# Evaluation of three Carbon Capture, Use and Storage (CCUS) Innovation Programmes

## Technical Annex
## December 2023

Ipsos, Perspective Economics and Technopolis

# Contents



 

# TECHNICAL ANNEX

This annex describes the methodology used to develop the evaluation of the three CCUS programmes. It describes the evaluation framework, the main methodological stages, the analytical approaches taken, the sources of data and data collection method, and the methodological challenges and limitations.

It accompanies the Main Evaluation Report, published separately, which describes the findings of the process and outcome evaluations and the evaluation conclusions and lessons learned.

## A1.1 The stages of the evaluation

The evaluation comprised a process and outcome evaluation. Initially it was anticipated that an economic evaluation would also be conducted. However, due to challenges with data availability and quality (see limitations section), this strand was removed. Instead, the economic barriers, and the extent to which the programmes addressed these, and the economic impacts in terms of jobs, business development, and growth have been integrated into the outcome evaluation. The stages are summarised below and described in more detail in section A1.3. Analytical activity was conducted in two main stages (interim and final) with the full summary findings included in this published report.

- **Scoping activities**: The evaluation was designed on the basis of an extensive scoping phase aimed at deepening the study team's understanding of the context surrounding CCUS technology (landscape, policies, and innovation), of programme design and of how the programmes aimed to implement Government objectives and address key barriers to CCUS progression (theory of change).

- **The process evaluation** assessed the relevance, internal coherence, design effectiveness and implementation effectiveness of the programme (EQ5 & EQ6), as well as project effectiveness in achieving intended outputs (EQ1).[1] An analysis of lessons for future CCUS innovation support (EQ6.6) and domestic vs international approaches to CCUS programming (EQ6.8) was also carried out.

- The **outcome evaluation** assessed the programmes' contributions to six different outcome areas, testing a list of causal hypotheses defined in the scoping phase (see A1.2). Additionally, the outcome evaluation considered and provided conclusions on:

    - Unintended outcomes of the programmes (positive or negative);
    - What additional evidence or effort is needed to achieve impact (in the longer term); and

[1] In the scoping study, EQ1 is considered an outcome evaluation question as it is focussed on results, but given that EQ1 is an effectiveness question focussed on outputs (to what extent have the projects produced the outputs foreseen in the programme business cases and individual grant applications?) we have shifted this to the process evaluation. To note, most of the outcome evaluation EQs will be evaluated using a Contribution Analysis approach which is unnecessary / inappropriate for EQ1.

- (Based on evaluation evidence) the contribution that the rollout of CCUS can be expected to make towards the UK's decarbonisation target of net zero by 2050.

## A1.2 Evaluation questions and framework

The following matrix lists all evaluation questions and sub-questions investigated for the process and outcome evaluations along with the analytical approach taken and data sources. More detail on each is provided in later sections.

**Table A1.1 Evaluation matrix**

| | Analytical approach | Data sources |
|---|---|---|
| Q1: To what extent have the projects produced the outputs foreseen in the programme business cases and individual grant applications? | | |
| 1.1a.What is the total amount of **private finance leveraged** through the projects? | Quantitative analysis of finance leveraged at through matched funding | **2021 KPIs**, additional project information collected through **interviews** |
| 1.1.b. How much of this would have been invested anyway, without the programme? | Qualitative analysis of additionality | **Interviews** with partners providing matched funding and follow-on funding |
| 1.2.Have projects provided evidence to demonstrate the **development of CCUS technologies** (e.g. increased TRL)? | Qualitative analysis of outputs and project / product progress | **Project final reports and key knowledge deliverables** (KKDs), complemented with **interviews** with: (i) academic partners; (ii) technology users (industry and innovators) |
| 1.3a.Have projects demonstrated actual (or the potential for) **cost reductions** in the deployment of CCUS that improve upon the current state of the art? | Techno-economic analysis (QA of cost reduction claims) | **Project final reports and KKDs**, complemented with **interviews** with project leads |
| 1.3b Have projects provided robust, detailed **data about the costs and benefits** associated with the deployment of CCUS in the UK through their technologies? | Qualitative analysis of outputs | **Project final reports and KKDs** |
| 1.4.Is the evidence generated by the projects conducive to facilitating demonstration of key components of CCUS (technologies, deployment, operation) to relevant stakeholders?[2] | Qualitative analysis of outputs | **Project final reports and KKDs** |
| 1.5.Have projects contributed towards **capacity building** (skills development, new posts, retention of expertise, dissemination of knowledge)? | Case studies, and qualitative analysis of views of research organisations funded | **Interviews** with staff from research partners in technological advancement projects.<br>**Project final reports and KKDs** – mapping of these. |
| 1.6.Have the programmes increased the international **visibility and reputation** of the UK in relation to CCUS capabilities? | Qualitative assessment of views of international organisations<br>Longitudinal landscape mapping | **Interviews** with international organisations.<br>Landscape mapping<br>Analysis of research outputs<br>ONS data |
| 1.7.Have new collaborations, partnerships | Compilation of KPIs | **2021 KPIs** and **interviews** with project |

[2] This question has been re-worded to make the difference between it and Q2.1 clearer.

| | Analytical approach | Data sources |
|---|---|---|
| and networks been established? | coupled with case study insights (particular focus on cluster-enabling case studies) | leads and project partners |
| 1.8.What are the **reasons for any differing levels of achievement**, including for any under-achievement against expectations / intentions? | Qualitative assessment and case studies | **Project final reports,** coupled and **interviews** with project leads across the portfolio and **case study interviews** with project partners |
| Q2: To what extent have the programmes contributed to altering perceptions of CCUS across relevant stakeholder groups (industry, policy, investors)? | | |
| 2.1.Have the programmes altered industries' and investors' perceptions of CCUS as a **viable pathway** to achieving future decarbonisation at scale? | Contribution analysis | **Interviews** with investors: (i) carbon-intensive industries (engaged with CCUS (BEIS-funded or not) and/or with climate mitigation); (ii) fund managers, and; (iii) institutional investors (e.g. pension funds). |
| 2.2.Have the programmes provided an evidence base (about the timing, scale, likelihood or cost of future deployment of CCUS at scale) to give sufficient **confidence to government** to make informed decisions concerning investment in a larger publicly funded programme / business model / support framework? | Contribution analysis | Interviews with BEIS staff, policy makers, coupled with Policy Landscape review |
| Q3: To what extent have the programmes contributed to stimulating investment and deployment of CCUS? | | |
| 3.1.Have the programmes leveraged **follow-on funding** for the projects concerned? | Quantitative analysis of follow-on funding and contribution analysis | 2021 KPIs, complemented by interviews with project leads |
| 3.3.Have the programmes contributed to **stimulating wider investment in RD&I** (industry, supply chain, academic) in the UK? | Quantitative analysis of secondary data on R&D and contribution analysis | Beauhurst and ONS data on RD&I investment from funded businesses |
| 3.4.Have the programmes resulted in a **pipeline of other projects** (i.e. outside of the programmes) engaging in activities to deploy CCUS technology at scale in the UK? | Case studies and contribution analysis | Case study interviews with project leads and partners |
| 3.5.Have the programmes contributed to the development of **domestic UK capability** that can service UK and international CCUS demand? | Case studies | Case study **interviews** with stakeholders in international CCUS projects close to deploying full chain CCUS and with Zero Carbon Humber (UK CCUS project not funded by BEIS) |
| 3.6.Have the programmes led to sustained international collaborations and partnerships? | Case studies | **Interviews** with project leads and partners |
| 3.7a [CCUS-I RI] Is the **Research Infrastructure** perceived as useful to the targeted audience (UK industry and academia)? | Case studies | **Interviews** with project leads and partners,<br>Academic panel views |
| 3.7b Is it considered a good quality / internationally competitive resource? | Case studies | **Interviews** with project leads and partners,<br>Academic panel views |

