National Audit Office

REPORT

Carbon Capture, Usage and Storage programme

Department for Energy Security & Net Zero

SESSION 2024-25
HC 120

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National Audit Office

Carbon Capture, Usage and Storage programme

Department for Energy Security & Net Zero

Report by the Comptroller and Auditor General

Ordered by the House of Commons
to be printed on 22 July 2024

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Gareth Davies
Comptroller and Auditor General
National Audit Office

5 July 2024

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CORRECTION SLIP

Title: Carbon Capture, Usage and Storage programme

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Correction:

The text in paragraph 1.8 currently reads:

At that time, the government was committed to having "the option of deploying CCUS at scale during the 1990s".

"1990s" should read "2030s".

The paragraph currently reads:

1.8 DESNZ sets its ambitions with reference to the Climate Change Committee's (CCC's) assessment of how much CO_2 needs to be captured to support its balanced pathway to net zero (paragraph 1.4). DESNZ has its own pathway based on its own assessment of how to meet the government's net zero target. This contribution is more than was established at the outset of the programme – in 2018, the government's overall climate ambition was to reduce carbon emissions by 80% in 2050 compared with 1990 levels. At that time, the government was committed to having "the option of deploying CCUS at scale during the 1990s". DESNZ told us that it considered whether, for example, an approach where government carried more of the cost and risk of the first projects was required in the light of the ambitions for CCUS, but we have not seen any substantial evidence of such an assessment. If the government only achieves its minimum ambition for 2030 then this will be below the CCC's assessment of what is required (**Figure 3** overleaf).

The paragraph now reads:

1.8 DESNZ sets its ambitions with reference to the Climate Change Committee's (CCC's) assessment of how much CO_2 needs to be captured to support its balanced pathway to net zero (paragraph 1.4). DESNZ has its own pathway based on its own assessment of how to meet the government's net zero target. This contribution is more than was established at the outset of the programme – in 2018, the government's overall climate ambition was to reduce carbon emissions by 80% in 2050 compared with 1990 levels. At that time, the government was committed to having "the option of deploying CCUS at scale during the 2030s". DESNZ told us that it considered whether, for example, an approach where government carried more of the cost and risk of the first projects was required in the light of the ambitions for CCUS, but we have not seen any substantial evidence of such an assessment. If the government only achieves its minimum ambition for 2030 then this will be below the CCC's assessment of what is required (**Figure 3** overleaf).

Date of correction: 4 September 2024

Contents

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Key facts

Up to £20bn

the amount HM Treasury has committed to supporting future costs of Carbon Capture, Usage and Storage (CCUS) projects

78bn tonnes

the UK government's estimate of how much captured carbon could be stored on the continental shelf under the North and Irish Seas

8.5mn tonnes per annum

the amount of CO_2 storage capacity targeted for 'Track-1', the first phase of the CCUS programme

4	the number of CCUS clusters announced by the Department for Energy Security & Net Zero (DESNZ) across the UK
8	number of emitter projects selected by DESNZ as part of Track-1 that are currently going through negotiations
2	number of transport and storage projects selected by DESNZ as part of Track-1
20–30 million tonnes per annum	the government's CO_2 storage ambition for 2030
£630 million	DESNZ's spending to date on the CCUS programme

Summary

Background

1 The government sees Carbon Capture, Usage and Storage (CCUS) as central to achieving net zero by 2050. CCUS can potentially address several challenges to decarbonising the economy, such as in the power sector, and may be the only practical way to decarbonise some industries, such as cement production. CCUS could also be used to capture carbon absorbed during the process of growing biofuel (such as biomass used for generating power), or through a technology known a Direct Air Capture, which captures carbon directly from the air, resulting in a net removal of carbon dioxide from the atmosphere. CCUS includes several technologies that cover the process of capturing carbon and permanently storing before it can be released into the atmosphere. These technologies include hydrogen production, energy generation, industrial and waste processes, and Greenhouse Gas Removals. The government considers that the UK is well placed to deploy CCUS given the possibility of storing 78 billion tonnes of captured carbon in the continental shelf under the North and Irish Seas. The government also hopes that CCUS will generate jobs in the UK and that, in the future, there may be a market for the UK to store carbon captured overseas. While the government first set out its intention to support CCUS in the early 2000s, there are no facilities operating at a commercial scale in the UK.

2 The government has attempted to launch CCUS programmes in the UK twice before without success. We reported on these in 2012 and 2017.[1,2]

- The Department of Energy & Climate Change cancelled the first competition for government support in 2011. It decided that the project could not be completed within the funding limits agreed by the government in its 2010 Spending Review. We concluded that the government had not undertaken sufficient planning and failed to recognise the significant commercial risks.
- The Department for Business, Energy & Industrial Strategy (BEIS) cancelled the second competition in 2016 when HM Treasury withdrew funding because of mounting costs. We highlighted how BEIS had not, at the outset, agreed with HM Treasury the amount of financial support that would be required for programme's lifetime. The cancellation of these competitions dented industry confidence in the government's commitment to CCUS.

1 Comptroller and Auditor General, *Carbon capture and storage: lessons from the competition for the first UK demonstration*, Session 2010–2012, HC 1829, National Audit Office, March 2012.
2 Comptroller and Auditor General, *Carbon capture and storage: the second competition for government support,* Session 2016-17, HC 950, National Audit Office, January 2017.

3 The Department for Energy Security & Net Zero (DESNZ) has lead responsibility for the current CCUS programme. Through its CCUS programme, DESNZ aims to establish the technology in four industrial areas, or clusters, in the UK to capture and then store 20 to 30 million tonnes of carbon per year by 2030. DESNZ has set targets which are based on the trajectory required to meet Carbon Budget 6, which is its legally-binding interim target for the period 2033-37 towards achieving net zero in 2050.

4 In October 2021, DESNZ announced that the first two clusters in the CCUS programme (known as Track-1) would be HyNet, spanning north-west England and north Wales; and the East Coast Cluster covering Humberside and Teesside. In March 2023, DESNZ announced that it had short-listed eight emitter projects across these clusters to proceed to commercial negotiations. DESNZ plans to identify additional emitters that could join these clusters later (known as Track-1 expansion). The application process for Track-1 expansion at HyNet was launched in December 2023. DESNZ also intends to launch two further clusters (Track-2) before 2030. These will be Acorn (centred on Peterhead, north of Aberdeen) and Viking (on Humberside), although no formal timeline has been announced.

5 In the March 2023 Budget, HM Treasury announced up to £20 billion to support the early development of the CCUS programme. This is a combination of direct government funding and consumer levies and, for example, levies on suppliers. DESNZ ultimately wants CCUS to run without public subsidy and published its CCUS Vision in December 2023, setting out at a high level how this might work in practice from the 2030s.

Scope and purpose of this report

6 This report examines:

- how DESNZ responded to the lessons of previous attempts to support CCUS in designing the current programme;
- the progress DESNZ has made with the current CCUS programme; and
- the key risks and issues that DESNZ will need to address to meet its targets for CCUS deployment.

7 This report is intended to support Parliament's understanding of the CCUS programme and the key issues DESNZ faces in achieving its objectives. We have assessed whether DESNZ has set up the CCUS programme in a way that is likely to achieve value for money and made recommendations aimed at supporting DESNZ's management of the programme. In doing so, we recognise DESNZ is operating in a high-risk environment given the inherent challenges of CCUS as a technology; the fact that DESNZ is aiming to support 'first of a kind' projects; and the complexities and high ambition of DESNZ's approach. This means risks of project failure, high upfront costs, and obsolescence will need to be accommodated if they are deemed to be outweighed by the programme's potential long-term benefits, particularly given the central role that DESNZ expects CCUS to play in achieving net zero. We also recognise that the CCUS programme is going to be one of government's largest projects financially, meaning HM Treasury has a crucial role toplay in overseeing and managing the financial risks.

8 As DESNZ is currently conducting commercial negotiations with the Track-1 projects we have not included information that is commercially sensitive and which might negatively affect these negotiations if made public. Given its long-term nature, we expect to report again on the CCUS programme in the future to assess whether DESNZ is achieving value for money and whether it is effectively managing the risks we have identified in this report.

Key findings

Setting up the CCUS programme

9 DESNZ and HM Treasury must manage a range of risks to be successful in deploying the first commercial-scale CCUS facilities in the UK. For example, DESNZ needs to manage risks inherent to CCUS, such as introducing a complex technology at scale and the uncertainties around the potential capacity and performance of storage sites. Given the approach to implementation it is adopting, DESNZ will need to define and agree appropriate allocations of risk between the government and private investors providing the capital for the projects, as well as between companies involved within projects (for example, between carbon emitters and transport and storage companies). Ultimately, these individual projects need to be operational at the same time for the programme to be successful. Given the expected scale and longevity of the CCUS programme, HM Treasury will have an important role in ensuring there is a clear plan for funding, either via the Exchequer or through consumers' bills, and will need to be closely involved in cross-government governance arrangements (paragraphs 1.11 to 1.13, 2.2, 3.2 and Figure 6).

10 DESNZ identified lessons from previous failed attempts to launch CCUS in the UK and sought to address them. DESNZ introduced its current approach to CCUS in 2018. It reflects lessons learned from previous attempts by introducing a new method of creating transport and storage companies that are separate from the emitter projects that will capture carbon. This is intended to reduce the risks from projects that manage the capture of carbon, its transportation and storage all together. By separating out the stages, DESNZ hopes that issues can be dealt with by those best able to manage them (for example, so that a problem with a storage site has less of a direct impact on the associated capture projects). Instead of single projects, DESNZ's current approach is built on emitters in tight geographical clusters. It considers this will reduce risks by connecting projects across sectors, so that they share the costs of transport and storage infrastructure. DESNZ is looking to secure competitive tension from the selection of emitter projects in each cluster (paragraphs 1.12, 1.13 and 2.6).

11 DESNZ acknowledges that its design of the CCUS programme introduces new risks. Launching new technology at scale is inherently challenging as there are a range of technical and commercial risks that need to be addressed and there are no established solutions. DESNZ will need to conduct negotiations and conclude agreements with a range of emitting projects as well as transport and storage projects simultaneously, all against tight deadlines, while handling the different commercial risks that arise from each different business model. DESNZ told us that it considered competitive tension would be created through its ability to 'walk away' from negotiations and by the projects being considered for Track-1 expansion, which might replace Track-1 projects currently in negotiations (paragraphs 1.12, 1.13, 2.1 and 2.2; Figure 6).

12 DESNZ has taken steps to fill the capability and capacity gaps it has identified. Carrying out separate negotiations across different sectors each with its own business model, has placed considerable demands on DESNZ's capacity and capabilities. DESNZ established the CCUS Directorate in January 2021, which worked with the Hydrogen and Industrial Carbon Capture Directorate to manage the programme. At that time, this group had 51.5 full-time equivalent (FTE) staff, compared with the 103.5 FTE that DESNZ assessed it needed. As the CCUS programme progressed, DESNZ calculated that it would need many more staff. By 2023-24 DESNZ had a target of 206.5 FTEs, but an actual staffing level of only 144.5 FTE at the start of the year. DESNZ is confident it now has the resources in place to conclude negotiations around Track-1 (paragraphs 1.13 and 2.13).

13 DESNZ has increased its reliance on CCUS to contribute to meeting its net zero targets since it began designing the current programme but it has not fully considered whether this should result in changes to the programme's design. DESNZ's predecessor, BEIS, began developing its approach to supporting CCUS in 2018, when the government's overall climate ambition was to reduce carbon emissions by 80% in 2050 compared with 1990 levels. At that time, the government was committed to 'having the option to deploy CCUS at scale during the 2030s'. In 2019, the government established its net zero target, for which the Climate Change Committee (CCC) has said CCUS is "essential". The CCUS programme has subsequently adopted the ambitions for carbon capture in 2030 that are implied by the CCC's balanced net zero pathway – a far higher level of ambition than at the outset of the programme. DESNZ told us that it considered whether, for example, an approach where government carried more of the cost and risk of the first projects was required in the light of the ambitions for CCUS, but we have not seen any substantial evidence of such an assessment (paragraph 1.8).

