

Call for Evidence reference: Call for evidence on the future policy framework for the delivery of power Carbon Capture, Usage and Storage

Audiences:

The government welcomes responses from anyone with an interest in the policy area. We envisage that the call for evidence will be of particular interest to those considering the development of new low carbon energy projects in Great Britain, those participating or interested in participating in the supply chain, businesses and trade bodies operating in the power sector including energy traders and suppliers, academics, prospective investors or investment bodies, and consumer and environmental groups. Should you wish to be involved in any future stakeholder events in connection with this policy area, please contact us by email at powerCCUS@beis.gov.uk.

Territorial extent:

This call for evidence seeks views on the Dispatchable Power Agreement and other electricity market structures that apply to the UK but do not currently operate in Northern Ireland. We are not currently seeking views on how power CCUS could be deployed in Northern Ireland. The call for evidence therefore applies to Great Britain only.

How to respond

Your response will be most useful if it is framed in direct response to the questions posed, and with supporting evidence wherever possible. Further comments and wider evidence are also welcome. When responding, please state whether you are responding as an individual or representing the views of an organisation.

We encourage respondents to make use of the online e-consultation wherever possible when submitting responses as this is the government's preferred method of receiving responses. However, responses in writing or via email will also be accepted. Should you wish to submit your main response via the e-consultation platform and provide supporting information via hard copy or email, please be clear that this is part of the same response to this call for evidence.

Respond online at: https://beisgovuk.citizenspace.com/clean-electricity/power-ccus-cfe/

or

Email to: powerCCUS@beis.gov.uk

Write to:

Power Carbon Capture Usage and Storage Policy Team
Department for Business, Energy and Industrial Strategy
3rd Floor
1 Victoria Street
London
SW1H 0ET

When responding, please state whether you are responding as an individual or representing the views of an organisation.

We will conduct engagement during the time period the call for evidence is open. If you want to be included in these engagement events, then please contact the department as soon as possible via email powerCCUS@beis.gov.uk.

Confidentiality and data protection

Information you provide in response to this call for evidence, including personal information, may be disclosed in accordance with UK legislation (the Freedom of Information Act 2000, the Data Protection Act 2018 and the Environmental Information Regulations 2004).

If you want the information that you provide to be treated as confidential please tell us, but be aware that we cannot guarantee confidentiality in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not be regarded by us as a confidentiality request.

We will process your personal data in accordance with all applicable data protection laws. See our privacy policy.

We will summarise all responses and publish this summary on GOV.UK. The summary will include a list of names or organisations that responded, but not people's personal names, addresses or other contact details.

Quality assurance

If you have any complaints about the way this call for evidence has been conducted, please email: beis.bru@beis.gov.uk.

Context

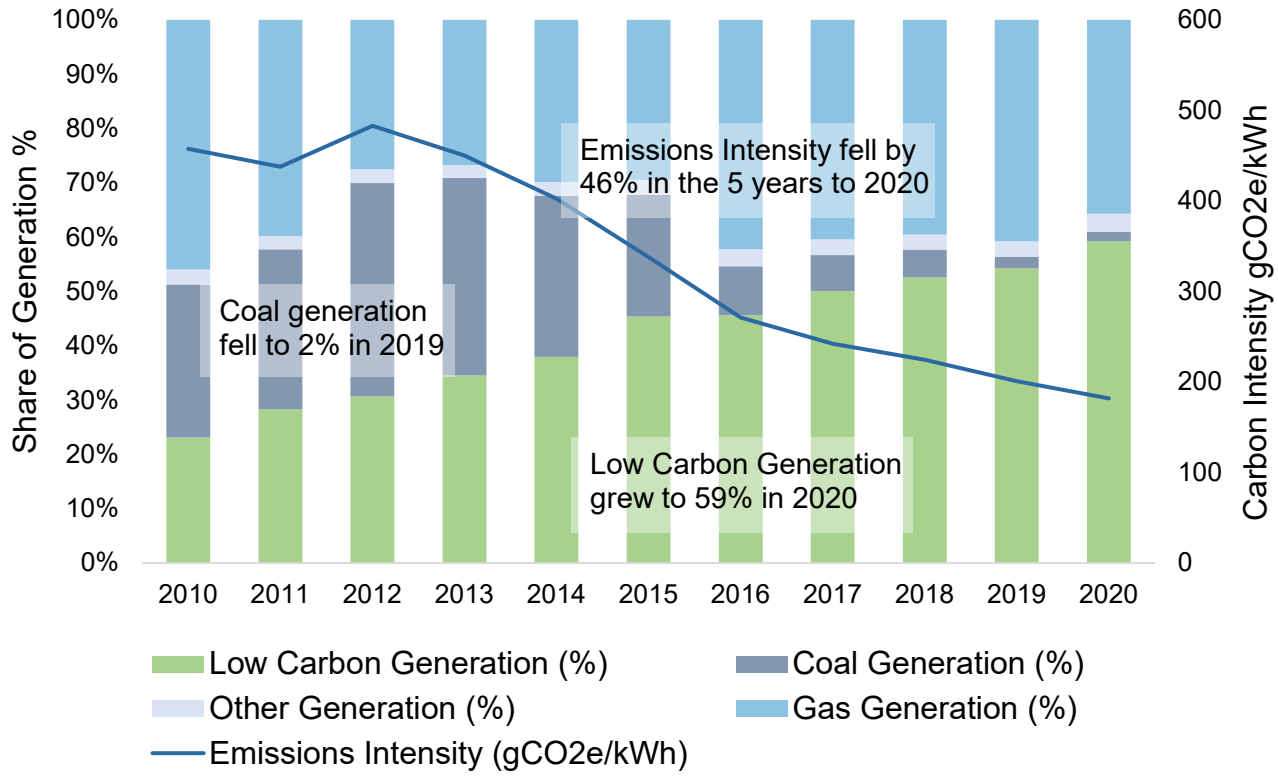
In April 2021, the government announced that the UK's sixth Carbon Budget (CB6) would enshrine in law a new ambitious decarbonisation target to reduce GHG emissions by 78% by 2035 compared to 1990 levels[4]. Widespread deployment of CCUS will play a key role in meeting that ambition, which is why, in the October 2021 Net Zero Strategy (NZS)[5], the government committed to delivering four CCUS clusters, capturing 20-30 Mt CO2 per year by 2030. The NZS also committed to the delivery of at least one power CCUS plant in the mid-2020s, through Track-1 of the Cluster Sequencing Process[6].