 

| | Analytical approach | Data sources |
|---|---|---|
| 3.7c Is it expected to enhance future innovation, demonstration and deployment efforts? | Case studies | **Interviews** with project leads and partners,<br>Academic panel views |
| 3.8a [CCUS-I RI] Is the CCUS **Research Infrastructure** enabling UK (and international) companies to develop, de-risk, and accelerate their innovations? | Case studies and portfolio analysis of research project results | **Interviews** with project leads and partners,<br>Academic panel views |
| 3.8b Is it helping bridge the gap between fundamental research and pilot-scale demonstrations? | Case studies | **Interviews** with project leads and partners,<br>Academic panel views |
| 3.8c Is it providing a training ground for researchers? | Case studies | **Interviews** with project leads and partners,<br>Academic panel views |
| Q4: To what extent are programmes on track to deliver intended future impacts (considering the assumptions, current situation, market barriers and failures as set out in the theory of change)? | | |
| 4.1.What contribution can rollout of CCUS be expected to make towards UK **decarbonisation targets** (net zero by 2050)? | See prev. Research Plan (a) analysis of project reporting emissions compared to broader UK targets and (b) theory-based analysis of plausibility of causal pathways from projects to net zero. | Project reporting emissions reductions (where available);<br>Portfolio analysis – appropriateness of portfolio.<br>Non-systematic review of relevant publications, modelling CCUS potential in the UK (including some covering a life-cycle approach for Hydrogen)<br>Theory of change |
| 4.2.To what extent have the programmes contributed to establishing **the UK as an international hub** for CCUS sector development and innovation? | Case studies and qualitative synthesis of views | Case study interviews with project leads and partners, and interviews with international organisations.<br>Project documentation on studentships and jobs<br>Analysis of nationality of jobs / studentships<br>ONS data |
| Q5: What insights can be gained to inform the delivery processes of future (CCUS) programmes? | | |
| 5.1.Were the programme launches, calls and associated communications successful in reaching target audiences? Why / not? | Programme documentation review, process map | Documentation review, interviews with applicants |
| 5.2.Did the programmes receive a sufficient number and range of high-quality applications? Why / not? | Portfolio analysis, process map | Interviews with DESNZ staff, interviews with applicants |
| 5.3.Was the application assessment process efficient and effective? Why / not? | Programme documentation review, process map | Programme documentation, interviews with DESNZ staff, interviews with applicants |
| 5.4.Was the approach to risk management during projects effective? Why / not? | Programme documentation review, process map | Programme documentation, interviews with DESNZ staff, interviews with applicants |
| 5.5.Was the programme management / monitoring efficient and effective? Why / not? | Programme documentation review, process map | Programme documentation, interviews with DESNZ staff, interviews with applicants |
| 5.6.To what extent were applicants / beneficiaries satisfied with programme | Process map, thematic analysis of | interviews with applicants |

| | Analytical approach | Data sources |
|---|---|---|
| processes? | interview data | |
| Q6: To what extent has design of the CCUS theme effectively supported the development of CCUS? [3] | | |
| 6.1.To what extent do the **portfolio of programmes** that comprise the CCUS theme act as a coherent and complimentary approach to supporting the development of a pathway to widescale deployment of CCUS? | Policy landscape analysis, theory of change review | Programme documentation, wider policy documentation, interviews with DESNZ and external stakeholders, expert panel |
| 6.2.To what extent did a coherent and appropriate **portfolio of projects** emerge from the three CCUS programmes? Were there any important gaps or duplications? Was there sufficient diversification of risk? | Portfolio analysis, analytical workshop (with expert panel) | Project documentation, expert panel |
| 6.3.What have been the advantages and disadvantages of different **approaches to phasing** programme funding? | Process map, thematic analysis of interview data | Interviews with DESNZ and project teams, expert panel |
| 6.4.Have the **aims and intentions** of (a) the programmes and (b) the projects evolved over time? How / why?[4] | Programme documentation review, process map | Programme documentation, interviews with DESNZ |
| 6.5.Were opportunities for **learning across the programmes and projects** (and beyond – e.g. across BEIS policy teams and other programmes) maximised? | Qualitative review of outputs | Desk review of monitoring reports, final reports and KKDs |
| 6.6.Can lessons be learned for **future CCUS innovation support** in terms of e.g. scale, scope, targeting of future BEIS programmes? | Case studies (including 'customer journey' and 'UK CCUS Capabilities' case studies) | Interviews with project leads, participants and stakeholders |
| 6.7.Have programmes identified **areas for investment** and effort to focus/not in future? | Case studies and qualitative review of programme outputs | Interviews with project leads, participants and stakeholders and review of final reports and KKDs |
| 6.8.How do the experiences and achievements of a **domestic vs international approach** to CCUS innovation programmes compare (i.e. CCUS-I vs ACT)? | Case studies (comparative analysis across ACT and non-ACT projects) | Interviews with project leads, participants and stakeholders |

In addition to the above-presented matrix, the outcome evaluation was designed around a contribution analysis framework that separated out the theory of change into several testable hypotheses and a framework of evidence that would need to be collected to assess whether (a) the anticipated change had occurred and, (b) evidence to indicate a contribution of the programmes to this change. The framework is provided at the end of this Annex.

## A1.3 Analytical approach

### A1.3.1 Scoping phase

The inception period for this evaluation was completed over three months (January-March 2021). The purpose of this period was to further develop our understanding of the landscape, policy, and innovation contexts in which the CCUS programmes were embedded, and to investigate how the programmes' design responded to these contexts.

[3] Question 5 is suppressed as it was sufficiently covered in Wave 1.

[4] Project dimension added – the sub-EQ originally only asked about programmes.

The phase began with the development of a **policy landscape review** and **theory of change development.**

The policy landscape review provided an overview of the policy landscape in the UK in which the three CCUS programme were developed. Centrally, the review, through outlining the background of wider policy announcements and commitments, contextualised the development of these programmes of their progress. It tracked the different iterations of the government's commitments to CCUS deployment, noting the publication of new policies, action plans and roadmaps; this includes the most recent developments at the time of writing this final report. This activity was a key step in developing the team's understanding of the programmes and of their relevance and coherence.