14 DESNZ and HM Treasury have committed up to £20 billion to the early deployment of CCUS, responding to lessons they had learnt from past failings, but uncertainty remains around the funding available for future stages of the CCUS programme. HM Treasury announced this commitment in the spring 2023 budget, but neither it nor DESNZ specified which elements of the programme are covered. DESNZ and HM Treasury acknowledge that further funding will be required for the CCUS programme and that they plan to agree the funding available in stages. Agreeing this will be important so that DESNZ can tailor its approach to the later stages of the programme within the available funding limits. In setting funding limits, they will need to give investors certainty without undermining the government's negotiating position by making clear to commercial parties the maximum funding available. HM Treasury told us it hoped agreeing government support for Track-1 projects would give industry confidence about the government's commitment to CCUS (paragraphs 1.11 and 3.17)

Progress to date

15 The government has so far spent £630 million on its CCUS programme, primarily through grants to support the early development of projects. For example, it has spent almost £200 million through the Industrial Decarbonisation Challenge fund (which invests in developing carbon capture and storage technologies) and a further £346 million on research and development projects. Around £30 million of this spending was through the Carbon Capture and Storage Infrastructure Fund, a total potential fund of £1 billion, which the government first announced in 2020. This Fund was established primarily to support the capital costs of establishing transport and storage infrastructure and early industrial capture projects. DESNZ will allocate the remainder to support construction through its negotiations with emitter projects. In addition, DESNZ has spent at least £84 million administrative support for the programme (paragraphs 1.9 and 2.13).

16 DESNZ is behind schedule in agreeing government support for the Track-1 projects. In November 2020, BEIS stated that it wanted to deploy CCUS in a minimum of two industrial clusters by the mid-2020s. DESNZ has now reduced its ambition so that it is "supporting" two clusters by the mid-2020s, rather than them being in operation by this date. DESNZ has pushed back the Final Investment Decision (FID) for the Track-1 cluster projects to at least September 2024, around nine months later than the original plan to have this stage completed by the end of 2023. However, DESNZ is considering whether it should have different FID dates for some of these projects, to prioritise the projects which can start construction rather than waiting for all projects to reach this stage (paragraphs 2.15 to 2.17).

17 DESNZ has reduced the amount of carbon it expects Track-1 projects to store because of delivery constraints in one of the two shortlisted clusters. DESNZ considered two options for Track-1 – one which involved 15.5 million tonnes per annum (Mtpa) of carbon storage and one which aimed for 8.5 Mtpa. DESNZ initially preferred the 15.5 Mtpa option as it offered lower lifetime delivery costs and a clear trajectory to meet its 2030 ambitions. In November 2022 it reversed its preferred option because of feasibility challenges with some storage sites. In addition to supporting fewer carbon capture projects overall, DESNZ concluded that the 8.5 Mtpa option was not compatible with a bioenergy with carbon capture and storage (BECCS) project. It is therefore unclear how DESNZ will meet the 2030 target for engineered Greenhouse Gas Removals as it expected BECCS to contribute significantly to the 5 Mtpa ambition (paragraphs 2.8 to 2.10).

18 There has been significant private sector investment in the programme, which DESNZ attributes to its creation of business models that allocate costs and risks between government and investors. DESNZ plans to support CCUS in eight sectors with taxpayer and consumer funding. To date, it has focused on developing business models for waste and industrial carbon capture, power generation, the production of hydrogen from methane (which, with carbon capture, is known as blue hydrogen production), and transport and storage networks. Across these, DESNZ is taking a proportion of the risk to incentivise private sector investment. This is supported by different funding structures which look to, for example, encourage technology specific outcomes such as investment in facilities and the functioning transport and storage network. Industry estimates that the private sector has invested around £1 billion of development expenditure in projects, which reflects its willingness to negotiate terms based on these business models (paragraphs 2.2 and 3.17, and Figures 6 and 7).

19 DESNZ has organised its negotiations with Track-1 projects to manage the risk of conducting multiple negotiations simultaneously. DESNZ has established a high-level mandate to guide negotiations for each business model and has established an approach to identifying and then managing risks across these. The precise terms of government support provided through its business models are subject to negotiation, such as the target rate of return for investors and the thresholds for government intervention. The effectiveness of DESNZ's approach can only be fully assessed once negotiations are complete (paragraphs 2.11 to 2.13).

20 DESNZ and HM Treasury are developing the framework for assessing the value for money of the Track-1 projects and deciding whether to award them government support. DESNZ and HM Treasury have been clear that the government's FID will be subject to assessments of value for money. HM Treasury told us that the parameters of its value for money assessment were still under review. Track-1 projects have particular characteristics which need to be considered when assessing value for money, such as being 'first of a kind' projects and potentially enabling greater benefits to be achieved by later stages of the programme. DESNZ and HM Treasury will also need to take account of the downside of not proceeding with support, particularly the government's environmental goals and the impact on investor confidence (paragraphs 1.12, 2.10 and 3.16).

Future risks to manage

21 Future progress of the CCUS programme is dependent on reaching FID for at least some of the Track-1 projects. While agreeing deals to support Track-1 projects on a slower timeframe than initially planned could be accommodated, not reaching FID at all would have a significant impact on the confidence of investors to engage with the government, as happened in the wake of the cancellation of the previous CCUS competition in 2016. Reaching FID will require the government to assure investors in the Track-1 projects that they have the prospect of a securing a return on their investment, which could be over a long period of operation following their initial expenditure on construction. There is a risk that failing to achieve FID on Track-1 projects would result in a delay of several years in deploying CCUS in the UK and may require the government to seek alternative approaches to meet its carbon budgets (paragraphs 2.14 to 2.16).

22 Once FID is achieved, DESNZ will have a new and significant set of risks to manage as the programme moves into the next stage of implementation. Numerous technical issues remain. For example, carbon capture facilities need to be installed onto existing plants, and pipelines need to be built to connect these to onshore terminals and then to undersea sites. There is also uncertainty surrounding the practicalities of the proposed methods for capturing and storing carbon. This includes how effective the solvents that projects will use to capture carbon will prove and whether proposed storage areas are viable. Fundamental to the programme's successful operation is the proper functioning of the regulatory framework, responsibility for which sits with Ofgem and other bodies (paragraphs 3.2 to 3.8 and Figure 10).

23 Slower progress with getting Track-1 up and running means that DESNZ will struggle to achieve its 2030 ambitions for carbon capture. This is for a number of reasons.

- DESNZ reduced its ambitions for the amount of carbon that could be stored. It estimates that the amount of carbon which could be captured by the eight emitters with which it is currently negotiating for Track-1 is less than a quarter of its lower target for 2030.
- There are currently no dedicated BECCS or other Greenhouse Gas Removal (GGR) projects being negotiated under Track-1, creating significant risk that it could miss its ambitions to capture and store 5 Mtpa of carbon from GGRs by 2030.
- DESNZ has launched a process to expand the HyNet Cluster and has begun engagement with the Track-2 clusters. However, it is likely that negotiations for Track-1 expansion and Track-2 will not advance significantly until DESNZ has concluded negotiations with Track-1 (paragraphs 2.8 to 2.10 and 3.12).

Conclusion on value for money

24 DESNZ and the CCC have described CCUS as being 'essential' to achieving net zero. The government does not have and is currently not developing a credible alternative pathway without the use of CCUS. In this context, it is critical that DESNZ succeeds with its CCUS programme if the UK is to achieve its legally binding climate ambitions. DESNZ has applied lessons it has learnt from previous failed attempts to launch CCUS. But the inherently challenging nature of CCUS remains, given the nascency of aspects of the technology. And DESNZ's current approach brings new complexities to be managed, depending on parallel, interdependent negotiations with projects across different technologies. Completing negotiations to support the Track-1 projects will be a very significant milestone in signalling the programme's commercial feasibility and the government's commitment to CCUS. Achieving this may require the government to accept that some risks can only be partly mitigated, including higher costs to support early projects, but this could be a risk worth taking if it determines that the potential costs of delays or pursuing alternatives could be significantly higher. The government will extract greater value for money from the first wave of projects if it ensures lessons are captured, both in terms of the negotiation process and technologically, to enable costs to come down in future, as has been the experience for offshore wind.

Recommendations

25 DESNZ and HM Treasury should:

a should ensure that the criteria for considering value for money, ahead of deciding whether to proceed with government support for the Track-1 projects, consider the follow-on benefits that will be achieved by launching a new technology in the UK;

b consider which sectors of the UK economy are most reliant on CCUS to decarbonise and what viable alternative means of decarbonisation may be available for the UK to achieve net zero; and

c in light of the outcome of Track-1 negotiations and prior to commencing negotiations on Track-1 expansion, consider what actions government needs to take to sustain investor confidence in the CCUS programme. This might include agreeing and communicating indicative funding available for Track-1 expansion and Track-2.

26 DESNZ should:

d identify lessons from its Track-1 negotiations, particularly relating to business models, resourcing and maintaining competitive tension, and ensure that these are carried over to its subsequent work on Track-1 expansion and Track-2;

e ensure it maintains sufficient oversight of the progress of Track-1 projects during construction and operation so that it can identify early any issues arising that impact on the CCUS programme's objectives, such as delays to construction or lower-than-planned injection capacity, and so that it can draw technical and commercial lessons that can inform projects in later stages of the programme; and

f ensure that the scale and timing of these next steps are achievable, given the resources available to it and, in turn, whether this enables the CCUS programme to achieve the emissions reductions required under Carbon Budget 6.

Part One

Setting up the programme

1.1 This part of the report:

- describes Carbon Capture, Usage and Storage (CCUS) and its role in achieving the government's net zero targets;
- describes the government's current CCUS programme; and
- sets out how the Department for Energy Security & Net Zero (DESNZ) learnt lessons from its previous attempts to support CCUS.

CCUS and its role in achieving net zero

1.2 CCUS enables the capture and storage of carbon dioxide (CO_2) before it is released into the atmosphere, to avoid it having a negative impact on the environment. CO_2 is produced in several ways during industrial processes. For example, as a byproduct of burning fuel to produce electricity or as a chemical reaction through the production of materials like cement. CCUS can be used on a range of CO_2 emitters, such as waste facilities, power stations, cement plants, and hydrogen producers.