The British Energy Security Strategy (BESS)[7] built on the NZS and showed that decarbonisation and energy security go hand in hand. The BESS also laid out the crucial role gas will continue to play in our economy and the importance of fully utilising our North Sea reserves to reduce the UK's reliance on imported fossil fuels. We expect to reduce gas consumption across the economy by over 40% by 2030 but gas is currently the glue that holds our electricity system together and it will be an important transition fuel. As the BESS set out, there is no contradiction between our commitment to net zero and our commitment to a strong and evolving North Sea industry. Decarbonisation of the continued use of gas in power, including through the deployment of power CCUS, will be key to meeting our commitment to decarbonise the electricity system by 2035 whilst maintaining security of supply.

To achieve our CB6 targets we require a decarbonised power sector and therefore continued deployment of power-CCUS beyond Track-1. The role of CCUS in the power sector will complement the growth of renewables and build upon the progress we have already seen over the previous decade. In 2010, over 75% of the electricity generated in the UK came from fossil fuelled sources, with only 7% coming from renewables[8]. By 2020, renewables made up over 43% of the electricity generated in the UK exceeding that of fossil fuels for the first time.

[4] UK enshrines new target in law to slash emissions by 78% by 2035
[5] Net Zero Strategy: Build Back Greener
[6] Cluster sequencing for CCUS deployment: Phase-1 - guidance
[7] British Energy Security Strategy
[8] Digest of United Kingdom Energy Statistics 2011

Fig.1 UK electricity generation share and GB emissions intensity from electricity generation



Source: DUKES; Energy Trends

Whilst we cannot predict today exactly what the generating mix will look like in 2050, we can be confident that renewables will play a key role and that the contribution of variable renewable generation such as wind and solar will continue to grow. To decarbonise our generation mix whilst maintaining security of supply and keeping costs low, we will need to balance renewable variability against demand.

Power CCUS can provide non-weather dependent, dispatchable low-carbon generation. We consider this to be vital alongside nuclear, demand side response, interconnectors and energy storage to support a primarily renewables-based system in 2035. Power CCUS has the added benefit of contributing to the stability of the electricity system. It is also possible that power CCUS could be cost competitive with unabated gas by the mid-2020s, assuming comparable load factors[9].

There is a developing pipeline of power CCUS ready for deployment, and power CCUS is one route that enables existing electricity generation from natural gas to decarbonise. We now have the policy framework under development to bring forward power CCUS and the CO2 transport and storage network (T&S) required to enable it.

As set out in the Net Zero Strategy we need to be in a position to deploy all major low-carbon generation sources at or close to their maximum rate if required. Significant growth of power CCUS will be required, and BEIS analysis published alongside the Net Zero Strategy shows

[9] https://www.gov.uk/government/publications/beis-electricity-generation-costs-2020

that to meet our Carbon Budget 6 targets we could need to deploy as much as 10GW of power CCUS by 2035[10].

To maintain the potential to reach this level of deployment we need to ramp up our deployment of power CCUS in the late 2020s and 2030s and we need to ensure that this is achieved whilst minimising the cost to consumers. The current market is unable to bring forward investment in power CCUS on its own, primarily due to the unpredictability of future revenues for power CCUS plants, the unique interactions with the rest of the CO2 network, and the high capex investment required. This is why we introduced the Dispatchable Power Agreement to incentivise investment in at least one power CCUS project by the mid-2020s and why, as part of the Net Zero Strategy, we announced our ambition to begin competitive allocation for power CCUS in the 2020s to support a future pipeline of projects and cost reduction via increased deployment and competitive tension.