The theory of change review focused on (a) developing the team's technical understanding of the programme's roles within the policy landscape and (b) developing the framework for the evaluation, particularly the outcome evaluation. Building upon logic models developed by Technopolis Group as part of a separately-commissioned scoping study, the team developed an overarching theory of change drawing on evidence from:

- Three scoping interviews were undertaken with programme managers and delivery leads in December 2020 and January 2021. A BEIS Senior Engineering Advisor the purpose of this interview was to understand more about the CCUS-I, CCUD and ACT programme strategies and processes, in order to support the development of frameworks and assumptions for the outcome and process evaluations being conducted.
- The BEIS CCUS policy lead for ACT, who also focused on R&D.
- BEIS' ACT project manager, focusing on monitoring and the central finances of projects.

These interviews picked up topics that were previously discussed in the inception and theory of change meetings (November/December 2020), and focused on understanding how CCUS-I, CCUD and ACT programmes work in terms of delivery and management, the key goals of programmes, their strategies and project progress.

In December 2020, a theory of change workshop was held to:

- Discuss and understand synergies within the portfolio / between the programmes.
- The study team's understanding of project outputs and outcomes.
- The evaluation questions.

Following the workshop, the team developed a **process evaluation framework** and a **contribution analysis framework** (see end of this Annex). On the basis of these activities the **methodology** set out in the proposal was elaborated into a **research plan**.

### A1.3.2 Process evaluation

The process evaluation was delivered against a framework setting out the metrics and judgement criteria against which we answered each evaluation question (see end of this Annex). Overall, the process evaluation comprised of an analysis of:

**Programme design coherence, relevance and effectiveness**: The first key step for this theme was a **review of the theory of change** and the design relevance against key issues raised by DESNZ CCUS experts and the expert panel. We then also conducted an **evidence review** of the programme documentation (business cases, programme applications, and end-of-project reports) against the sub-EQs and lines of inquiry with the findings being mapped into an **analytical framework**. We then explored these lines of inquiry also in interviews with project leads and DESNZ staff involved in the design and delivery of the programmes. We further triangulated emerging findings, conclusions and lessons for ongoing and future policymaking and programming on this theme with our **expert panel** at two workshops.

**Project selection:** We mapped the processes / steps involved in project applications and selection (including pre-programme engagement, launch promotions and communications, call design and the selection process) in reaching and engaging high quality applications and in generating a coherent and appropriate portfolio of projects (**process map**). Drawing also on interview data (with successful and unsuccessful applicants and DESNZ staff) we made judgments as to the quality of these processes. We then developed a detailed **portfolio analysis** of the 26 projects funded covering their size, location, value, objectives, themes, causal pathways, and intended outputs and outcomes.

**Programme monitoring, support and guidance and governance effectiveness and efficiency**: As with project selection, we developed a **process map** of the governance, management and monitoring activities and the support and guidance to applicants and projects and assessed the effectiveness and efficiency of these based on qualitative evidence coming from interviews, especially with successful and unsuccessful applicants.

**Programme communications and dissemination:** We reviewed knowledge products, and mapped communications activity over the evaluation period, and gathered the views of keys stakeholders (policymakers, project target audiences, and project participants) on the value and application of these.

**Project progress in achieving outputs**: The primary sources of data for this assessment were project monitoring and reporting, interviews with project leads and – for case study projects only – additional interviews with project stakeholders (and a deeper dive into project documentation).

### A1.3.3 Outcome evaluation

To assess programme outcomes, the evaluation will collect / analyse quantitative data from internal data sources (management information and monitoring (KPI) data) and external data sources (national databases collecting company information e.g. on size, investment and revenue) and qualitative data from stakeholder interviews. A deep dive into outcomes for

eight case study projects will be conducted (see section 4.4). The evaluation team are also considering currently the extent to which an analysis of research publications and technology patents will be possible within the scope of the evaluation, to feed into sub-EQs 3.5 and 4.2 on UK research innovation and deployment capabilities and the UK's reputation as a global CCUS leader.[5]

Overall, the outcome evaluation used **contribution analysis**. To operationalise this approach, the evaluation team first developed a portfolio level / overarching theory of change which was validated by BEIS and the external panel of academic and industry representatives. Then, a contribution analysis framework was developed (see end of this Technical Annex) which set out – for every causal hypothesis listed above – the causal 'mechanisms' through which the programme expected to achieve results, internal and external dependencies of success, what 'no effect' would look like, and other factors which might explain any observed change. We also considered the strength of the evidence available. In applying contribution analysis we gathered evidence and reviewed the theory of change and the contribution analysis framework at three points: during the scoping phase, interim phase and final phase.

Three other analytical strands were important to the outcome evaluation:

- **Seven project case studies**: These were framed to reflect the contribution analysis structure to enable exploratory and explanatory research into outcomes and programme contribution.

- **Secondary data analysis:** We analysed quantitative and qualitative evidence of project effectiveness and outcomes achievement as reported by projects in their reporting to DESNZ, and of fundraising company data (for funded and non-funded comparator projects) available through Beauhurst to draw conclusions on outcomes.

- **Economic barrier analysis**: The scoping study identified the key market failures and market barriers that prevent an efficient level of commercial activity related to CCUS. Via analysis and triangulation of in-depth interview data, survey data from Project Partners and Wider Industry Representatives, and analysis of secondary data including R&D investment, private equity and grant funding and patent data we will analyse the extent to which the BEIS CCUS programme has addressed market failures and barriers that have historically prevented technology advances and / or commercial activity.

## A1.4 Primary and secondary data collection

The evaluation drew on a range of secondary and primary data. These data sources and the purpose these methods served in the evaluation is set out in the table below.

[5] Since such data would be sourced externally from existing databases, a decision on whether there is sufficient scope and budget within the evaluation to

### A1.4.1 Project documentation review & portfolio analysis

Project and programme-level documentation was reviewed as a key source of information on the strategy and delivery of CCUS programmes. This included providing vital details on the type of technology being developed, the ambitions of different businesses, industries and sectors in CCUS, and how projects were going to work, including their scope, processes and strategies for achieving their KPIs.

Documentation that was analysed at a programme level included:

- Programme business cases.
- Feedback on applications (the level of documentation of this type varied between programmes. For ACT 2, only project scores were available rather than detailed feedback; whereas for CCUS-I and for CCUD P2 and P3, more in-depth feedback on both successful and unsuccessful applications was available).
- Programme-wide DESNZ Science and Innovation for Climate and Energy (SICE) KPI monitoring databases.
- Monitoring reports.
- Documents outlining lessons learned from programmes.
- Existing documents on programme management and governance.

At a project level, this documentation included:

- Project application documents (both successful and unsuccessful applications).
- Project reporting documents, for example annual or progress reports.
- Project monitoring data such as progress against KPIs, feedback surveys and knowledge outputs.
- Meeting minutes, where available.