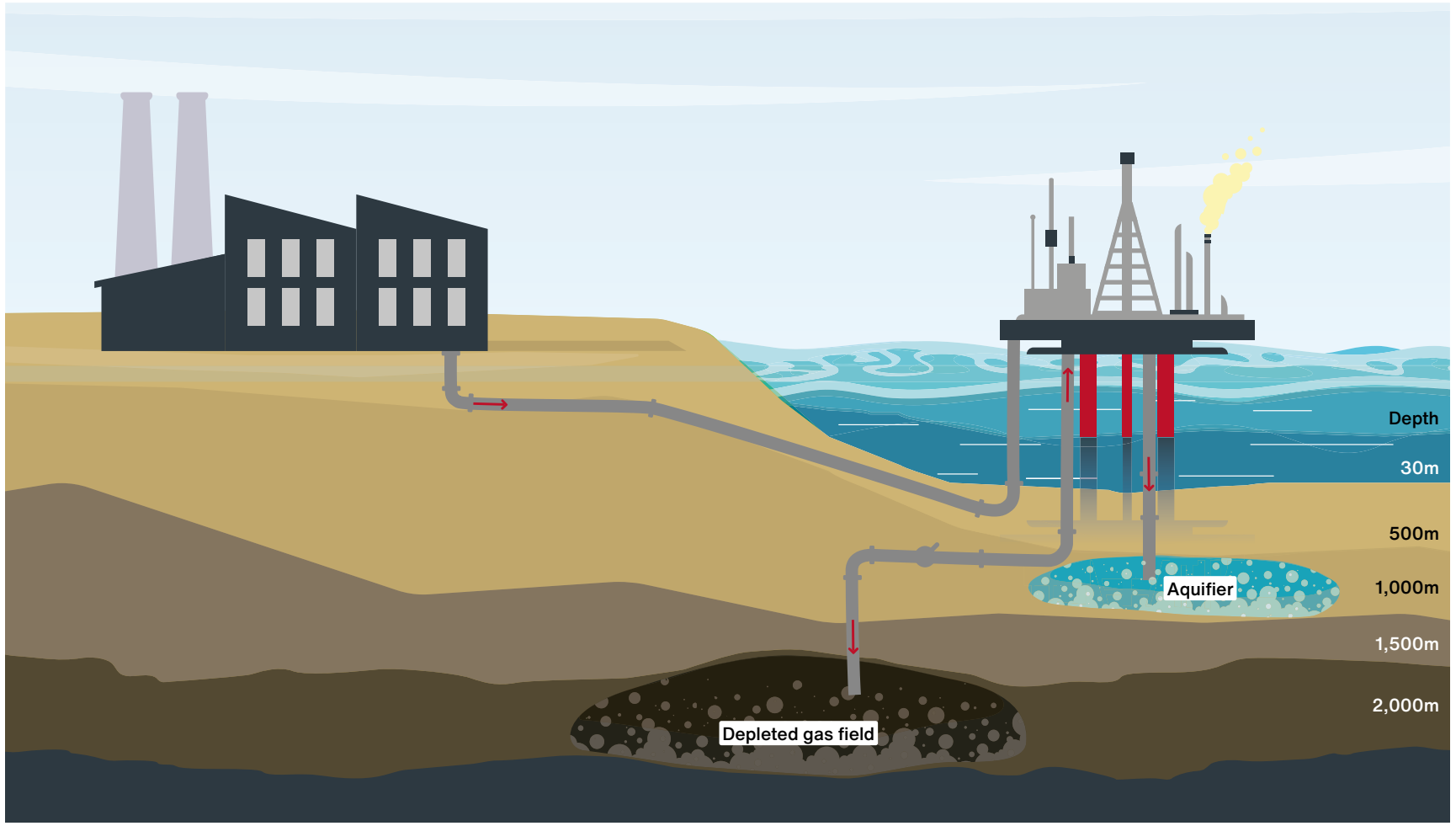
1.3 CCUS can have four stages: capture; transport; usage; and storage (**Figure 1**).

- Capture: a capture plant removes CO_2 when it is produced. Current technologies are designed to capture around 90% of the CO_2 from emissions, but this varies depending on the type of emitter. Capturing CO_2 requires large amounts of energy to work.
- Transport: either the project capturing the CO_2, or a separate entity, then transports the captured and compressed CO_2 through pipelines (sometimes repurposed from transporting gas) to a storage site. Alternatively, non-pipeline transportation, such as ships, rail and road, is being considered to transport CO_2 from capture projects to stores.
- Usage: an alternative to being stored is where captured CO_2 can be fed into industrial processes that require CO_2 to work. For example, Enhanced Oil Recovery which injects CO_2 in oil and gas reservoirs to increase extraction or areas such as the food and beverage sectors.
- Storage: CO_2 is injected into storage locations underground or under the seabed – this is typically at a depth of greater than 800 metres. Depleted oil and gas reservoirs or saline aquifers are preferred locations as the surrounding rocks help to prevent CO_2 from escaping. Storage sites must store CO_2 permanently because if it were to be released this could cause negative environmental effects.

Figure 1

The Carbon Capture, Usage and Storage process

Carbon is captured from an industrial process then stored in depleted gas fields or saline aquifers at depths of more than 800 metres



Note

1 Depths are approximate and not to scale.

Source: National Audit Office analysis of Department for Energy Security & Net Zero documents

1.4 The Climate Change Committee (CCC) views CCUS as "essential to achieving Net Zero". All pathways to net zero in the CCC's Carbon Budget 6, the interim target for emissions between 2033 and 2037, feature an element of CCUS that will be required if the UK is to meet its ultimate 2050 net zero goal. This is because:

- **CCUS can potentially support the decarbonisation of several sectors across the economy.** This includes: enabling fossil-fuelled power stations, such as those using gas, to continue operating in a decarbonised power sector; enabling a clean way of producing hydrogen for home heating or powering heavy goods vehicles; and decarbonising some heavy industry.

- **CCUS could be the only way to decarbonise certain industrial processes, such as cement production.** CCUS is not the only way to reduce the carbon emissions produced by the industrial sector, with potential alternatives such as electrification and the use of hydrogen for fuel, instead of natural gas. But in some sectors CCUS is seen as "essential" to decarbonise industries which emit a large quantity of CO_2. For example, around 60 to 70% of CO_2 from the cement industry does not come from the combustion of fuels, but from a chemical reaction during production.

- **CCUS could provide vital flexibility in a decarbonised power system.** Decarbonising power is the backbone of the government's plan to achieve net zero because many sectors will use electrification as a clean alternative to fossil fuels. A decarbonised power system, which relies primarily on intermittent renewable sources like wind and solar, will require flexible power to meet demand when there is limited generation from renewables. CCUS combined with gas-fired power stations is one of the technologies that might fulfil this role.

- **The government considers that CCUS could enable negative emissions.** CCUS combined with sustainable biomass – known as BECCS (bioenergy with carbon capture and storage) – could generate negative emissions. This is because biomass absorbs carbon as it grows. If, when it is burnt to generate heat or power rather than being released back into the atmosphere, the carbon is captured and stored it could result in an overall net decrease in atmospheric carbon dioxide. Other ways of producing a net decrease in carbon emissions is through Direct Air Capture (DAC). This is where CO_2 is removed directly from the surrounding air and is not linked to a specific emitter project. The CCC considers that the achievement of the net zero target is dependent on "engineered solutions" like BECCS and DAC, with different levels per scenario depending on how widespread alternative methods such as behaviour change become.

1.5 Despite its potential, there are no CCUS facilities operating at commercial scale in the UK. The government has attempted to launch carbon capture in the UK before (**Figure 2** overleaf):

- In 2007, the Department for Business, Enterprise & Regulatory Reform (BERR) launched a competitive process to fund up to 100% of the costs of building and operating carbon CCUS technology at a UK power plant. In October 2011, BERR terminated negotiations on the grounds of affordability and differences in positions on risk. In 2012, we published a report in which we concluded that BERR did not review alternative options for achieving its objectives, nor did it do enough to consider commercial risks and the impact that these would have on costs.[3]
- In 2012, the Department of Energy & Climate Change (DECC) launched the UK's second CCUS competition. This varied from the previous competition, as it looked to enable developers to invest in CCUS by offering financial support through a contract for difference, as with other low-carbon generating technologies. However, in the 2015 Spending Review the government withdrew funding. In our 2017 report on the competition, we found that DECC had not agreed a funding limit with HM Treasury, and therefore was unable to manage the competition within the bounds of agreed affordability constraints.[4] We also found that one of the two projects in the running would not have been able to proceed in the competition because it could not accommodate DECC's requirement to cover the "full CCS chain" (capture, transport and storage) as it struggled to allocate risks between the parties covering these different elements in a way that would enable it to secure external investment. Overall we concluded that the department responsible for that programme had not secured value for money from its spending.

The government's CCUS programme

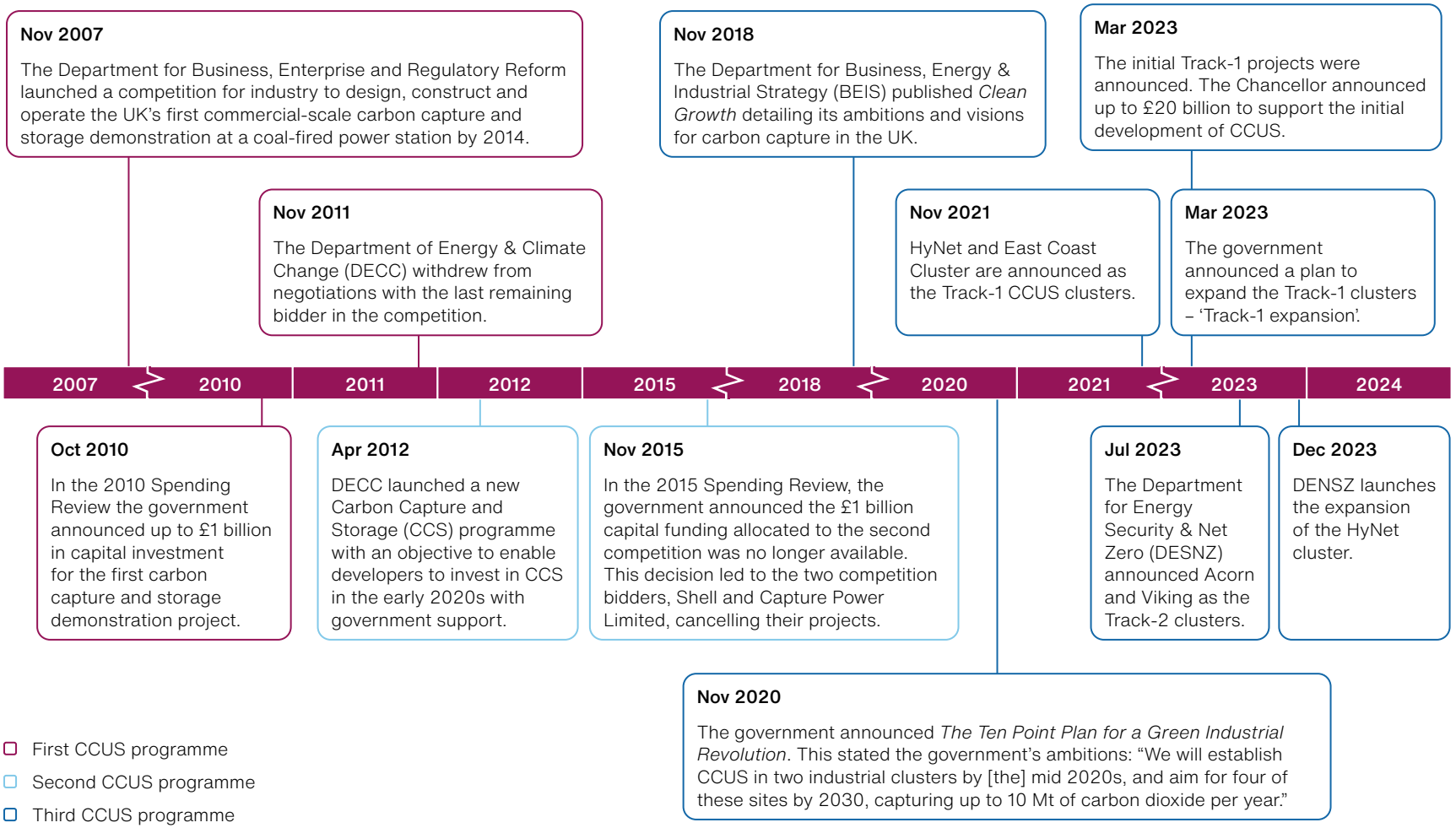
1.6 DESNZ has responsibility for the government's current CCUS programme. DESNZ has based the CCUS programme around 'clusters', locations in which there are projects across different sectors which emit CO_2, such as power stations and heavy industry, which can share the infrastructure to transport and store the CO_2.[5] There will be a single transport and storage company within each cluster which will be responsible for the transportation of captured CO_2 to its permanent undersea storage. As emitter projects are near one another this also reduces the amount of pipeline needed to connect emitters to a network. Being located on or near the coast also means that clusters are closer to the permanent CO_2 storage offshore (Figure 4). An emitter project which is not part of a cluster is known as a 'dispersed site'.[6] Deploying CCUS through clusters has become the dominant model for advancing the technology globally.