To ensure the accelerated future deployment of power CCUS, we need to consider the wider policy framework within which power CCUS operates. Firstly, it is a technology that will form a crucial part of our electricity sector and will need to operate within existing and future market frameworks. This interaction is explored in this call for evidence and responses will also be used to inform the government's comprehensive review of Review of Electricity Market Arrangements in Great Britain (REMA)[11]. We would recommend reading this call for evidence in conjunction with the REMA consultation document which the government has published. REMA will assess the capability of market arrangements for ensuring energy security, including assessing options to reduce exposure to volatile global commodity markets, as well as meeting our climate targets and ensuring value for money for consumers. We will introduce reform where this proves necessary.

Power CCUS can play an important role in the provision of low carbon electricity generation, but also in creating a pathway for the decarbonisation of existing or future unabated combustion generation. In Summer 2022, we intend to publish our consultation on expanded Decarbonisation Readiness (DR) requirements for all new build and substantially refurbishing combustion power plants to demonstrate a viable plan for decarbonisation by converting to either hydrogen generation or CCUS technology. This DR consultation follows on from the DR call for evidence which closed in September 2021[12].

In addition to its role in the decarbonisation of the electricity system, the deployment of power CCUS forms part of our overall CCUS programme where we rely on sufficient transport and storage networks being established and we also need to ensure that our ambitions for capture projects in other sectors can continue to be achieved. As we seek to harness the benefits and innovation that can be achieved through additional competition, we will remain conscious of the need to continue to coordinate the approach to power CCUS and the buildout of an expanding transport and storage network for CO2. The interplay between the different elements of the CCUS chain is dealt with through the Cluster Sequencing Programme. The next stage of this

[10] Energy and emission projections: Net Zero Strategy baseline (2022), Annex O Supplementary data: Total electricity generating capacity (net zero scenarios in Annex L format)
[11] Review of Electricity Market Arrangements
[12] Decarbonisation Readiness call for evidence

process will be Track-2 which is expected to deliver two further clusters by 2030, making a significant contribution to our overall CCUS Programme ambition of 20-30Mtpa by 2030.

Chapter 1 - Evolution of the power CCUS business model

The Dispatchable Power Agreement (DPA) is being introduced to support the deployment of power CCUS projects as part of Track-1 of the Cluster Sequencing process. The DPA is the proposed contractual framework for power CCUS and is based on the Contracts for Difference (CfD) Allocation Round 4 (CfD AR4) standard terms and conditions but adapted to enable natural gas fired power CCUS facilities to play a mid-merit role in meeting electricity demand, displacing unabated thermal generation plants. The DPA includes an Availability Payment (AP), linked to facility performance, to incentivise the availability of low carbon, non-weather dependant dispatchable generation capacity. The Availability Payment will be calculated and paid regardless of whether a facility is dispatching, and so will not incentivise facilities to displace lower cost and lower carbon sources of generation such as renewables and nuclear. To ensure that a power CCUS Facility generates electricity ahead of higher carbon alternatives, a Variable Payment will account for the additional cost of generation for a power CCUS Facility compared to an unabated Reference Plant, which is intended to be a combined cycle gas turbine (CCGT) based power station with the best-in-class thermal efficiency, on the GB electricity system[13]. We are confident that the DPA will be an effective tool to bring forwards first-of-a-kind (FOAK) power CCUS plants and it has been welcomed as such by industry to date.

One of our stated aims for developing the DPA was for it to have the capacity to be competitively allocated. As such, we are seeking views on whether to continue with the awarding of DPAs in the 2020s and would like to understand if any elements of the DPA should be considered to be adapted to be best used as part of a deterministic competitive allocation process[14] in the 2020s. Questions in this chapter are inter-related with Chapter 6 (creating suitable market arrangements for power CCUS) so reading both chapters in conjunction before responding is recommended. All responses received to this call for evidence will be used to inform the development of the future policy framework for supporting power CCUS only and will not be used to inform the design or use of the DPA as part of the Track-1 Cluster Sequencing process. The latest information on the DPA to be used as part of the Track-1 Cluster Sequencing process can be found online at gov.uk[15].

To introduce additional competition, we will need to define the elements on which that competition is based. One option could be allocation based on the value of the Availability Payment (AP), if the DPA continues to be used. This would be similar to the CfD scheme for renewable technologies where competition is also based on a single element: the strike price. The current DPA however does a lot more to support investment than just provide an AP. This includes, but is not limited to, managing cross-chain risks, allocating T&S fees and protecting

[13] See 'Definition of Reference Plant' in the April 2022 DPA Business Model Update.
[14] See 'Introducing competitive allocation in the 2020s' section in this document where what this process is could be explored further
[15] https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-dispatchable-power-agreement-business-model

investors from any perceived change in law risks. The DPA also includes a Variable Payment (VP). Elements within the VP formula could also be used as part of competition. More broadly we are interested in exploring the longer-term role of the VP and whether there is a case to review its continued inclusion if carbon prices rise over time. If carbon prices are high enough, gas plants with CCS should have a lower short run marginal cost than unabated plants without the need for support from the VP.