The portfolio analysis mapped data from project applications, progress reports (where available), KPI returns, and feedback from programme management, against EQs and sub-EQs. The analysis covered 24 projects across the three CCUS programmes.

**Table A1.2: Portfolio analysis framework**

| Project characteristic | Details |
|---|---|
| General project information | • Project name<br>• Public description<br>• Lead & partner organisations<br>• Technology / Infrastructure focus<br>• Target sector |

 

| | |
|---|---|
| | • KPIs and project status<br>• Where available, project application score and feedback |
| EQ1: *To what extent have the projects produced the outputs foreseen in the programme business case and individual grant applications?* | Sub-EQs:<br>• Focusing on: finance (EQ1.1); Increases in TRL (EQ1.2); Cost reductions (EQ1.3); the key components of CCUS and the methods used to demonstrate improvements (EQ1.4); capacity building (EQ1.5); Collaborations and partnerships (EQ 1.7).<br>• For all of these, there was varying evidence available across programmes, with financial information in particular lacking for ACT 1 & 2 programmes, and with justifications for cost reductions across most projects. For EQ 1.5, capacity building, information was often lacking in number of jobs created or retained, and in how skills development is supported. |
| EQ 3 – *To what extent have the programmes contributed to stimulation investment and deployment of CCUS?* | Sub-EQs:<br>• These sub-EQs focus on how the project influences policy making (liaising with and/or supporting policymakers – EQ 3.2); how far the project liaises with other industrialists to keep up CCUS more broadly (EQ 3.3); and how the project is securing ongoing funding or other projects (EQ 3.4).<br>• As with EQ 1, there was varying evidence for each of these. While most projects had included in their work plans some research dissemination, exact details were only sometimes given in project documentation. |
| The logic frame | The project's progress along the theory of change, including its anticipated outputs, outcomes and impacts, as well as key project risks. |

### A1.4.2 Interviews

Two waves of semi-structured interviews took place in April-June 2021 (first wave) and March-June 2023 (second wave). A wide range of stakeholders were interviewed, and classified in the following categories:

- **Programme Management and Project Delivery**: Stakeholders who participated in the management or delivery of BEIS CCUS programmes, with the list of potential contacts supplied by BEIS. These interviews sought stakeholders' views on programme management and delivery processes, as well as any observed outcomes, barriers and/or challenges to date, in programme delivery.

- **Project Coordinators / Leads (non-case study)**: Stakeholders who participated in a CCUS project that successfully received funding from CCUS-I, CCUD and/or ACT. Their contact details were gathered via project documentation with support from BEIS. In wave 1, the interviews aimed to explore participants' views on the application for funding process, their organisation's motivation for doing so, and to learn more about the project's activities, and any outcomes, barriers, or challenges, both anticipated and/or observed. In wave 2, the interviews aimed to explore the outputs (e.g., publications, knowledge dissemination events, new networks), outcomes (e.g., TRL progression, follow-on funding, new project relying on the outputs) and potential impacts of the projects.

- **Project Stakeholders (case studies only)**: This category was similar to the project coordinators/leads, except that project partners were included in the scope of the recruitment process to give a fuller picture of the project in the case studies.

- **Policymakers and International Actors**: These participants were identified by BEIS and Ipsos. For policymakers, interviews aimed to understand whether the programmes had built confidence in the technology to encourage further investing, if they had contributed to the debate surrounding the timescale and cost of future CCUS deployment, and if they had achieved value for money. For international actors, interviews aimed to gain insight on how far the programmes have established the UK as a leader or hub in CCUS sector development and innovation, and if they have developed the UK's domestic capability in servicing national and international CCUS demand.

- **Wider industry**: These interviews included a range of stakeholders within the wider CCUS industry. Individuals and organisations were identified via the expert panel and desk research. A brief description of each is included here:

    - *CCUS tech developers*: Those contacted in this category had been identified as a key researcher or technology developer in the area of CCUS. Interviews aimed to explore the participant's current research in the field of CCUS, their views on the UK's place in the international CCUS development landscape, and their awareness of, and, if aware, their perspectives on, CCUS-I, CCUD and/or ACT.

    - *Carbon users*: Stakeholders falling into this group will be employees of businesses or organisations that use captured carbon, and therefore form a key part of the carbon capture supply chain. Interviews explored their work/activity (i.e. what they use carbon for, how their business developed etc.); how they have interacted with CCUS technologies and businesses, in

particular who they have worked with to access carbon, and how partnerships were developed; and their knowledge of the programmes, and, if aware, their perspectives on them (including, for example, how far the programmes represent value for money, and how much of an impact they may make).

- *Carbon capturers*: As above, participants in this category were employees of businesses or organisation that capture carbon. Interviews explored similar evaluation questions as the above.

- **Unsuccessful applicants**: Participants were engaged for this group because they had participated in a CCUS project that was not successful in receiving funding from any programme. Similarly to successful project participants, the interviews aim to establish views on and motivations for applying for funding, any barriers or challenges the project encountered, and, differently, whether the project went ahead without CCUS programme funding. Unsuccessful applicants were only engaged in the first wave of interviews.

Table A1.3 provides a summary of recruitment process for the first wave of interviews. In wave 1, engagement with the study was higher for some categories of stakeholders than for others. Of the 11 wider industry interviews that have taken place, none were with carbon capturers who were classified as such i.e., working for a carbon capturing organisation with no formal involvement with CCUS programmes. Moreover, at the time of the interim report, the quota of case study interviews remained just over 25% below the quota stage for that stage. This led to re-evaluating the case studies whose stakeholders were unresponsive (e.g., OFFCALC).

**Table A1.3: Stakeholder samples targeted for interview and reached (wave 1)**

| | Programme management / Delivery | Project coordinators / Leads (non-case study) | Project stakeholders (Case studies only) | Policymakers and international actors | Wider industry | Unsuccess-ful applicants | Total |
|---|---|---|---|---|---|---|---|
| # Contacted | 10 | 16 | 37 | 16 | 20 | 14 | 113 |
| # Scheduled | 0 | 0 | 4 | 0 | 0 | 0 | 4 |
| # Completed | 10 | 15 | 24 | 10 | 11 | 9 | 79 |
| # Unsuccessful[6] | 0 | 1 | 9 | 6 | 9 | 5 | 30 |

[6] Unsuccessful means that the interview did not take place (e.g., Stakeholder remained unresponsive, could not find a time to schedule the interview, declined the interview or cancelled the interview)

 

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total completed or scheduled | 10 | 15 | 28 | 10 | 11 | 9 | 83 |
| # Targeted | 10-11 | 16 | 40 | 10 | 10 | 10 | 93 |

Table A1.4 provides a summary of recruitment process for the second wave of interviews. In wave 2, engagement with the study was low across several categories. Once again, carbon capturers and users were more difficult to identify and engage. Out of four interviews, three were conducted with technology developers, one with a carbon capturer, and none with carbon users. Regarding the project coordinators / leads and partners interviews, most projects had closed since the first wave of data collection and many participants stayed unresponsive, declined the invitation, or their email addresses were no longer monitored. The research team could only complete 37% of the quota for non-case study interviews, and 45% of the quota for case study interviews.