3 Comptroller and Auditor General, *Carbon capture and storage: lessons from the competition for the first UK demonstration*, Session 2010–2012, HC 1829, National Audit Office, March 2012.
4 Comptroller and Auditor General, *Carbon capture and storage: the second competition for government support*, Session 2016-17, HC 950, National Audit Office, January 2017.
5 A Carbon Capture, Usage and Storage cluster is defined as a group of capture projects that are physically close to one another in the UK. For Track-1 of the CCUS programme, the government defined a cluster as 'a minimum of two capture projects connected to a transport and storage network'.
6 DESNZ defines a dispersed site as all the industrial sites that are more than 30 km (around 18 miles) from a central point established within each of the 11 clusters.

Figure 2

Carbon Capture, Usage and Storage (CCUS) development in the UK, 2007 to 2024

The government tried to launch CCUS at a commercial scale in 2007 and 2012. In 2020, the government started its third CCUS programme



Notes

1 The current CCUS programme – the third programme – is being developed in stages. These are known as Track-1, Track-1 expansion and Track-2.

2 The department responsible for the carbon capture programme has changed over time in response to machinery of government changes: the Department for Business Enterprise & Regulatory Reform (2007 to 2009); the Department of Energy and Climate Change (2009 to 2016); the Department for Business, Energy & Industrial Strategy (2016 to 2023); and the Department for Energy Security & Net Zero (2023 to present).

Source: National Audit Office analysis of publicly available documents

1.7 DESNZ has set what it describes as 'ambitions' for its CCUS programme:

- to have two industrial carbon capture clusters operational by the mid-2020s, and four clusters operational by 2030;
- for these clusters to be capturing 20–30 million tonnes of carbon per year (Mtpa) by 2030, including 6 Mtpa of industrial emissions;
- for there to be at least one power station with carbon capture operating by 2030; and
- to capture at least 5 Mtpa of carbon though engineered Greenhouse Gas Removals by 2030.

1.8 DESNZ sets its ambitions with reference to the Climate Change Committee's (CCC's) assessment of how much CO_2 needs to be captured to support its balanced pathway to net zero (paragraph 1.4). DESNZ has its own pathway based on its own assessment of how to meet the government's net zero target. This contribution is more than was established at the outset of the programme – in 2018, the government's overall climate ambition was to reduce carbon emissions by 80% in 2050 compared with 1990 levels. At that time, the government was committed to having "the option of deploying CCUS at scale during the 2030s". DESNZ told us that it considered whether, for example, an approach where government carried more of the cost and risk of the first projects was required in the light of the ambitions for CCUS, but we have not seen any substantial evidence of such an assessment. If the government only achieves its minimum ambition for 2030 then this will be below the CCC's assessment of what is required (**Figure 3** overleaf).

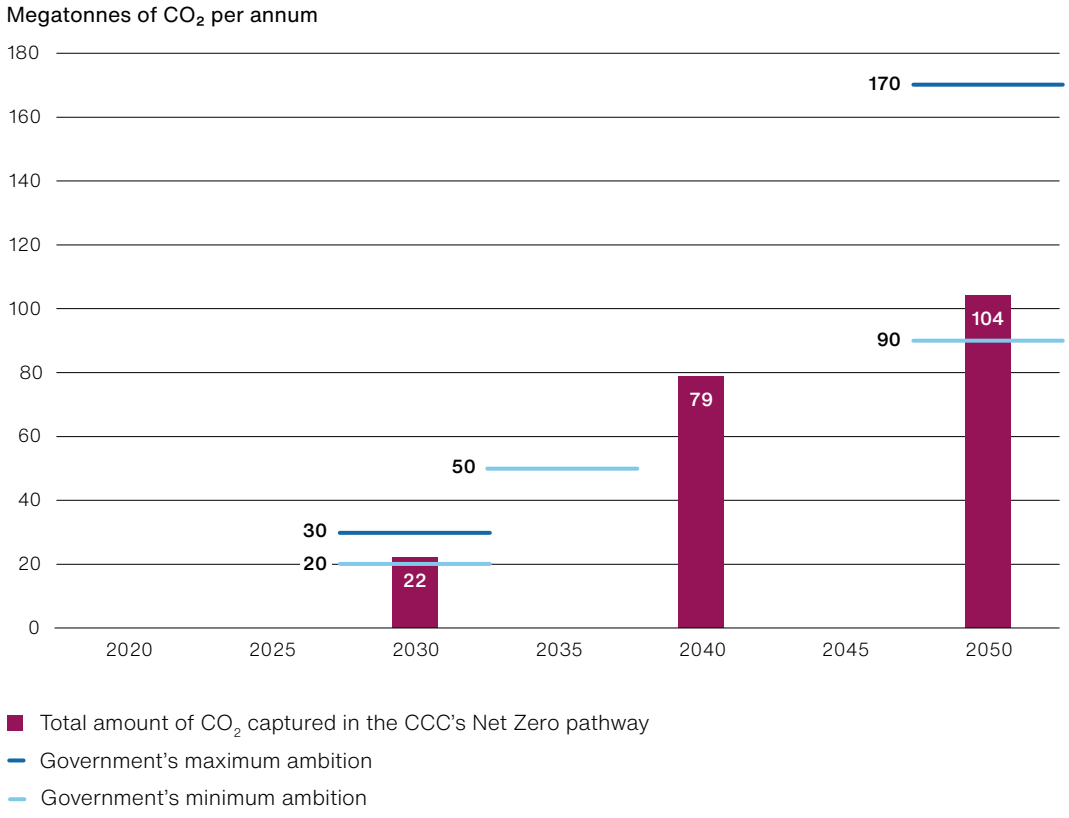
1.9 To date, the government has focused on supporting the early development of CCUS projects. For example, it has committed £210 million through the Industrial Decarbonisation Challenge fund, which invests in developing low-carbon technologies such as CCUS. To date it has spent almost £200 million in this way and a further £346 million on research and development projects. Around £30 million of this spending was through the Carbon Capture and Storage Infrastructure Fund, a total potential fund of £1 billion, which the government first announced in 2020. This Fund was established primarily to support the capital costs of establishing transport and storage infrastructure and early industrial emitter projects. DESNZ will allocate the remainder to support construction through its negotiations with emitter projects.

1.10 DESNZ has identified the first four clusters that it plans to support: HyNet (north Wales/Merseyside); East Coast (Teesside and Humberside); Acorn (northeast Scotland); and Viking (Humberside). HyNet and East Coast are the 'Track-1' clusters that will be launched first. Across these two clusters, DESNZ is currently negotiating with eight emitter projects and two transport and storage companies for government support. In March 2023, DESNZ announced that it would launch a process to increase the capacity of the Track-1 clusters by identifying and selecting further projects. Known as 'Track-1 expansion', this will also include Humberside. By January 2024, the North Sea Transition Authority had awarded 27 carbon storage licences (**Figure 4** on pages 21 and 22).

Figure 3

Climate Change Committee's (CCC's) assessment of how much Carbon Capture, Usage and Storage (CCUS) will need to be deployed under its Balanced Net Zero pathway, 2020 to 2050

If the government achieves its minimum ambition for CCUS deployment, this will be below the CCC's assessment of how much CCUS will be needed to achieve the Balanced Net Zero pathway



Notes

1 The Climate Change Committee developed its Balanced Net Zero pathway as a potential trajectory of emissions reductions and action that reaches net zero by 2050. It designed the pathway to drive progress through the 2020s while creating flexibility to changing circumstances.

2 The Department for Energy Security & Net Zero has its own pathway based on its own assessment of how to meet the government's net zero target.

3 For 2035, the government has only stated a minimum ambition.

Source: National Audit Office analysis of Climate Change Committee and Department for Energy Security & Net Zero data

Figure 4

The UK's carbon capture and storage landscape

The Department for Energy Security & Net Zero (DESNZ) has confirmed four carbon capture clusters close to areas of large industrial emissions or potential carbon storage areas

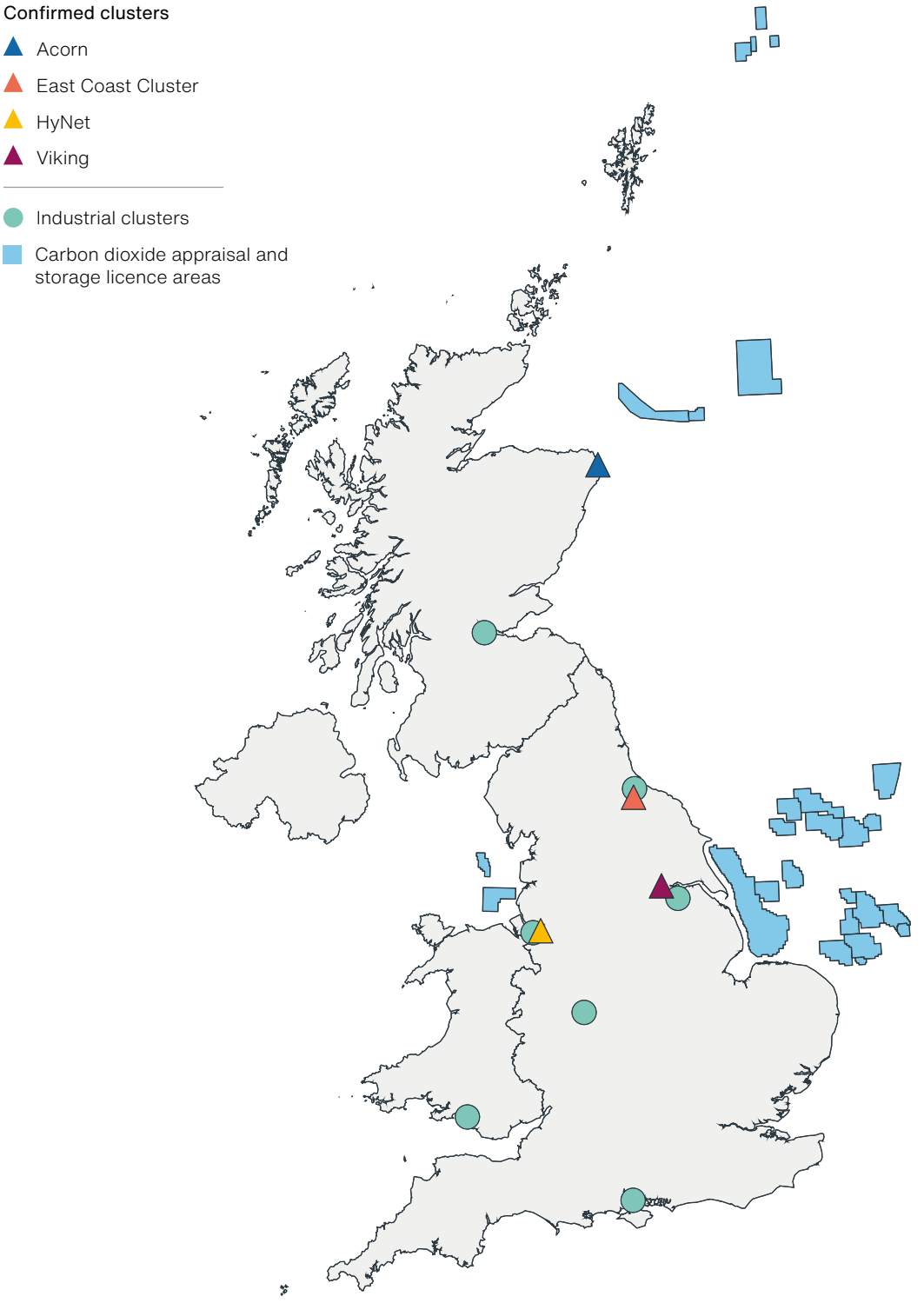


Figure 4 *continued*
The UK's carbon capture and storage landscape

Notes

1 A carbon dioxide (CO_2) appraisal and storage licence allows the licensee to explore a geological feature for the long-term storage of CO_2 in the UK. 21 of the 27 existing carbon dioxide appraisal and storage licences were awarded in September 2023 from the first UK Carbon Storage Licensing Round. The remaining six licences were awarded between 2012 and 2021.