Outside of the elements on which competition is based we are likely to need to make other elements in the DPA, which are currently subject to negotiation as part of the Track-1 Cluster Sequencing process, fixed. For instance, contract length. We welcome views on which elements could be fixed and the implications of doing so.

As part of the continued evolution of the DPA we would also welcome feedback on any elements that could be modified or removed to further enhance value for money, reduce complexity or redistribute risk as the market matures.

It is acknowledged that providing feedback on how the DPA model can best be evolved to work as part of competitive allocation may be challenging given the lack of use of the DPA to date and the fact that competitive allocation is yet to be defined. Competitive allocation is the subject of the second set of questions in chapter 2 of this call for evidence.

Whilst the DPA is our proposed method for supporting power CCUS plants as part of the Track-1 Cluster Sequencing process, we would be interested in hearing about any alternative models or methods for our consideration along with supporting evidence as to why they may more efficiently address market failures and barriers to deployment in the later 2020s or work better with a competitive allocation process.

Considering the 2030s and beyond, we'd like to gather views on the principles for business model evolution and how this may work with other market frameworks. Questions in the 'Creating suitable market arrangements for power CCUS' section of this call for evidence will further explore how power CCUS could be supported through wider market mechanisms once it has reached the maturity to do so.

1. **What is your view on the continued need for a business model to bring forward power CCUS in the 2020s? If you see the need for continued use of a business model what is your view on the continued use of the DPA as that business model?**

2. **If the DPA were to continue to be used as a business model to support power CCUS in the 2020s, how could it be evolved to be used as part of a competitive allocation process in the 2020s? What key changes, if any, would need to be made? Please include your views on the elements on which projects should compete and your views on which elements would need to be consistent across competing projects and the implications of those decisions.**

3. **Are there alternatives to the DPA that the Government should consider for use in the 2020s? How could these alternatives work better with a competitive allocation process than the DPA?**

4. **What key principles should be considered for business model evolution into the 2030s?**

Chapter 2 - Introducing competitive allocation in the 2020s

Ambition and commitments

In the Net Zero Strategy we said we would aim to begin running a competitive allocation process for power CCUS in the 2020s and we would like to gather views and evidence on what such a competitive allocation process could look like, when in the 2020s it could be introduced from, and how it could be operated. To focus responses to this section, we would like to gather views and evidence on what a power CCUS-only competitive allocation could look like. Views around power CCUS competing with other technologies in the future and interactions with wider energy frameworks will be considered later in chapter 6 later of this document but also as part of the recently published REMA consultation which has a much broader technology scope.

What we mean by competitive allocation and evolution from Track-1

By ‘competitive allocation’ we mean determining the project(s) that will receive support based solely upon bids against one or more pre-set numerical criteria. Competitive allocation processes used elsewhere in the energy sector, range from tenders for specific products to open technology-neutral auctions. One example is the Contracts for Difference (CfD) scheme, the governments primary mechanism for supporting low-carbon electricity generation and one of the most prominent examples of auction use in the energy sector. The replication of a similar scheme may be appropriate for power CCUS, but there are additional considerations such as the interactions with the Cluster Sequencing Process, and the buildout of the T&S network for CO2 that will need to be taken into account.

It should be noted that the bilateral negotiations to be used as part of the Track-1 Phase-2 process already involve a level of competition through the use of assessment criteria and as such, we consider the move to ‘competitive allocation’ to be an evolution of our support for power CCUS as opposed to a revolution. The primary change from the Track-1 process would be the requirement for final bids to be submitted upfront against a fixed set of terms, rather than certain terms being determined during a period of negotiations. We are seeking views on the most appropriate format of competitive allocation for power CCUS.

Strategic aims of a competitive allocation process

Before designing a competitive allocation process for power CCUS in detail, we will first need to make a decision on what we are aiming to incentivise. Potential strategic choices could be to focus on the delivery of capacity, generation, carbon abatement or learning. For example, a

capacity focussed strategy may lead to an allocation design where all projects compete against one another to drive cost efficiencies and allow the delivery of as much capacity as possible at least cost. Alternatively, a learning focussed strategy may lead to an allocation design that seeks to ensure that a wide breadth of projects in terms of technological design and/or location are supported. We would like your views on what the strategic aims of any competitive allocation in the 2020s should be.

Aspects of competitive allocation design

A critical aspect of the design of any allocation process and a key reason for moving to a competitive allocation process, is to seek to deliver enhanced value for money for consumers whilst efficiently delivering against key objectives. We would like to receive views and feedback on the components of the allocation framework design that will help us deliver our deployment objectives whilst prioritising value for money.