**Table A1.4: Stakeholder samples targeted for interview and reached (wave 2)**

| | Programme management / Delivery | Project coordinators / Leads (non-case study) | Project stakeholders (Case studies only) | Policymakers and international actors | Wider industry | Unsuccessful applicants | Total |
|---|---|---|---|---|---|---|---|
| # Contacted | 10 | 19 | 34 | 13 | 18 | / | 94 |
| # Scheduled | 5 | 10 | 11 | 9 | 4 | / | 39 |
| # Completed | 5 | 10 | 11 | 9 | 4 | / | 39 |
| # Unsuccessful [7] | 3 | 9 | 23 | 4 | 14 | / | 53 |
| Total completed or scheduled | 5 | 10 | 11 | 9 | 4 | / | 39 |

[7] Unsuccessful means that the interview did not take place (e.g., Stakeholder remained unresponsive, could not find a time to schedule the interview, declined the interview or cancelled the interview)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| # Targeted | 6 | 27 | 24 | 10 | 10 | / | 77 |

## A1.5 Analytical activities

### A1.5.1 Analysis of quantitative evidence of outcome

Secondary data from project reporting and external databases of company information was analysed to assess some of the output and outcome questions. To analyse the data, Perspective Economics established an economic indicator framework, noting the evaluation area and evaluation question a data source was relevant to, and what it indicated (e.g. amount of private sector funding).

**Table A1.5: Quantitative indicators against evaluation questions**

| Evaluation Area | Evaluation Question | Indicator |
|---|---|---|
| Delivering Against Business Case Outputs | To what extent have the projects produced the outputs foreseen in the programme business cases and individual grant applications? | • £ private sector match funding |
| | | • £ private investment in participating companies |
| | | • # projects demonstrating potential cost reductions |
| | | • £ technology cost reduction demonstrated |
| | | • £ energy cost reduction demonstrated |
| | | • CO2 reduction |
| | | • # and content of relevant research publications by project participants |
| | | • # and focus of patents by project participants |
| | | • # and size of participating companies involved |
| | | • # and content of relevant research publications by project participants |
| | | • # and focus of patents by project participants |
| | | • # participant companies with international presence |
| | | • # participant companies with international presence |
| Altering Perceptions of CCUS | To what extent have the programmes contributed to altering perceptions of CCUS across relevant stakeholder groups (industry, policy, investors)? | • £ private sector match funding |
| | | • £ private investment in participating companies |
| | | • £ technology cost reduction demonstrated |
| | | • £ energy cost reduction demonstrated |
| | | • CO2 reduction |
| | | • De-risking has led to sustainable investment |
| Stimulating Investment and | To what extent have the programmes contributed | • £ private sector match funding |
| | | • £ private sector follow-on funding |

| | | |
|---|---|---|
| Deployment | to stimulating investment and deployment of CCUS? | • £ private investment in participating companies |
| | | • £ R&D investment |
| | | • £ private investment in participating companies |
| | | • £ increased attributable total revenue among participating companies |
| | | • £ increased attributable export revenue among participating companies |
| Intended Future Impacts | To what extent are programmes on track to deliver intended future impacts (considering the assumptions, current situation, market barriers and failures as set out in the theory of change)? | • CO2 reduction |
| | | • £ technology cost reduction demonstrated |
| | | • £ energy cost reduction demonstrated |
| | | • £ increased attributable total revenue among participating companies |
| | | • £ increased attributable export revenue among participating companies |
| | | • # and content of relevant research publications by project participants |
| | | • # and focus of patents by project participants |
| | | • £ attributable Gross Value Added (GVA) |
| | | • £ attributable GVA |
| | | • # attributable additional jobs by SOC |
| | | • £ R&D investment |

The secondary data was pulled from a number of sources:

- SICE KPI
- Office for National Statistics
- Beauhurst
- Crunchbase
- UKRI Gateway to Research
- ResearchFish
- Lens
- Bureau van Dijk (BvD)

- Burning Glass

### A1.5.2 Case studies

This report draws upon analysis from eight deep-dive case studies across CCUD, CCUS-I and ACT 1 programmes:

**Table A1.6: Case study scope**

| | | |
|---|---|---|
| CCUS-I | 3 | PACT-2<br>Allam Cycle/8 Rivers<br>Clean Gas/OGCI |
| ACT 1 | 3 | ACORN<br>ALIGN CCUS<br>ELEGANCY |
| CCUD | 2 | OFF-CALC<br>CCUD Tata Chemicals |
| | 8 | |

The case studies were selected during the Scoping Phase to cover a range of technologies, CCUS components, TRL focus, project values, sectoral focus and roles in developing UK CCUS capabilities. ACT 2 projects were not covered as most close before or after the final reporting period of this evaluation, hence the opportunity to explore project outputs and outcomes is limited.

Each case study involved a desk review of relevant background documentation including pre and full-proposal applications, and final reports (if available), up to 5 in-depth semi-structured interviews with project leads, consortium members, target customers and/or supply chain businesses. Each case study included an introduction to the project, detailed descriptions of project aims, objectives, and project logic model; an analysis of the project progress to date, including progress towards intended outcomes; an assessment of the project's relevance; an assessment of the early and emerging outcomes observed in terms of value demonstration and technology take-up, skills and capabilities development, partnerships involved, and dissemination activities; and finally, an overview of next steps and potential areas of research for the second wave of case studies research.

### A1.5.3 Internal analysis workshop

An internal analysis session with Ipsos project evaluators was held on the 3rd of June 2021 and on the 8th of June 2023 for wave 2. These analysis sessions sought to internally discuss emerging findings from in-depth interviews with project leads, programme delivery staff, unsuccessful applicants, and broader CCUS stakeholders (carbon users, technology developers, policymakers, and international actors). The sessions also sought to identify how the key findings answered the evaluation questions and identified points to be discussed with the expert panel in the expert analysis workshop.

### A1.5.4 Expert analysis workshop

An analysis workshop was held on the 9th of June 2021 with four members of the expert panel; Jan Hopman, Niall Mac Dowell, Stuart Haszeldine and Jennifer Roberts. It was led by Ipsos and three members of BEIS attended as observers. The session provided an overview of the evaluation's objectives, progress to date, and emerging findings from project and programmes documentation review, portfolio analysis and in-depth interviews with relevant stakeholders. Experts were provided with the content of the workshop in advance and the session was used to discuss preliminary findings, contextualise, validate and discuss implications.

## A1.6: Methodological challenges and limitations

The context in which this evaluation is developed means that it is only possible to assess the EIP CCUS programmes' contribution to the intended outcomes, but it is not possible to directly attribute observed changes to the programmes.