2 A Carbon Capture, Usage and Storage cluster is defined as a group of capture projects that are physically close to one another in the UK. For Track-1 of the Carbon Capture, Usage and Storage (CCUS) programme, the government defined a cluster as 'a minimum of two capture projects connected to a transport and storage network'.

3 Industrial clusters are areas defined by the National Atmospheric Emissions Inventory. Data for these areas are accurate as of 2021.

4 This map shows a number of major industrial clusters in the UK, but does not include other areas that have an interest in carbon capture.

5 Industrial clusters shown on this map include: Black Country (0.4 metric tonnes of carbon dioxide equivalent ($MtCO_2e$)); Teesside (2.2 $MtCO_2e$); Southampton (3.0 $MtCO_2e$); Grangemouth (3.6 MtCO2e); Merseyside (4.8 $MtCO_2e$), Humberside (8.3 $MtCO_2e$); and South Wales (8.6 $MtCO_2e$).

Source: National Audit Office analysis of Department for Energy Security & Net Zero and North Sea Transition Authority data. Office for National Statistics licensed under the Open Government Licence v.3.0. Contains OS data © Crown copyright and database right 2023

1.11 As well as DESNZ, a number of other organisations have a key role in the CCUS programme (**Figure 5** on pages 23 and 24). For example, providing funding for the programme, issuing licences and permits for storage sites, regulating transport and storage companies, and managing the revenue support schemes under some of the contracts.[7] Given the expected scale and longevity of the CCUS programme, it is important to maintain cross-government governance arrangements, which ensure critical risks which span wider than DESNZ's control can be managed. Previous government projects which had overall budgets of many tens of billions of pounds and project lifetimes spanning decades, such as HS2 and the New Hospital Programme. These saw decisions to proceed that were not accompanied by sufficiently robust and realistic assessments of affordability, with emerging overspends then becoming one of the government's overall priorities to deal with. On CCUS, HM Treasury will have an important role in ensuring there is a clear plan for funding, either via the Exchequer or through consumers' bills.

7 Other organisations involved in the CCUS programme include the Environment Agency, Offshore Regulator for Environment & Decommissioning, the Crown Estate and Crown Estate Scotland.

Figure 5

Key organisations' roles and responsibilities in the Carbon Capture, Usage and Storage (CCUS) programme

There are a number of government departments, regulators and private companies involved in the CCUS programme

Government department

Department for Energy Security & Net Zero (DESNZ)

DESNZ is responsible for the CCUS programme. Its key responsibilities include:

- selecting the transport and storage companies;
- selecting the future users of the networks; and
- negotiating and awarding government support packages.

HM Treasury (HMT)

HMT is responsible for:

- providing the funding for the CCUS programme and approving key decisions where there are funding implications;
- ensuring that public spending presents value for money; and
- providing oversight and challenge to DESNZ through representation on the CCUS Programme Board.

Main CO_2 regulatory bodies and contract counterparties

Office of Gas and Electricity Markets (Ofgem)

Ofgem is the economic regulator for the transport and storage networks. Its responsibilities include:

- promoting the economic, efficient and effective development and operation of transport and storage networks; and
- protecting interest of current and future users of the networks.

North Sea Transition Authority (NSTA)

The NSTA is a CO_2 store regulator for the CCUS programme. Its key responsibilities include:

- issuing licences for carbon storage area appraisals;
- issuing carbon storage permits; and
- seabed licensing.

Low Carbon Contracts Company (LCCC)

LCCC works as the government's contract counterparty. Its responsibilities include:

- managing government support contracts;
- managing revenue support agreements; and
- paying and collecting monies due under contracts.

Figure 5 *continued*
Key organisations' roles and responsibilities in the Carbon Capture, Usage and Storage (CCUS) programme

Government department

CO_2 emitters/capture projects

Individual companies that capture carbon before it can be released into the atmosphere. Key responsibilities include:

- designing, building and operating collection infrastructure.

Transport and Storage companies

These are the companies that transport and store captured carbon. Key responsibilities include:

- designing, building and operating transport and storage infrastructure.

Notes

1 This figure does not include all organisations involved in the CCUS programme.

2 A government contract counterparty signs a contract on behalf of government with a private company. For the CCUS programme LCCC shall act as the counterparty on completion of required administrative formalities for business models that provide government support.

Source: National Audit Office analysis of Department for Energy Security & Net Zero documents

Drawing lessons from previous attempts to support CCUS

1.12 DESNZ learnt lessons from the previous two CCUS programmes when designing the current programme.

- Using industrial clusters: deploying support across industrial clusters rather than supporting transport and storage for individual emitter projects allows key infrastructure, such as pipelines for transport and storage to be used by multiple CO_2 emitters. DESNZ intends this to increase the use of the network and create economic resilience by preventing an issue with a single emitter causing the network to fail.

- Splitting the chain: DESNZ's new approach separates the transport and storage functions from the emitter projects which capture carbon. This enables specific risks to be precisely allocated to the relevant part of the chain and helps to mitigate the risks which occur when different parts of the CCUS process are dependent on each other. These were seen as a significant factor in the failure of previous attempts to launch CCUS as the projects were expected to handle all steps in the CCUS chain. As a result, problems in any part of the CCUS process could derail the entire project.

- Creating a pipeline of projects: having planned the introduction of four industrial clusters, DESNZ sees this as a way of maintaining a stream of potential emitter projects, therefore allowing it to retain options in how it will deploy future CCUS projects.

- Working with HM Treasury to agree on funding availability: previous cancellations were partly due to lack of agreement between DESNZ's predecessor departments and HM Treasury on the long-term operational costs of the CCUS programme.[8] For the current CCUS programme, HM Treasury has announced a budget of up to £20 billion for government support to the operation of early CCUS projects. This support is a mixture of direct government funding and consumer levies. HM Treasury has not publicly stated how many projects it expects this funding to support. HM Treasury is on the CCUS Programme Board (see paragraph 3.9).

1.13 While DESNZ has designed a new approach to CCUS that responds to learning from previous competitions, it has created new complexities. In particular, DESNZ needs to conduct negotiations separately with a range of emitter projects, as well as with the transport and storage companies which pose different commercial risks, and conclude them to coordinated deadlines.

8 In 2023, following machinery of government changes, the Department for Business, Energy & Industrial Strategy (BEIS) split into three departments. These being, the Department for Energy Security and Net Zero (DESNZ), the Department for Business and Trade (DBT), and the Department for Science, Innovation & Technology (DSIT).

Part Two

Progress of the Carbon Capture, Usage and Storage programme

2.1 This part of the report covers the Department for Energy Security & Net Zero's (DESNZ's) progress in agreeing government support for the first wave of Carbon Capture, Usage and Storage (CCUS) projects (Track-1), including:

- how it has established the business models on which it will base the terms of support;
- how it has selected the clusters and projects to be included in Track-1;
- how DESNZ has organised itself to negotiate with the Track-1 projects; and
- DESNZ's progress against its planned timetable for agreeing support.

Establishing business models for Track-1 projects

2.2 DESNZ has established business models on which to base the terms of government support for the Track-1 projects. Each business model sets out in principle how costs and risks are allocated between DESNZ and the projects and establishes the payment mechanism (**Figure 6** on pages 28 and 29). DESNZ developed, in consultation with industry, these models ahead of negotiations with projects to limit the number of issues which were subject to negotiations. The precise terms of the government's support remains to be agreed between DESNZ and the commercial projects, including agreeing a rate of return for investors over a long period of time and establishing the circumstances which will prompt an intervention from government. DESNZ told us that industry had estimated the private sector had invested around £1 billion of development expenditure in projects, which reflects their willingness to negotiate terms based on these business models.

2.3 **Figure 7** on page 30 provides an overview of how the business models supporting each technology relate to the transport and storage companies. It also highlights the technologies that Track-1 of the programme is focusing on: power generation; industrial carbon capture; waste; and blue hydrogen production.[9]

9 'Blue hydrogen' is defined as the production of hydrogen from methane with carbon capture.

2.4 The business model for transport and storage companies means they may need to be classified as public bodies. The Office for National Statistics (ONS) is currently considering how to classify the two Track-1 transport and storage companies. Although it has yet to reach a final decision, DESNZ expects the ONS to classify the companies as central government bodies because of the indemnities that the government is providing against certain risks. These include the government acting as an "insurer of last resort" against significant leaks from storage facilities and its agreement to provide financial support if there is less demand for the transport and storage network than planned.

2.5 The transport and storage companies being classified as central government bodies would present challenges for DESNZ and HM Treasury to manage. This would require DESNZ to consolidate the accounts of the companies into its group accounts and elements of their expenditure would need to be covered by spending limits agreed with HM Treasury. The companies would also be subject to the provisions of *Managing Public Money* and subject to central government spending controls. DESNZ is discussing potential derogations (that is to say, exemptions from certain controls) with HM Treasury, and whether implementing controls could be delayed until the transport and storage companies start operations rather than when they reach Final Investment Decision (FID).[10] This issue could result in delays to negotiations or potentially prevent any agreement being reached between government and the companies. As such, FID is not guaranteed.

Selecting the first clusters and projects

2.6 DESNZ took a two-stage approach to selecting the first two clusters and projects for the CCUS programme. Firstly, it identified the clusters to support. This was then followed by selecting the emitters that could use the transport and storage infrastructure (**Figure 8** on page 31). It used this as the basis for requesting funding from HM Treasury. It also wanted to achieve some competitive tension from the selection of emitter projects in each cluster.

2.7 DESNZ considered five criteria when selecting clusters and projects, prioritising deliverability and emissions reduction potential (**Figure 9** on page 32). As well as ranking individual clusters and projects, DESNZ considered bids in different combinations (described as a 'portfolio assessment'). For example, it considered whether the first and third ranked clusters would allow for a greater range of technologies to be taken forward as part of Track-1. Similarly, it considered how well combinations of projects worked in the cluster as a whole. In October 2021, it announced that the two Track-1 clusters would be HyNet (covering Merseyside and north Wales) and the East Coast Cluster (covering Teesside and Humberside). These clusters were ranked highest when assessed against the five criteria highlighted earlier. The portfolio assessment exercise did not change this position.

10 HM Treasury, *Managing Public Money,* May 2023. Available at: https://assets.publishing.service.gov.uk/media/65c4a3773f634b001242c6b7/Managing_Public_Money_-_May_2023_2.pdf. This document offers guidance to, for example, departments on how to handle public funds.