One key design choice is the process for receiving bids and determining which bids are successful. A first order decision will be whether an auction-based approach or a tender-based approach is more suitable for power CCUS. Auctions have been commonly used in UK energy policy, but it is important to note that in the 2020s we are deploying power CCUS at the same time as developing a transport and storage network for CO2 and that those activities need to be coordinated to ensure the full chain of projects can be successfully delivered. We are particularly interested in views around how the interdependencies across the CCUS chain can be best managed whilst also maximising the benefits of competition.

Another key strategic design choice is the extent to which all projects can compete together, versus the extent to which there should be separate competitive processes split into ‘pots’. In the context of power CCUS, there could be a benefit in separation by technology type, links to cluster sequencing and therefore delivery dates or location, or a combination of these factors. For example, there could be separate pots for new build and retrofit or for more established power CCUS technologies versus more novel CCUS technologies. There could also be pots linked to the maturity or location of the individual CCUS clusters. The strategic aims of any competitive allocation process will influence what ‘pots’, if any, we would like to utilise.

There are also more granular design choices, such as how the design of the bid process achieves the best value for money. These choices are illustrated in the differences between the auctions used in the CfD scheme and Capacity Market (CM). For the CfD, participants submit a single sealed bid, whereas the CM uses an iterative sequence of auction rounds at decreasing prices. Beyond just the design of the bidding process, various additional means can be used to ensure value, such as setting a maximum price that will be paid per unit and/or capping the total cumulative amount of support awarded. We are seeking views on how a power CCUS competitive allocation process could be designed to ensure best value for money and what points are most pertinent to consider as part of the design.

Institutional Framework Design

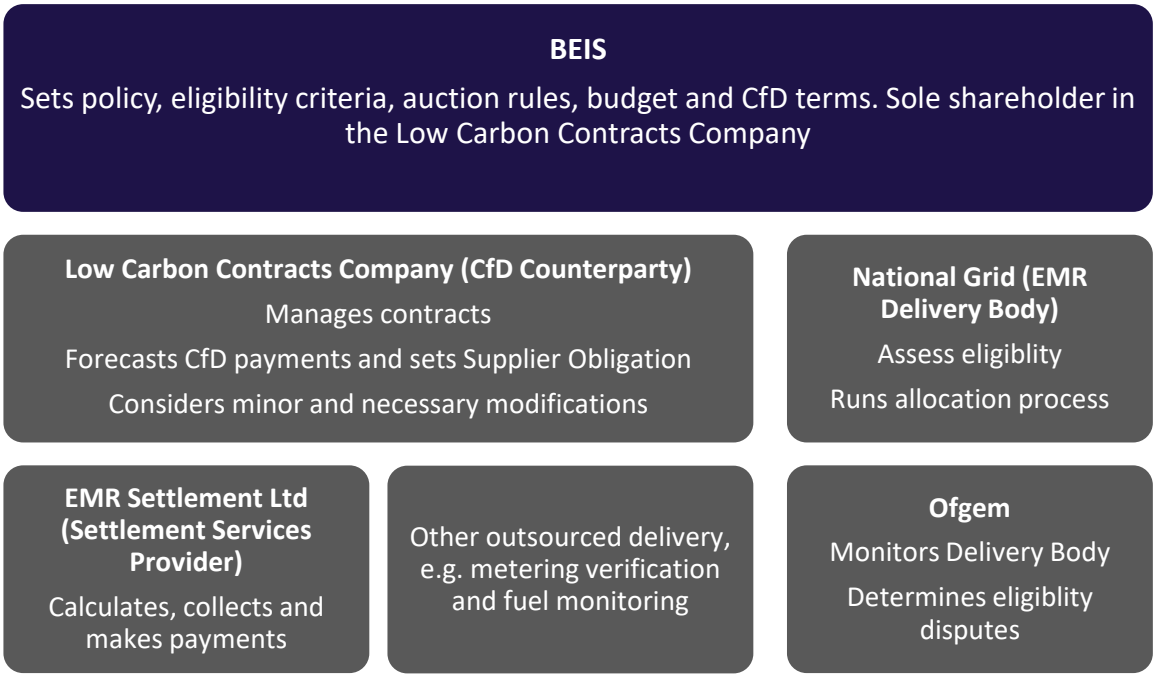
The delivery of any competitive allocation process will require a clear institutional framework to be in place including the underpinning legislation and clarity around the roles of the organisations responsible for developing and delivering the scheme. We would like to gather views and evidence on what an institutional framework for the administration of a competitive allocation process for power CCUS would ideally look like. The institutional framework in Box 1 is that in place for the CfD scheme and is provided as an illustrative example.

Broadly similar roles are required for the allocation of power CCUS contracts. Depending on the design of the allocation process there will need to be a body, or bodies to:

- Determine the objectives, scope and size of the competitive process and the frequency at which it is run
- Determine the rules by which the competitive process will be run
- Determine the eligibility criteria, and assess whether these criteria have been met
- Assess bids and allocate successful bidders (i.e., execution of the competitive allocation process)
- Managing contracts with, and payments to, successful bidders
- Monitor participants' adherence to rules and resolve disputes

Views and evidence on how the institutional framework for power CCUS could be optimised would be welcome in addition to views on the above list of roles (which may not be exhaustive) and evidence on institutional frameworks for other competitive allocation processes you believe we should consider.