Beyond this, one of the primary limitations of the study revolve around the fact that many project leads and partners who were initially involved in CCUS project delivery during Wave 1 of the evaluation have since transitioned to different roles, either within the organization or externally with other companies or universities. As a result of this, we were able to conduct fewer interviews than initially projected, which in turn constrained the diversity of perspectives and insights across various projects.

The interviews conducted were qualitative in nature, designed to target and uncover comprehensive and detailed insights into individual experiences, behaviours, and contexts. This approach facilitated a thorough exploration of individuals' thoughts, behaviours, and experiences. While these qualitative interviews provided intricate insights into specific personal experiences, they may have limitations in drawing overarching conclusions and generalizations applicable to the entire population of interest, in this case, the leaders of CCUS projects and other broader stakeholders.

Similarly, since the inception of Wave 1, substantial changes have occurred in the overall decarbonisation policy and landscape. New CCUS programmes have been introduced, and additional public funding has been directed toward CCUS and industrial decarbonisation projects. These shifts in the policy landscape have added complexity to the evaluation process. They have made it more challenging to precisely gauge the overall contribution and attribution of the CCUS programmes to these policy changes, as these developments unfolded concurrently with project implementation. Furthermore, projects funded by the three CCUS programmes have also received public funding through alternate channels, leading to a more intricate scenario for isolating specific impacts.

## A1.7: Evaluation Frameworks

### Table A1.7: Process evaluation framework

| Topic | Proposed secondary evaluation questions | Evaluation criteria | Lines of enquiry | Programme documentation review | Primary data collection |
|---|---|---|---|---|---|
| Design | 6.1.To what extent do the portfolio of programmes that comprise the CCUS theme act as a coherent and complementary approach to supporting the development of a pathway to widescale deployment of CCUS? | (Internal) coherence | Did the programmes' business cases acknowledge one another? | Business cases | |
| | | | To what extent the programme's activities and intended outputs and outcomes complement or duplicate each other? | Programme's theories of change (produced by the evaluation) | |
| | | | To what extent do the programmes address coherent and complementary aims? | Programme's theories of change (produced by the evaluation) | |
| | | | To what extent do they address different (or the same) problems? | Programme's theories of change (produced by the evaluation) | |
| | | | To what extent have the same project applied to more than one of the three programmes? | Review of applications | BEIS staff interviews<br>Applicants interviews |
| | | | What is the 'unique value' of each programme and does this align with project-specific design or project-specific needs? | Programme's theories of change (produced by the evaluation) | BEIS staff interviews<br>Applicants interviews |
| | | | Do BEIS staff see the programmes as complementary | | BEIS staff interviews |
| | 6.3.What have been the advantages and disadvantages of different approaches to phasing programme funding? | Effectiveness | What is the rationale for different phases of funding? | Business cases | BEIS staff interviews |
| | | | How have projects progressed / evolved through different phases (if relevant) and what appear to have been the costs and benefits of the process (e.g. in terms of effects of discontinuation, costs of involvement when the project is discontinued, benefits in terms of project quality, development and timings) | Project monitoring and reporting<br>Programme reporting<br>Meeting minutes (where relevant) | BEIS staff interviews<br>Applicants interviews<br>Views of experts / external observers? |
| | | | Views of BEIS staff and applicants | | BEIS staff interviews<br>Applicants interviews |
| | 6.4.Have the aims and intentions of the | Relevance | Changes in scope, programme objectives, | | BEIS staff interviews |

 

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| | programmes evolved over time? How / why? | | targets, policy context | | |
| | | | Changes in focus in terms of technologies, TRL, CRI, participant profile, etc. across calls | | BEIS staff interviews |
| | | | Reasons for change (assume to a great extent because of policy change, but also tech change) | Programme docs (incl business case and change reviews)<br>Policy docs (landscape review) | BEIS staff interviews<br>Expert panel |
| | 6.6.Can lessons be learned for future CCUS innovation support in terms of e.g. scale, scope, targeting of future BEIS programmes? | Lesson-learning / design effectiveness | Views of BEIS staff | | BEIS staff interviews |
| | | | Applicant's views about the appropriateness of the programmes' design | | Applicants interviews |
| | | | Drivers of programme and project effectiveness (or lack of thereof) | Impact evaluation findings | |
| | 6.7.Have programmes identified areas for investment and effort to focus/not focus in future? | Lesson-learning | Learnings from supported projects | Review of final reports | |
| | | | Strategy development | Programme reporting | |
| | | | Views of BEIS staff | | BEIS staff interviews |
| | 6.8.How do the experiences and achievements of a domestic vs international approach to CCUS innovation programmes compare (i.e. CCUS-I vs ACT)? | Lesson-learning / design effectiveness | Comparative analysis of the different outputs, outcomes and other achievements of CCUS-I and ACT projects | Project monitoring and reporting | |
| | | | Case-based analysis of the pathways taken to reach these achievments per project and the extent to which these pathways are necessarily domestic vs intl | Programme's theories of change (produced by the evaluation) | BEIS staff interviews |
| | | | The comparative effects that a domestic vs intl approach has on anticipated portfolio outcomes, such as technology acceleration, UK capacity-building and skills development, trade, economic/market growth, the UK's leadership in CCUS | Programme's theories of change (produced by the evaluation)<br>Impact evaluation findings | BEIS staff interviews<br>Applicant interviews<br>Expert panel |
| Application | 5.1.Were the programme launches, calls and associated communications successful in reaching target audiences? Why / not? | Implementation & programme design effectiveness, relevance | Profile of applicants in each call versus that which was intended by the programme | Successful and unsuccessful applications<br>Business cases | BEIS staff interviews |
| | | | Sources from which applicants heard about the calls and reasons for applying | | Applicant interviews |
| | | | Awareness of the programmes across the wider industry | | Survey of wider industry |
| | | | Profile of attendees in | Lists of | |

 