Figure 6

Carbon Capture, Usage and Storage (CCUS) business models – an overview of funding mechanisms

Each business model takes a different approach to funding projects

Business model	Purpose	How it works during 'business as usual'	When the government might intervene
Transport and Storage (T&S)	To set up a regulated carbon transport and storage operator for each confirmed CCUS cluster. The business model is designed to ensure that the operator delivers a network that meets the needs of the emitter for a regulated return.	A transport and storage company is paid through fees it charges emitters for its services. It will receive an 'allowed revenue' – an amount that it is entitled to recover, through charging transport and storage fees to an emitter, over a defined period. This is based on an agreed return on investment negotiated between the Department for Energy Security & Net Zero (DESNZ) and the transport and storage company.	**Transport and Storage** If an emitter project is delayed, then the cluster cannot start operations and the T&S company does not receive any 'allowed revenue'. If emitter projects do not successfully concluded negotiations and reach the Final Investment Decision or do not complete construction leading to the T&S company being underutilised. If there are differences between estimated and actual flow volumes, leading to lower than planned network utilisation. An emitter project's contract is terminated (for example, due to insolvency) so overall utilisation of the network is reduced.
Industrial Carbon Capture	To compensate the emitter for the cost of installing and operating carbon capture equipment on existing and new industrial facilities. For example, cement production.	The emitter receives a payment from the government for each tonne of CO_2 captured and stored – the difference between an amount negotiated by the government with each emitter and a reference price (based on the UK Emissions Trading Scheme). Initial projects will also have access to funding for a proportion of their capital costs.	**Emitter project** If the construction of the T&S network is delayed, an emitter project cannot transport and store the CO_2 it collects. If there are periods of either full or partial outage of the T&S network, meaning the expected level of network capacity is not met. Emitter projects are unable to use the network as intended. If there are prolonged outages of the network, which will only become available after a long period and/or after significant remedial expenditure. The emitter project's assets risk becoming stranded.
Waste	To compensate the emitter for the cost of installing and operating carbon capture equipment on existing and new waste management facilities.	The emitter receives a payment from the government for each tonne of CO_2 captured and stored – the difference between an amount negotiated by the government with each emitter and a reference price (fixed in advance of contract signature and based on the UK Emissions Trading Scheme).	
Dispatchable Power Agreement	To compensate the power producer for the cost of building and operating a plant with carbon capture. The subsidy is designed to allow power generators that capture their carbon to compete with unabated gas power generators.	The power generator receives a payment from the government made up of two components. ● Availability – the government pays the plant an amount to be ready to produce electricity. This is paid regardless of whether it generates electricity. ● Variable – the government pays an amount for the electricity produced by the CCUS plant that means this electricity is despatched ahead of unabated alternatives.	
Hydrogen production	To compensate the hydrogen producer for the cost of building and operating a plant. The contract subsidises the producer when revenues for selling the hydrogen are insufficient to compensate for production costs.	The government's payment to producers is made up of a number of elements. ● An amount for producing and then selling qualifying low-carbon hydrogen (known as the variable premium). ● An amount to encourage the sale of hydrogen above the price of natural gas (known as the price discovery incentive). ● An additional amount per unit of hydrogen sold to compensate producers when demand (sale of hydrogen) falls below a certain level (known as the sliding scale top up).	

Note

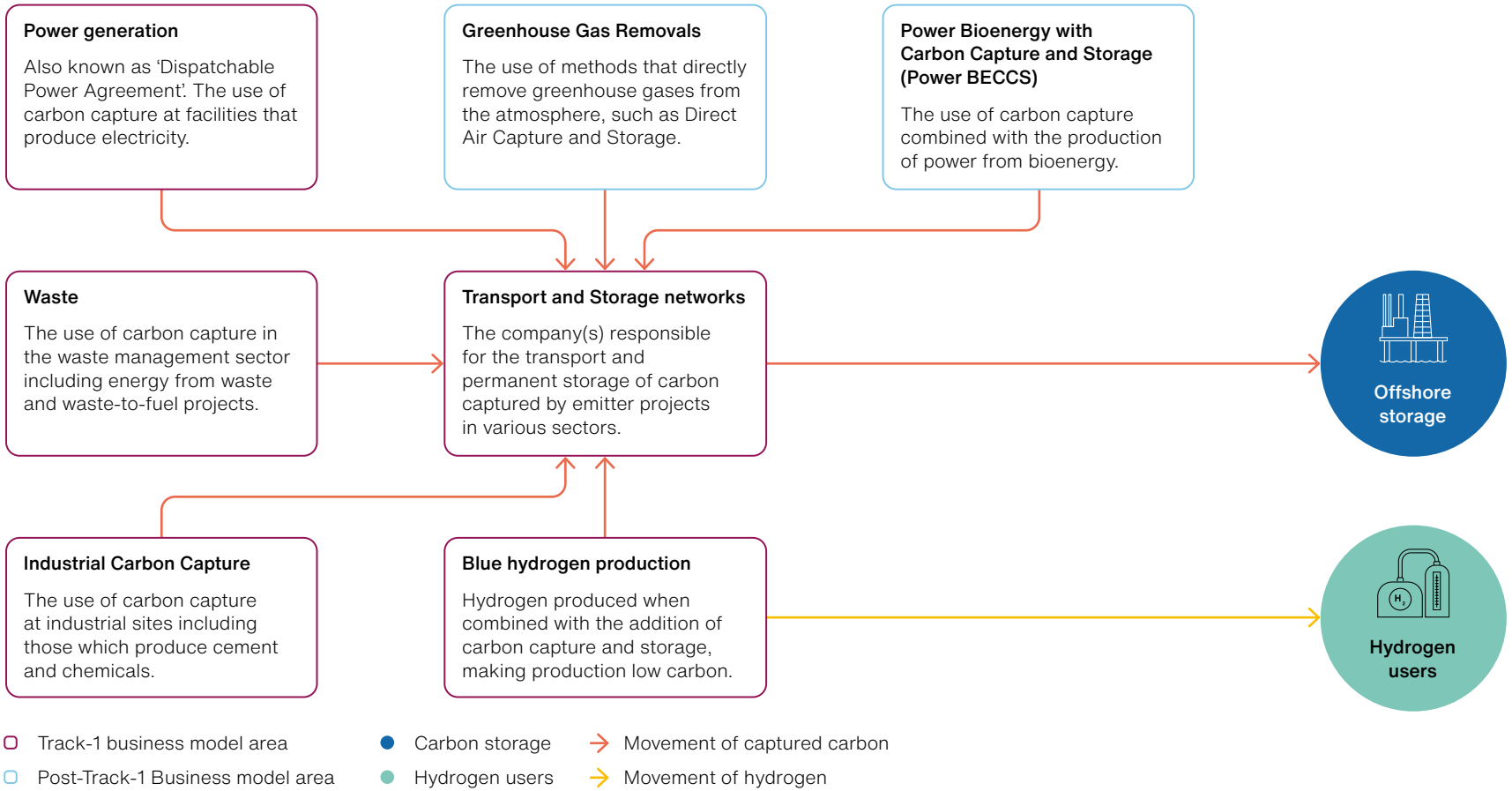
1 This does not include non-Track-1 business models which cover greenhouse gas removals and power bioenergy with carbon capture and storage (BECCS).

Source: National Audit Office analysis of the Department for Energy Security & Net Zero's documentation

Figure 7

An overview of Carbon Capture, Usage and Storage (CCUS) business models

The Department for Energy Security & Net Zero (DESNZ) is developing business models for each technology – an approach to allocating costs and risks between the government and the private sector



Notes

1 DESNZ is implementing the initial stages of the CCUS programme in three phases: Track-1; Track-1 expansion; and Track-2.

2 The post-Track-1 business models are in a later stage of development than the Track-1 business models. DESNZ is developing business models for the technologies it plans to introduce in later in the programme.

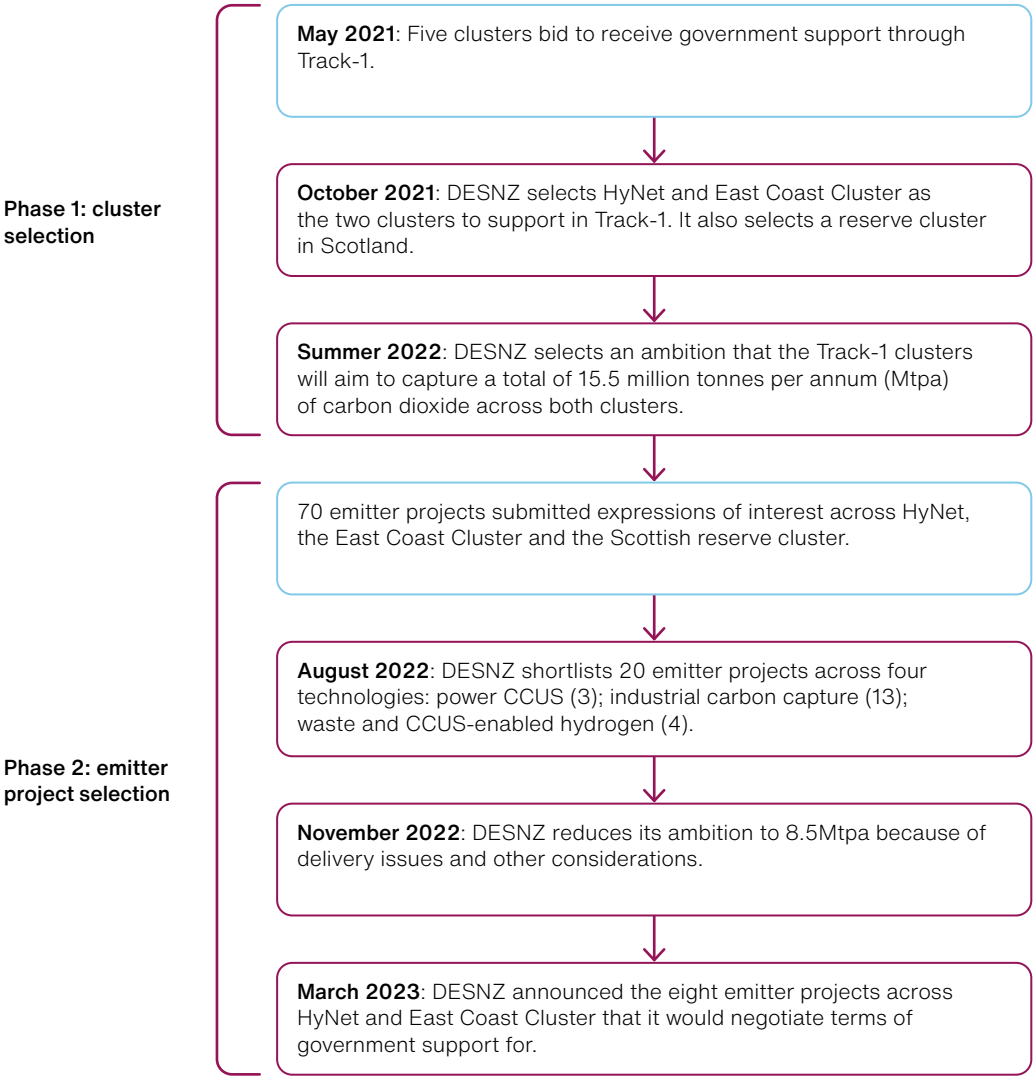
3 'Blue hydrogen' is not the only type of hydrogen production. Other methods exist – however we have highlighted 'Blue hydrogen' as this is a business model being developed within the CCUS programme.

Source: National Audit Office analysis of Department for Energy Security & Net Zero documents

Figure 8

The Department for Energy Security & Net Zero's (DESNZ's) Track-1 cluster and emitter project selection process for the Carbon Capture, Usage and Storage (CCUS) programme

As at July 2024, DESNZ negotiating terms of support for eight emitter projects across two clusters

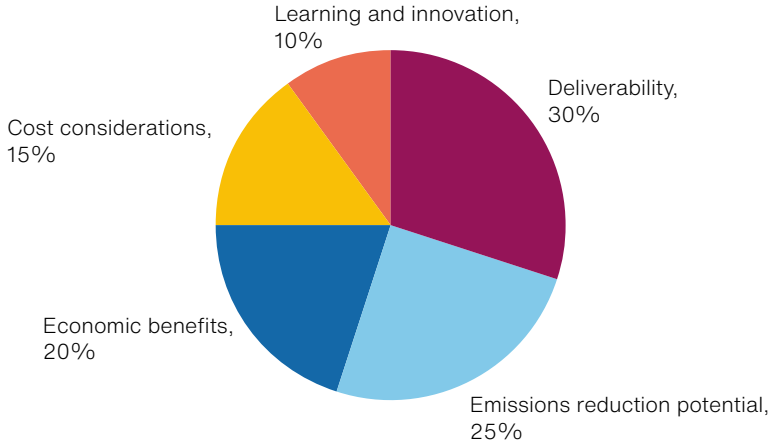


Source: National Audit Office analysis of the Department for Energy Security & Net Zero's documentation

Figure 9

The Department for Energy Security & Net Zero's (DESNZ's) five criteria for cluster selection – Track-1 of its Carbon Capture, Usage and Storage programme

DESNZ's consideration of deliverability and emissions reduction potential were central to its selection of Track-1 clusters



Note

1 DESNZ weighted its selection criteria for clusters and projects by assigning them percentages.

Source: National Audit Office analysis of the Department for Energy Security & Net Zero documents

2.8 In the summer of 2022, DESNZ considered two storage options: 15.5 million tonnes per annum (Mtpa) and 8.5 Mtpa. It decided to proceed with the 15.5 Mtpa option because, for example, it provided a clearer pathway to meeting its overall carbon capture targets and lower lifetime costs. In August 2022, DESNZ announced an initial shortlist of 20 emitter projects across the two Track-1 clusters on the basis of the 15.5 Mtpa storage option. This announcement was made once HM Treasury had agreed that the proposals had the potential to offer acceptable value for money.