BOX 1: Institutional framework for Contracts for Difference allocation rounds



Managing interactions across the CCUS chain

We will need to decide on which projects will be eligible to compete as part of a competitive allocation process and when. In particular, it will be important to understand at what point in the Cluster Sequencing Process competitive allocation could be introduced.

We would ideally like as many projects as possible to compete against one another as part of a competitive allocation process, however with CCUS clusters still being established in the UK, we appreciate that this may not be achievable as part of a first competitive allocation process. For example, it may be challenging to include power CCUS projects that are anchor projects, essential to the formation of a new T&S cluster, as part of any competitive allocation process given the T&S interdependencies. We are also aware that prospective power CCUS projects may be exploring multiple transport and storage options, and we will need to consider how to reflect this into eligibility for individual allocation processes.

We would welcome views on the extent to which competitive allocation for power CCUS could be run independently from the process of introducing new clusters and developing any clusters already established, or how the two processes could be best incorporated.

5. **What should an ideal competitive allocation process look like when introduced? As part of your answer, you should provide views on what the strategic aims of any competitive allocation should be, competitive allocation design and the institutional framework design. We would also welcome information and views on any existing schemes which you believe we could utilise or adapt.**

6. **With regards to a first competitive allocation process in the 2020s what projects do you think should compete and when in the 2020s could this first competitive allocation process take place from? Do you have any views of how a competitive allocation process for power CCUS can best be incorporated into, or aligned with, the Cluster Sequencing Process? In your answer you should consider the points raised in the 'managing interactions across the CCUS chain' section above.**

7. **Through our competitive allocation design how can we ensure that value for money is achieved? What mechanisms could be used and how should they be implemented? Your answer should pay particular attention to the points raised in the last paragraph of the 'aspects of competitive allocation design' section.**

Chapter 3 - Managing barriers to deployment

The DPA has primarily been designed to encourage investment in power CCUS deployment. Outside of the business model though there are other barriers which could impact the successful deployment of current and future power CCUS projects. We are interested to understand more about the barriers that are faced by the power CCUS projects currently being developed, as well as any barriers that could arise due to the cumulative deployment of multiple power CCUS projects over time. We recognise the fact that power CCUS is an emerging sector which is being incorporated into a wider policy and regulatory landscape and are seeking to understand any persisting regulatory challenges, barriers or gaps that could limit deployment. Notable areas that we are wanting to explore are: planning and consenting; skills, capability, and supply chains; managing impacts on local communities and the local environment; and tensions with other sectors. However, we do not want to restrict the scope of this section and welcome views on barriers outside of the above categories.

Different parties may be best placed to manage these barriers. We also want to understand how stakeholders can support any suggested lead party to manage any individual barrier. This should be seen as a cooperative process; by seeking to manage these barriers in a collaborative and transparent way, we can build public and investor confidence in power CCUS. This will help to deliver decarbonisation and economic opportunity while protecting people and the environment.

Respondents should not limit themselves to barriers specific to any part of CCUS Cluster Sequencing and should consider power CCUS deployment more broadly. We are interested in hearing about barriers to power CCUS deployment as a whole, but also project level barriers which may only affect certain cases. This should not be seen as an opportunity to resolve specific project challenges or risks.

Where feasible, respondents are encouraged to provide this information in a spreadsheet or table format as displayed below.

#	**Barrier**	**Details and impacts**	**Key stakeholder(s) who should manage the barrier**	**Management actions**	**Priority**	**Desired outcome**

8. **What are the barriers to future power CCUS deployment in the 2020s?**

9. **Who is best positioned to manage each barrier, and how can parties support the best placed stakeholder to do so?**

Chapter 4 - Realising the economic benefits

CCUS represents a huge opportunity for the UK economy. The deployment of power CCUS is expected to deliver social and economic benefits, such as new highly paid jobs, including nationally and regionally and we are keen to ensure power CCUS plays an important role in our overall ambition to level up the UK. We believe the UK is ideally positioned to lead the global development of CCUS technology and infrastructure. The UK has the industrial ecosystems and wider investment landscape to enable innovation, development, and growth across the fast-developing CCUS economy: existing capability, policy leadership, capital support and access to global markets. It is expected that there will be rapid growth in the global market for CCUS as deployment ramps up. Analysis suggests that global turnover from power CCUS tradable goods and services could reach £53 billion annually by 2040[16].

There are natural areas where we consider the UK is positioned to support the deployment of CCUS such as in Engineering, Procurement and Construction Management (EPCM) services, given strong pre-existing capabilities. However, we also welcome views from industry and training boards about the skills requirements and gaps which need to be addressed to deliver future CCUS projects.