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| | | | dissemination events | attendees | |
| | 5.2.Did the programmes receive a sufficient number and range of high-quality applications? Why / not? | Implementation & programme design effectiveness, relevance | Volume and rating of applications | Successful and unsuccessful applications | BEIS staff interviews |
| | | | Applicants' views around guidance available for developing applications | | Applicant interviews |
| | | | Applicants' views around resources required to develop the applications | | Applicant interviews |
| | | | View of experts on project quality and relevance | | Expert panel Interviews with external experts |
| | 5.3.Was the application assessment process efficient and effective? Why / not? | Implementation & programme design effectiveness, relevance | Level of resources applied to the assessment | | BEIS staff interviews |
| | | | Views of applicants and BEIS staff | | BEIS staff interviews Applicants interviews |
| | 6.2.To what extent did a coherent and appropriate portfolio of projects emerge from the three CCUS programmes? Were there any important gaps or duplications? Was there sufficient diversification of risk? | Implementation & programme design effectiveness, relevance | Assessment of gaps and overlaps in terms of CCUS stage (capture, transport, use, storage), UK geography or profile of participants | Portfolio analysis | BEIS staff intervIews Applicants interviews Expert panel Interviews with external experts |
| Monitoring and reporting | 5.4.Was the approach to risk management during projects effective? Why / not? | Implementation effectiveness | How did risk management approaches vary across programmes? | Monitoring reports | |
| | | | Views around how arising challenges during were dealt with | | BEIS staff interviews Applicants interviews |
| | 5.5.Was the programme management / monitoring efficient and effective? Why / not? | Implementation effectiveness | Were the monitoring requirements proportionate?<br>Were the monitoring reports useful and relevant? | Monitoring reports | BEIS staff interviews Applicants interviews |
| Support and guidance | 5.7.To what extent were applicants / beneficiaries satisfied with programme processes? | Implementation effectiveness, efficiency | - | Monitoring reports | BEIS staff interviews Applicants interviews |
| Decision making | [NEW] 5.8. Was governance of the programmes efficient and effective? Why / not? | Implementation effectiveness | What were the decision-making processes established?<br>What are the programme delivery staff's views on these processes? | Programme documentation | BEIS staff interviews Applicants interviews |
| Internal and external communications | 5.6.Were appropriate / sufficient mechanisms in place to share progress and insight from the programmes to support ongoing development of policy? | Relevance, design effectiveness | Existing mechanisms to promote knowledge exchange<br>Number of policy documents mentioning the CCUS programmes<br>Views of other BEIS staff of the CCUS programmes knowledge | Policy documents | BEIS staff interviews |

 

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| | | | sharing | | |
| | 6.5.Were opportunities for learning across the programmes and projects (and beyond – e.g. across BEIS policy teams and other programmes) maximised? | Relevance, effectiveness | Existing mechanisms to promote knowledge exchange | Knowledge products | BEIS staff interviews<br>Applicants interviews |
| | | | Extent to which evidence of inter and intra-programme knowledge exchange is available | | BEIS staff interviews<br>Applicants interviews |
| | | | Evidence of partnerships formed cross-project participants | | Successful applicants interviews |
| Project outputs and project effectiveness | 1.1.What is the total amount of private finance leveraged through the projects? How much of this would have been invested anyway, without the programme? | Project effectiveness | Data from projects on the total amount of private finance leveraged during the lifetime of the project | Project monitoring and reporting | Successful applicants interviews |
| | | Project effectiveness / impact | The steps leading to the investment – i.e. what attracted the investors to the project and what catalysed the investment – investor 'journey' approach | | Case study interviews with investors<br>Successful applicant interviews |
| | | Project relevance & additionality | Investor and investee (i.e. project participant) views on whether the money (and if so, how much) would have been invested anyway | | Case study interviews with investors<br>Successful applicant interviews |
| | | Project effectiveness / impact | Typical patterns for investment in similar CCUS projects | Desk-based landscape analysis | Expert panel<br>Interviews with external experts<br>Interviews with industry (including non-applicants) |
| | 1.2.Have projects provided evidence to demonstrate the development of CCUS technologies (e.g. increased TRL)?<br><br>1.3.Have projects demonstrated actual (or the potential for) cost reductions in the deployment of CCUS | Project effectiveness | Extent to which projects meet their anticipated goal – i.e. whether they manage (or not) to increase TRL or prove costs can be less or create shortcuts to (otherwise uncertain / time-consuming – and therefore costly) processes – effectiveness Q | Project monitoring and reporting | BEIS interviews<br>Successful applicants interviews |

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| | that improve upon the current state of the art? Have projects provided robust, detailed data about the costs and benefits associated with the deployment of CCUS in the UK through their technologies?<br><br>1.4.Have projects successfully demonstrated key components of CCUS (technologies, deployment, operation) to relevant stakeholders? | Project relevance | End user / target audience perspectives on what the projects have demonstrated to them / value they see in the projects | | Interviews with end-user / audiences (industry, policymakers, investors) |
| | | Project relevance | End user / target audience perspectives on what the gaps were at the outset of the project – i.e. what are the current (info / tech) gaps and uncertainties, matched with what the project set out to do | Analysis of project aims and objectives (project 'theories of change') – **for case study projects only** | Interviews with end-user / audiences (industry, policymakers, investors) |
| | | Project effectiveness / impact | Take-up of the processes, technologies, products, mechanisms outside of the CCUS project (i.e. replication, scale-up, | Monitoring and reporting | Expert panel<br>Interviews with external experts<br>Interviews with industry (including non-applicants) |
| | 1.5.Have projects contributed towards capacity building (skills development, new posts, retention of expertise, dissemination of knowledge)? | Project effectiveness / impact | # new posts paid for (or otherwise generated) through the project<br># retained posts paid for (or otherwise generated) through the project<br># outputs disseminated through the project<br># papers produced and published<br># dissemination events held<br>User satisfaction with knowledge products | Monitoring and reporting | Successful applicants interviews |
| | | | Skills and capacities developed / supported compared to pre-project | Monitoring and reporting<br>Company-level data | Successful applicants interviews |
| | | | Exploration of how the projects sought to (and managed to, according to key stakeholders) develop skills (in which areas, through what activities) | | Case study interviews with investors<br>Successful applicant interviews |
| | | | Exploration of how the projects sought to (and managed to, according to key stakeholders) create and disseminate knowledge | Analysis of event websites and comments on them<br>Monitoring and reporting<br>Feedback surveys (if exist) from events<br>Mentions of knowledge products elsewhere | Case study interviews with knowledge product users (e.g. attendees at events)<br>Successful applicant interviews<br>Interviews with external experts |

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| | 1.6.Have the programmes increased the international visibility and reputation of the UK in relation to CCUS capabilities? | Project effectiveness / impact | # international partnerships created during the project duration<br># international markets accessed<br>#international events at which the project was promoted<br>#publications and articles<br># patents created | Project documentation<br>ResearchFish | Stakeholder Consultations<br>Case studies |
| | 1.7.Have new collaborations, partnerships and networks been established? | Project effectiveness / impact | # of new collaborations, partnerships and networks established | Monitoring and reporting<br>Company-level data<br>ONS analysis?? | Successful applicants interviews<br>BEIS interviews |
| | | | Exploration of extent to which these collaborations, partnerships and networks established have been formed through the project and would not have been created otherwise | | Case study interviews with members of the networks / partners<br>Successful applicant interviews |
| | 1.8.What are the reasons for any differing levels of achievement, including for any under-achievement against expectations / intentions? | Project effectiveness / impact | | Portfolio analysis | Case study analysis<br>Successful applicants interviews<br>BEIS interviews |