2.9 In November 2022, DESNZ reduced its ambition for Track-1 to a storage capacity of 8.5 Mtpa because of potential delivery challenges associated with the clusters and emitter projects it had shortlisted. For example, it identified feasibility challenges with regard to some storage sites. In addition, DESNZ had set a condition that all Track-1 projects should be operational by 2027 at the latest. However, five of the shortlisted projects for the East Coast Cluster were located south of the Humber, requiring a pipeline to be built under the estuary to the onshore terminal for the cluster's storage site. DESNZ concluded that, while this was technically feasible, the work could not be completed until 2029. Therefore, DESNZ opted not to include Humberside based projects in Track-1.

2.10 As DESNZ decided on a smaller level of carbon storage capacity for Track-1, this meant fewer Track-1 emitter projects could be selected and a lower budget was required. DESNZ revisited its shortlist of projects from August 2022 in light of the new decision on storage capacity and, in February 2023, presented HM Treasury with a range of combinations of emitter projects from HyNet and East Coast Cluster. Based on the options provided by DESNZ, HM Treasury approved eight projects for Track-1 that will potentially capture a total of 4.9 Mtpa of carbon across the two clusters (therefore using just over half of the 8.5 Mtpa storage capacity). It considered both monetised and non-monetised costs and benefits in making this decision and announced up to £20 billion of funding in the March 2023 Budget for the initial deployment of CCUS.

DESNZ's approach to Track-1 negotiations

2.11 Agreeing FID on the Track-1 projects requires DESNZ to conduct multiple sets of negotiations simultaneously. This is because the transport and storage element needs to be operational at the same time as emitters. DESNZ has organised its negotiations with individual projects to manage the risk of dealing with interdependent projects simultaneously. This includes:

- establishing a broad set of principles, known as the Track-1 mandate, for each negotiating team to follow;
- establishing a shared understanding of the risks to the successful operation of an emitter project because of operational issues with, for example, the transport and storage company (and vice versa); and
- managing, for example, budgets at project, cluster and programme level.

2.12 DESNZ has established a team to manage the commercial assurance around the negotiations; and manage programme-wide, and cluster- and project-specific budgets. Its role is to ensure compliance with the Track-1 mandate and to make sure cross-cutting risks (risks shared by business models) and crosschain risks (risks that exist between emitter, transport facility and storage facility within each business model) are being managed consistently by each negotiating team. The effectiveness of DESNZ's approach can only be fully assessed once negotiations are complete.

2.13 DESNZ created the CCUS Directorate to manage the programme in January 2021 which, together with staff from the Hydrogen and Industrial Carbon Capture Directorate, manages the CCUS programme. It also appointed a director-level senior responsible owner. When the Directorate was established, 51.5 full-time equivalent (FTE) staff, less than half the 103.5 FTE that DESNZ assessed it would need for 2021-22, were in post. DESNZ considers this difference reflects the time it takes to fill vacancies. The number of staff required increased sharply, particularly as Track-1 negotiations started. By 2023-24 DESNZ calculated that it needed 206.5 FTE, compared to a staffing level of 144.5 FTE at the start of that year. DESNZ had problems recruiting people with the required negotiating and commercial skills during 2022-23, noting that civil service pay scales were a significant barrier. To date, DESNZ has spent £84 million on staff supporting the programme.

Assessing the value for money of the Track-1 projects

2.14 DESNZ and HM Treasury are clear that the FID for each cluster is subject to an assessment of whether the clusters represent value for money for the taxpayer and the consumer. As part of this assessment they will need to consider, amongst other things, how to manage the risks of taking forward first of a kind projects. DESNZ will also need to consider the impact that not going ahead with the projects might have on investor confidence. DESNZ told us that it will also be considering other issues before making a final decision. For example, the cost effectiveness in capturing carbon of the selection of projects considered at the FID stage and the impact these will have on its net zero commitments and the level of investment into specific regions. HM Treasury told us there are challenges in considering the costs and benefits of going ahead with Track-1 as it is the first step in a much larger programme. The final decision as to whether to proceed is, ultimately, one for ministers.

DESNZ's progress agreeing support for Track-1

2.15 DESNZ has taken longer than it planned to agree the terms of government support for the first wave of CCUS projects, although it considers it remains on track to establish two clusters by the mid-2020s. In April 2021, DESNZ said the first of two Track-1 clusters would reach FID in the second quarter of 2022, with the other Track-1 cluster following in 2023. By March 2022, DESNZ had moved the FID dates to May and October 2023. In April 2023, DESNZ reviewed the CCUS programme as it considered the earlier FID dates it had set were not achievable. The Infrastructure and Projects Authority told us that DESNZ moved back its target date for FID partly because of delays in getting HM Treasury and ministerial agreement to the funding package that was announced in the March 2023 Budget. In June 2023, DESNZ settled on a revised FID date of September 2024 after consulting with delivery partners in the public and private sectors.

2.16 DESNZ is currently considering whether achieving FID across all eight projects by September 2024 is feasible. It therefore expects to achieve FID with at least some of the Track-1 projects by September 2024, with the rest reaching FID in 2025. This approach may risk reducing the programme's value for money, because it could lead to fewer projects making use of common transport and storage infrastructure. But it may also lead to earlier carbon reductions as it means prioritising projects that are able to commence construction, rather than waiting untilall projects reach this stage. In addition, DESNZ considers this approach may prevent more mature projects needing to retender contracts if they are delayed by waiting for other projects to be ready to take FID.

2.17 DESNZ no longer describes having two clusters operational by the mid-2020s as a target. The November 2020 *Ten Point Plan for a Green Industrial Revolution* included a target of "two clusters operational by the mid 2020s".[11] DESNZ's early planning interpreted this as meaning that both clusters should be operational by the end of 2026, which was echoed in the schedule published in the *Net Zero Strategy* in October 2021.[12] However, by May 2022 DESNZ was working towards the Track-1 clusters starting operations by the end of 2027 which remains its target. More recently, DESNZ has adapted this target to 'support' two clusters by the mid-2020s, indicating that it expects them to begin operating later. The Infrastructure and Projects Authority completed a Gateway Review in April 2023 and issued the programme a red rating because it was behind schedule. In September 2023, it issued an amber rating because of the progress DESNZ had made in a number of areas.

11 HM Government, *Ten Point Plan for a Green Industrial Revolution*, November 2020. Available at: https://assets.publishing.service.gov.uk/media/5fb5513de90e0720978b1a6f/10_POINT_PLAN_BOOKLET.pdf

12 HM Government, *Net Zero Strategy: Build Back Greener*, October 2021. Available at: https://assets.publishing.service.gov.uk/media/6194dfa4d3bf7f0555071b1b/net-zero-strategy-beis.pdf

Part Three

Next steps for the programme

3.1 This part of the report covers:

- the risks the Department for Energy Security & Net Zero (DESNZ) faces in launching Track-1 of the Carbon Capture, Usage and Storage (CCUS) programme once it has concluded commercial negotiations;
- DESNZ's plans for Track-1 expansion and Track-2 of the CCUS programme; and
- DESNZ's longer term vision of developing a market for CCUS that will not require government support.

Risks to delivery of Track-1 projects

3.2 DESNZ's current aim is for Track-1 projects to begin operations by the end of 2027. DESNZ will need to maintain sufficient oversight of the projects, both in construction and operation, to identify risks that may impact the delivery of the CCUS programme's objectives. DESNZ needs to manage a number of different types of risk that include technological risks (because it is dependent on as yet untried technology), construction risks (in common with other major infrastructure projects), and financial risks (because it is underwriting many aspects of the programme).

Construction risks

3.3 Delays to construction of the emitter or transport and storage projects would impact on DESNZ's objectives for carbon capture and, consequently, its overall net zero pathway. We often see overoptimism in the scheduling of government major projects, with the government's ambitions to meet its goals overriding a frank assessment of mounting risks.[13] There is also a risk that higher than expected construction costs may mean that carbon capture projects may become unviable without additional revenue support from the government or consumers.

13 Comptroller and Auditor General, *Lessons learned from Major Programmes*, Session 2019-20, HC 960, National Audit Office, November 2020, page 14. Available at: www.nao.org.uk/wp-content/uploads/2020/09/Lessons-learned-from-Major-Programmes.pdf

3.4 For the CCUS programme, there is a particular risk associated with the technology being unproven at the scale being planned, and dependence on specialist expertise and equipment. For example, one of the Track-1 emitter projects is planning to build a gas-fired power station with carbon capture, but this would be 40-times larger than any existing examples globally. A previous attempt to scale up CCUS in the United States ended before it started operating due to cost overruns attributed to the massive scaling up from pilot to commercial scale. Similarly, applications of CCUS in the cement industry are unproven at scale, with potential limits to technical experience. Several countries around the world are also currently pursuing CCUS, so there is a risk that limitations of global supply will cause unexpected cost increases or delays.

3.5 The Track-1 projects will also need to ensure they obtain sufficient finance to fund project construction. The private sector will need to provide most of the capital to build and install carbon capture equipment, pipelines and infrastructure for the storage sites. The UK Infrastructure Bank (UKIB) estimates that the HyNet and East Coast Clusters will require £8 billion to £10 billion of private finance in 2024-25 alone. There is a risk that the transport and storage companies and carbon capture projects might not be able to get enough funding to finish construction. The UKIB has developed a number of ways to support capital investment by providing, for example, debt. These may expose the government to a level of financial risk as these products effectively underwrite private sector investments.

Operation risks

3.6 There are some unknowns around how effectively the projects will operate (**Figure 10** overleaf). Should any of these risks materialise, the projects could contribute less to DESNZ's overall objectives for carbon capture and its net zero ambition.

Regulation risks

3.7 DESNZ has developed bespoke business models for carbon capture that outline how risks will be shared between government and the private sector and how the projects will receive financial support. The precise arrangements are being worked out through negotiations between DESNZ and the various projects. Ofgem and the Low Carbon Contracts Company will be required to collect, monitor, gain assurance over and act upon a range of data sources to ensure that items like power generated and carbon captured are accurately recorded.[14] This will be fundamental to the entire CCUS programme functioning as intended and ensuring that the carbon capture projects receive the correct levels of financial support.