The government recognises the importance of building a diverse and inclusive sector and the economic benefits this can bring. Whilst we expect industry leaders to lead by example and develop their own diversity and inclusion initiatives, we also understand the impact policy levers can have. We therefore want to understand how any policy we deliver can best support the creation of a diverse and sustainable sector.

10. **Which areas of the power CCUS supply chain are well provided for in the UK and internationally, and where is there room for further development of supply chains to support power CCUS?**

11. **How can the future policy we develop maximise social and economic benefits such as supporting businesses, including optimising opportunities for supply chains at home and globally?**

12. **What are the anticipated bottlenecks in the supply chain and what can be done about them?**

13. **How do we best ensure that economic benefits are realised at a regional level where power CCUS plants and businesses are located?**

[16] Seizing sustainable growth opportunities from carbon capture, usage and storage in the UK, Centre for Economic Performance

14. **Across the whole CCUS sector we anticipate that 50,000 jobs[17] could be supported. How can future policy best support businesses to develop a diverse sector that provides opportunities for all?**

[17] EINA 2019 https://www.gov.uk/government/publications/energy-innovation-needs-assessments

Chapter 5 - Future plans in the GB power CCUS sector

Understanding the potential pipeline of power CCUS projects through the 2020s and into the 2030s will help us ensure that any strategies and policies we develop are correctly targeted and do not prohibit the development of more novel project types that we may wish to support.

We would therefore like to gather your views on the prospective size of the total GB power CCUS sector but are also interested in information on specific power CCUS projects or technological innovations that could contribute to deployment over the late 2020s and into the 2030s. For these projects we would be particularly interested in understanding any existing or novel technology innovations that may require changes to existing policy frameworks. With these technology innovations we would be keen to understand the potential for cost and time reductions, or sustainability improvements, for large scale power CCUS plants, including retrofits.

The scope of technology innovations we are interested to hear about include any aspect of gas power generating plants with associated post-combustion, pre-combustion or oxy-fuel combustion capture plant technologies that provide baseload or dispatchable power to the electricity grid. These technologies could be retrofitted to existing equipment or new-build and located on or offshore.

It is appreciated that you may be unable to provide significant detail on proposed projects due to uncertainties and commercial sensitivities. Therefore, we would also be interested in your more general thoughts on future power CCUS deployment. For instance, we are particularly wanting to further understand how quickly the future pipeline for power CCUS projects could develop. Any information on the total magnitude of that pipeline, the pace at which it can be expected to grow, and the timeframes for the development and construction of power CCUS projects would be very valuable.

15. **Our CB6 targets could require as much as 10GW of power CCUS by 2035. In general, what do you think the trajectory for power CCUS deployment should look like to meet our CB6 targets in the most cost-effective manner? Do you think the current pipeline is developing at the scale and pace necessary to meet our CB6 targets? Please provide evidence to substantiate your views.**

16. **What are your views on the composition of the current and future pipeline? For example, what is the anticipated locational make-up of future power CCUS deployment across the UK and what mix of power CCUS projects do you expect to come forward?**

17. **Are there any specific power CCUS projects that you are planning for the late 2020s and into the 2030s that you would like to make us aware of at this stage?**

18. **Are there any particular technology innovations that government should be made aware of? What support might these innovations require and what potential do they have to contribute further to the cost-effective delivery of our decarbonisation ambitions?**

Chapter 6 - Creating suitable market arrangements for power CCUS

The development of power CCUS, the CO2 transport and storage network and the wider electricity market and system are all co-dependent. They will need to evolve together in a coordinated way to achieve our net zero ambitions. The DPA is designed to address this coordination problem in the immediate term, by providing certainty to developers on investment and management of cross chain risk, whilst preserving the relevant incentives in the power market to ensure system benefits are achieved.

Power CCUS cannot currently be deployed without support under the current electricity market arrangements and power CCUS may continue to need bespoke support until:

a) A significantly more developed CO2 transport and storage network that includes both pipeline and non-pipeline transport is in place
b) Multiple power CCUS projects have been deployed to reduce the technology costs and investment risks
c) Market conditions fully value the benefits power CCUS brings to the electricity system and incentivise power CCUS to run at appropriate times, for instance before unabated generation

Points a and b are concerned with the maturation of the CO2 T&S network and power CCUS as a technology which we see as being advanced through the current Cluster Sequencing process and any competitive allocation process we may begin in the 2020s. The questions in this section will focus on point c and how the relevant market failures could be addressed going forwards so that once mature, power CCUS is able to compete with other technologies that provide similar services to the electricity system.

Responses in this section may also be used to inform the Review of Electricity Market Arrangements (REMA) as well as power CCUS policy development. Whilst bespoke support schemes are outside of the scope of REMA and are currently required to de-risk investment in first-of-a-kind technologies such as power CCUS, REMA will consider how to design market arrangements that allow a transition away from bespoke schemes once individual technologies are sufficiently developed.

A decarbonised power sector will increasingly need non-weather dependant, dispatchable low carbon generation alongside other forms of flexibility such as storage and demand side response. Our assessment is power CCUS can deliver against many of these needs working in harmony with other low carbon technologies, and that we should provide relevant support to help bring it to a stage of maturity where it can compete in an electricity market which rewards these needs. The primary benefits of power CCUS that we should therefore value in bespoke support are the provision of low carbon, firm, dispatchable generation. Power CCUS can also provide additional services to our electricity system, for example inertia. It is recognised that power CCUS generation is not zero carbon, although over 90% (and much higher in most cases) of the CO2 is expected to be captured. Therefore, our current policies are aimed to

incentivise dispatch behind renewable sources such as wind and solar and it will continue to be important to ensure power CCUS sits in the right place in the merit order. We would like to seek views on the role power CCUS is expected to play in the future electricity system and its position in the merit order relative to other forms of generation.

We would also like to explore the interactions between policy to support power CCUS and the Capacity Market (CM). The CM is the key market mechanism for ensuring security of supply and options for reform of this mechanism and wider electricity market arrangements are being considered as part of the REMA consultation. Any future reforms would need to be carefully planned and introduced gradually over time and will be subject to public consultation. We would like to explore how the CM could work with power CCUS going forwards, particularly whether it would be beneficial in the future for plants with an existing multi-year CM agreement to move to having a DPA contract in order to decarbonise or whether it would be desirable to hold a combination of the two in parallel with adequate measures taken to ensure compliance with UK subsidy control requirements. We are seeking views and evidence on what the relationship between the CM and the DPA (or indeed an alternative power CCUS business model) should be going forwards. We note that reforms to the CM to better align with net zero were considered as part of a call for evidence process, which BEIS responded to in July 2022[18].

We also are aiming to expand Decarbonisation Readiness (DR) requirements. All new build and substantially refurbishing combustion power plants will need to demonstrate a viable plan for decarbonising by retrofitting either CCUS or hydrogen-firing technology. We intend to publish a consultation on DR in summer 2022.

It is possible that power CCUS deployment without direct support such as that provided through the DPA could remain unlikely for some time, but it is our intention to move towards a market-based system as soon as possible where power CCUS is in direct competition with other technologies providing similar services to the electricity system. Enabling technologies to transition from a bespoke scheme to market-wide arrangements will be a key design consideration for REMA. We believe that the introduction of competitive allocation in the 2020s and the expansion of DR requirements will help drive cost-reduction, by enhancing preparedness and improving competitive tension – advancing us towards a market-based solution as quickly as possible. We would like to gather views and evidence on the timespan over which the transition to a market-based solution may occur.

19. **Do you agree with the continuation of the mid-merit role we envisage for power CCUS relative to other technologies? Please provide evidence to support your view.**

20. **Noting the need to secure best value and to avoid overcompensation, what should the relationship between the CM and the DPA (or indeed an alternative power CCUS business model) be in the future? What changes would be required to facilitate such a relationship?**

[18] Capacity Market 2021 call for evidence on early action to align with net zero

21. **Over what time period do you believe power CCUS could move from requiring direct support under a competitive allocation system to that of a market-based solution in direct competition with other technologies providing similar services to the electricity system?**

Glossary

Term	Description
AP	Availability Payment
AR4	Allocation Round Four (Contracts for Difference)
BECCS	Bioenergy with Carbon Capture and Storage
BESS	British Energy Security Strategy
BEIS	Department for Business, Energy and Industrial Strategy
CB6	Carbon Budget Six
CCGT	Combined Cycle Gas Turbine
CCUS	Carbon Capture, Usage and Storage
CCS	Carbon Capture and Storage
CfD	Contract for Difference
Cluster	Transportation and storage network (incorporating the onshore and offshore network and offshore storage facility) and an associated first phase of carbon capture projects.
CM	Capacity Market
CO_2	Carbon Dioxide
DPA	Dispatchable Power Agreement

Decarbonisation Readiness	Government policy ensuring new build combustion power plants can demonstrate readiness for decarbonisation technologies.
FOAK	First-Of-A-Kind
GB	Great Britain
gCO2e/kWh	Grams of CO2 equivalent per unit of electricity produced (kilowatt hours)
GHG	Greenhouse gases
HMG	Her Majesty's Government
ICC	Industrial Carbon Capture
LHV	Lower Heating Value
Mt	Megatonnes
Mtpa	Million tonnes per annum
MW	Megawatt
MWh	Megawatt hours
NZS	Net Zero Strategy
O+M	Operations and Maintenance
Power CCUS	Power generation with Carbon Capture, Usage and Storage
REMA	Review of Electricity Market Arrangements
Storage	Geological store for the captured CO_2 from the end of the injection well.

Track-1	Cluster selection (Phase 1) followed by project selection (Phase 2)
T&S	Transport and Storage
UK	United Kingdom of Great Britain and Northern Ireland
VP	Variable Payment

This consultation is available from: www.gov.uk/government/consultations/future-policy-framework-for-power-with-carbon-capture-usage-and-storage-ccus-call-for-evidence

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