14 Ofgem's and the Low Carbon Contracts Company's responsibilities are described in Figure 5.

Figure 10

Carbon Capture, Usage and Storage (CCUS) programme – Track-1 project operation risks

The Department for Energy Security & Net Zero (DESNZ) has identified a number of risks it needs to manage when Track-1 programmes become operational

Risk	Description
Carbon capture solvents	In carbon capture a solvent is a substance that reacts with carbon dioxide to separate it from other emissions. The carbon dioxide-rich solvent is then heated, separating back into solvent (which is used again) and carbon dioxide (which is sent for storage). The Track-1 projects will use either a generic or proprietary solvent. For a permit application, the Environment Agency needs to know all the solvent components and breakdown products so the impact on air quality, habitats and the environment can be assessed. The Environment Agency has a legal duty to place any information that relates to an emission onto the public register. Some operators are reluctant to disclose this proprietary solvent information so have applied for a permit using a generic solvent. DESNZ considers that this could have an adverse effect on the efficiency of carbon capture projects and permits will need to be varied post FID as the operators will likely want to change to using a proprietary solvent. DESNZ is currently trying to assess the potential extent of this issue and is working with the Environment Agency to ensure that industry understands and complies with the legal requirements around solvent disclosure. Previous attempts to apply CCUS in the power sector using post-combustion capture encountered difficulties with carbon dioxide (CO_2) capture rates being lower than expected. For example, Boundary Dam in Canada was the first-of-a-kind project to retro-fit a coal-fired power station with CCUS and is estimated to have captured less than 65% of its emissions versus a target of 90%.[1]
Pipeline flow rates	The pipelines that will transport carbon need to have a certain level of carbon dioxide flow to function optimally.
Storage sites	There are only a handful of sites worldwide where carbon has been pumped underground for long-term storage at significant scale. The oldest storage site is Sleipner Vest, a gas field located under Norwegian waters in the North Sea, which has had over 17 million tonnes of carbon injected since 1996. Storing carbon securely underground involves a complex range of geological factors and there will be a need for ongoing monitoring. There is therefore an element of risk as to the long-term viability of storage sites given the lack of real-world experience in this area. Some stakeholders say that DESNZ should have a backup storage site in case its first choices do not work, particularly given the potential long lead times in developing an alternative.
Injection rates	The proposed storage sites have a massive potential capacity, but there is a limit on how quickly carbon can be pumped into them. If the rate of carbon being captured by the emitter projects exceeds the rates at which it can be injected into the underground stores, it will have to be vented into the atmosphere.

Note

1 Carbon Tracker Initiative, *Curb your Enthusiasm: Bridging the gap between the UK's CCUS targets and reality*, March 2024, p.15, available at: https://carbontracker.org/reports/curb-your-enthusiasm/

Source: National Audit Office summary of the Department for Energy Security & Net Zero's documentation

3.8 DESNZ's work in this area thus far has focused on identifying all the key procedures and actions that will be needed for the programme to operate on a 'business as usual' basis. It is working with the key regulators to ensure that responsibilities are clear and that all parties are adequately resourced. It is also developing a system of testing to ensure that there are robust processes in place, and that all relevant parties are ready when projects begin to capture carbon.

DESNZ's approach to risk management

3.9 The CCUS Programme Board is the main body for managing risks to the programme. The Board is led by DESNZ, and includes HM Treasury and the Infrastructure and Projects Authority (IPA) as members. The Programme Board considers and makes decisions around, amongst other things, the programme's affordability, scope and timeline. While HM Treasury was not originally a member of this board, it joined during 2023 and is a full member, contributing to decision making. Below this, a Tranche 1 board, of which HM Treasury is also a member, is focused on issues relating to Track-1. There is a monthly process for teams to identify, assess and escalate risks to the appropriate board and these are logged on the programme risk register. A similar board will be established to have oversight of Track-1 expansion and Track-2. HM Treasury also has an advisory role on the DESNZ group that considers issues arising from the current negotiations with projects for Track-1.

3.10 DESNZ established these arrangements in response to reviews that had identified weaknesses in its risk management. The Government Internal Audit Agency (GIAA) reviewed the CCUS programme in November 2022 and concluded that "There are significant weaknesses in the framework of governance, risk management and control for planning and scheduling." The IPA completed a Gateway review in April 2023 when it made the following recommendation its highest priority: "... that the Programme implement a fundamental review of the governance arrangements to ensure a fit-for-purpose delivery model for the Programme". The most recent GIAA review in March 2024 concluded that DESNZ had addressed almost all of its recommendations and that it had made "significant progress".

3.11 DESNZ has identified capability and capacity issues, both for itself and for the regulators, as a risk for the CCUS programme once Final Investment Decision has been achieved for Track-1. DESNZ has struggled to recruit and retain enough specialist staff to progress the CCUS project. As of April 2024, it considered that it needed an additional 31 full time equivalent (FTE) staff to manage the Track-1 clusters effectively and a further 154 FTE for later sections of the programme. It also noted that there is a higher turnover of staff on the CCUS programme (17%) compared to BEIS as a whole (13%), in part because of the lack of clear career opportunities for technical and specialist staff.

DESNZ's plans beyond Track-1

3.12 DESNZ's CCUS programme will need to capture significantly more carbon beyond Track-1 to achieve its ambitions for the programme (see paragraph 1.7). Even if DESNZ agrees terms with all eight of the short-listed projects for Track-1, these will only provide a quarter of the carbon capture capacity needed to meet the government's targets for 2030. DESNZ estimates that the eight projects currently under negotiation will capture and store a maximum of 4.9 million tonnes per annum (Mtpa) of carbon, less than a quarter of its lower target for total carbon capture by 2030. A further 15 Mtpa of carbon will need to be captured by 2030 in order to reach the lower end of the government's target. No dedicated bioenergy with carbon capture and storage (BECCS) or other Greenhouse Gas Removal (GGR) projects were included in Track-1, creating a significant risk that DESNZ will miss its target to remove 5 Mtpa carbon through engineered removals by 2030.[15] In addition to meeting decarbonisation targets, BECCS plays a role in the government's plans to improve the UK's energy security.

3.13 In addition to the eight Track-1 carbon capture projects currently under negotiation (see paragraph 1.10), DESNZ has two further stages planned to achieve the 2030 targets for CCUS in the UK: Track-1 expansion and Track-2.

Track-1 expansion

3.14 DESNZ is looking to identify additional carbon capture projects that could connect to the carbon stores developed by the HyNet and East Coast Clusters. DESNZ hopes that these could be in operation before 2030. DESNZ considers these projects will provide alternatives to the initial Track-1 projects if DESNZ is unable to agree contracts or if the projects are considered to offer poor value for money. It also intends that they will add additional carbon capture projects to already-established clusters, increasing the value for money offered by the initial expenditure on Track-1 by more fully utilising the pipeline and storage infrastructure put in place. Applications for Track-1 expansion at HyNet were opened in December 2023. DESNZ has yet to set a date for when the process will be started at the East Coast Cluster.

Track-2

3.15 DESNZ intends to have a further two carbon capture clusters operational by 2030. In July 2023 it announced that these Track-2 clusters would be Acorn, in northern Scotland, and Viking, on Humberside. DESNZ has asked the transport and storage companies at these clusters to submit lists of initial carbon capture projects in "early 2024". This process had not formally commenced before the General Election was announced in May 2024. DESNZ told us it is currently determining the scope of Track2 and its timetable and cost, but that it does not know when it will complete this process. It told us it had shared high level estimates of the cost of Track-2 with HM Treasury.

15 The Track-1 shortlist does include an energy from waste facility. A portion of its output will count as BECCS and therefore produce negative emissions, provided that it uses as element of biogenic waste as feedstock.

Budget for Track-1 expansion and Track-2

3.16 The budget available for the later stages of the CCUS programme remains uncertain. This could bring similar risks to the programme like those which contributed to the failure of the previous government's competition. HM Treasury and government ministers will ultimately decide whether the CCUS programme will receive financial support, and how much will come from the government and from consumers. It has made it clear that it will only support the programme as long as it considers that it offers value for money. While HM Treasury has announced up to £20 billion of funding for the current CCUS programme, this is unlikely to be enough to meet government's ambitions for CCUS deployment to 2030. DESNZ has shared high-level cost estimates for the entire CCUS programme, but HM Treasury has yet to make any further spending commitments. One of the key findings of our 2017 report on the previous failed attempt to launch CCUS in the UK was that DESNZ had not secured HM Treasury agreement on how much long-term funding it would provide. This led to the programme being cancelled when estimated costs rose. The lack of funding certainty also poses risks for potential investors who may be less willing to invest in projects without clarity of the government's support. HM Treasury has told us that it hopes agreeing government support for Track-1 will provide industry with confidence over government's long-term commitment to CCUS. DESNZ and HM Treasury currently plan to agree the funding available in stages.

Developing a self-sustaining CCUS market

3.17 As set out in its 2023 CCUS Vision, over time DESNZ wants to establish what it describes as a "commercial and competitive [...] market for CCUS in the United Kingdom".[16] It sees such a market as not only supporting the government's net zero ambitions but also supporting, for example, the creation of new jobs. It has estimated that CCUS exports – such as expertise and access to storage – could add between £4 billion and £5 billion to the UK economy annually by 2050. To support its aim to create a "self-sustaining CCUS market" by 2035, DESNZ has a highlevel plan for how the UK will move away from early projects backed by the government through taxpayer and consumer funding. It plans to achieve this in three phases: creating a market (up to 2030); transitioning to a market (2030 to 2035); and supporting a selfsustaining market (2035 onwards). The government has also been engaging with industry on how to integrate dispersed sites into its CCUS programme.

16 Department for Energy Security & Net Zero, *Carbon Capture, Usage and Storage: A Vision to Establish a Competitive Market*, December 2023. Available at: https://assets.publishing.service.gov.uk/media/6594718a579941000d35a7bf/carbon-capture-usage-and-storage-vision-to-establish-a-competitive-market.pdf

Appendix One

Our audit approach

Scope

1 We examined the government's strategy for Carbon Capture, Usage and Storage (CCUS) and how far it has progressed its CCUS programme to date. This report covers:

- the role CCUS plays in government plans to decarbonise the UK by 2050;
- how the government has learnt lessons from previous failed attempts;
- the progress that the government has made in launching CCUS in the UK; and
- the risks that government will need to address to ensure that the CCUS programme meets its targets.

2 We have previously written two reports on the government's attempts to launch CCUS in the UK. Although we make references to these reports, we did not conduct a full comparative analysis of each of government's CCUS programmes.

3 We prepared and published this report while the Department for Energy Security & Net Zero (DESNZ) was conducting commercial negotiations with the eight carbon capture projects and two transport and storage companies that make up Track-1 of the CCUS programme. We therefore have not included any information that could be considered commercially sensitive or could negatively affect these negotiations.

Methods

4 In examining these issues, we drew on a range of evidence which we analysed between April 2023 and May 2024.

Document review

5 We reviewed DESNZ documents on CCUS. These included:

- documents focusing on the planning of the CCUS programme;
- strategy documents including DESNZ's vision for the future of the CCUS market;
- financial and funding documents;
- risk registers and DESNZ's strategy for identifying and mitigating short and long-term risks;
- business models on the different types of emitter projects and the transport and storage companies;
- business cases, focusing both on parts of the programme and the programme as a whole;
- ministerial submissions; and
- correspondence with HM Treasury.

6 In addition, we reviewed documents and data from the Climate Change Committee. The focus of this was how CCUS fits in with the UK's carbon budget and net zero goals. Furthermore, we engaged with the Infrastructure and Projects Authority on assessments of how the CCUS programme is progressing.

Interviews

7 We conducted a series of interviews with relevant government departments and stakeholders. These include:

- DESNZ;
- HM Treasury;
- Office of Gas and Electricity Markets (Ofgem);
- Climate Change Committee;
- National Infrastructure Commission;
- North Sea Transition Authority;
- UK Research & Innovation;
- UK Infrastructure Bank;
- Low Carbon Contracts Company; and
- Carbon Capture and Storage Association.

Interviews were conducted through a mix of in-person meetings and conversations via Microsoft Teams.

8 We used these interviews to understand:

- how DESNZ identified lessons from previous CCUS competitions and what different approaches were considered for the new CCUS programme;
- the roles and responsibilities of DESNZ, Ofgem, LCCC and other bodies in preparing for and administering the CCUS programme;
- the key risks to the programme and how DESNZ and other bodies are mitigating them;
- how decisions on which clusters and projects to select to take forward were made; and
- how groups outside the government view the CCUS programme.

Teach-ins

9 We held a series of in-depth workshops with officials from DESNZ on a wide range of issues relating to the CCUS programme. These teach-ins focused on providing greater insight and information on specific areas of the CCUS programme. Teach-ins were conducted through a mix of in-person meetings and conversations via Microsoft Teams.

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