## Table A1.8: Contribution analysis framework

| Index | Causal link ('contribution claim') | Mechanisms | Theory of no change | Alternative explanations | Indicators of:<br>1) achievement<br>2) mechanisms<br>3) contribution / no contribution / other contributing factors | Sources | Data strength considerations / possible limitations |
|---|---|---|---|---|---|---|---|
| 1 | ACT/ CCUD/ CCUS-I projects convince industry to deploy CCUS technologies = EQ2.1 | 1. Projects address perceived industry needs / gaps<br><br>[e.g. they address barriers to deployment (financial, regulatory, technical, operational), they demonstrate sufficient 'readiness' (FEED, etc.), and/or shows other co-benefits - e.g. how CO2 can be used (thus reducing overall operational costs), making other industrial processes less costly / more efficient].<br><br>2. Projects are of high quality / effective. [I think this can stay as a dependency only]<br><br>3. Projects disseminate knowledge / generate awareness around the technologies. | There is no / low take-up of the CCUS technologies supported.<br><br>Industries take up CCUS technologies / participate in CCUS projects, but not those supported by the CCUS programmes. | It is other factors which convince industry, such as regulatory requirements to decarbonise, cultural shifts towards decarbonisation, activities of other programmes.<br><br>For example, to date, industrial CCUS plant have been deployed more widely in other countries than in the UK. The IEA website gives a good source evidence on the global landscape (see here). Investors (including banks/fund managers with a global portfolio) as well industrial firms, will likely base their decisions on whether to invest in and build certain types of CCUS in the UK (in part at least), on evidence of their success internationally. The emerging international projects are also helping to advance the technology. Therefore, external factors such as 'successful demonstration of CCUS | Achievement *[from shorter to longer term and from 'most likely to be a direct result of programme' to 'less likely to be a direct result / likely to be only partially driven by programme]*<br>- Increasing number of industries propose projects for CCUS funding / partner with project participants<br>- Take-up of the programme-supported CCUS technologies by industrial stakeholders not involved in the project<br>- More businesses capturing CO2<br>- More businesses utilising CO2<br>- More businesses participating in large-scale transport and storage projects<br><br>Mechanisms *[investigated through process evaluation]*<br>- Extent to which project outputs address needs of industry<br>- Extent to which the projects are effective / achieve their objectives<br>- Scale and nature of dissemination / knowledge sharing activities | Achievement<br>- project results reporting<br>- programme reporting (results of interactions with industry)<br>- media analysis / literature review (for mentions of the technologies)<br>- interviews with industry<br>- other statistics on uptake of CCUS<br><br>Mechanisms<br>- project results reporting<br>- interviews with project partners<br>- interviews with BEIS<br>- analysis of programme knowledge and info outputs<br>- consultation with industry<br><br>Contribution<br>- economic barrier analysis<br>- consultation with industry<br>- case studies (that will delve into the contribution story and evidence for/against causal pathways)<br>- overview of international progress in CCUS: https://www.iea.org/fuels-and-technologies/carbon-capture-utilisation-and-storage | First, it is important to underline the scope of this EQ. We will only be investigating the extent to which the programmes have convinced industry to take up the supported technologies (not CCUS in general) - as we understand broader behaviour change is not a primary goal of the programmes. Further, such a broader impact would be highly challenging to discern given all of the other influential activities ongoing in relation to CCUS in the UK presently.<br><br>We anticipate it should be fairly easy to build an evidence base showing growth of increasing take-up of programme-supported CCUS technologies, but will be more difficult to 'prove' that the take-up was driven by the programmes (i.e. to show programme contribution). This is |

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| | | *A more tenuous mechanism to be investigated through the evaluation (as it is desired by BEIS but not explicitly enacted upon) is as follows:*<br><br>4. Projects / the programmes create demand for / a market for CCUS technologies (including those not necessarily supported by the programme).<br><br>*5. Projects involve industries directly (as grant receipients) and indirectly, building formal and informal partnerships with carbon emitters, carbon users and the wider CCUS supply chain.*<br><br>*6. Projects bring together reputable organisations investing in CCUS development, creating reassurance for other, less engaged, industries to get involved.* | | technologies internationally' could be more explicitly stated as a contributing factor to why industrial firms do or do not decide to invest in their uptake (if they reduce risks for investors).<br><br>The new UK ETS (upcoming) may be an alternative contributing factor towards stimulating investment over and above the success of projects funded by the CCUS innovation programmes. | <u>Contribution</u> *[assessed through triangulated and validated qualitative data]*<br>- The projects address specific barriers (economic, financial, political, etc.) to deployment.<br>- Industrial stakeholders report that it was because of their involvement in the CCUS programmes / interaction with (incl. awareness of) ACT/CCUD/CCUS-I projects that convinced them + further probing / evidence collection does not contradict / invalidate this or suggest that other explanations were greater.<br>- Industrial stakeholders do not explicitly state that the CCUS programme activities / ACT/CCUD/CCUS-I projects convinced them, or provide alternative explanations, but further probing / evidence collection (e.g. tracing of awareness, knowledge, attitudes, behaviours, etc.) suggests that it was a contributory factor. | | for two reasons: (1) programme-supported technologies have often been developed with funding from several sources - not only ACT / CCUS-I / CCUD - to pick apart the particular role that the programmes have played we will need to conduct in-depth qualitative analysis with the project participants; (2) there will be multiple factors at play governing industry decisions to deploy CCUS technologies - the focus will therefore be on understanding the role that the programmes' technologies played and - to the extent possible - defining how (i.e. the effective mechanisms).<br><br>To trace contribution we will take a case study approach, which will allow us to follow carefully the progression of a particular programme-supported technology, and to map the key stakeholder behaviour leading to the take-up, and also to pick apart what other factors may have driven the |

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| | | | | | | | take-up (or not).<br><br>Main limitations (additional to those outlined above) are in the scope of stakeholder consultation we will be able to conduct - i.e. it is highly unlikely we will be able to speak to all people who have been 'convinced / not convinced' by the programmes. For each case study we will need to understand the project in detail first in order to select the stakeholders we should best consult. We will also check our case study approach with BEIS and with the expert panel before starting fieldwork recruitment.<br><br>Finally, we will complement this 'deep dive' case study approach with a cross-programme 'shallower' approach of consulting wider industry to assess their views on the technologies, their take-up of the technologies and the drivers of this. |
| 2 | The ACT/ CCUD/ CCUS-I programmes grow UK | 1. Investment in projects (i.e. grants) pay for new jobs (for the duration of | UK R&I and deployment capabilities (in the areas | Capabilities grow, but this is mostly or partly driven by other factors, such as support from | <u>Achievement</u><br>- Number of people trained/able to develop and/or deploy CCUS | <u>Achievement</u><br>- project reporting<br>- project participant consultation<br>- case studies | We consider that it will be fairly straightforward to robustly measure |

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| | research, innovation and deployment capabilities = EQ3.5 | the project, which are sustained).<br><br>2. Investment in projects (i.e. grants) supports innovation / skills development which are sustained (i.e. passed onto other people within the organisation).<br><br>3. Investment in projects (i.e. grants) is spent on infrastructure [especially the CCUS-I RI] which is sustained and used for ongoing research, innovation, deployment.<br><br>4. Investment in projects (i.e. grants)supports sustainable (and productive) collaborations and partnerships = EQ3.6 | targeted by the three programmes) plateau / do not increase as much as expected. | other government programmes, universities and/or industry's own investment in such capabilities. | technologies through the projects (by type of skill - e.g. research, design, engineering, operations, procurement, legal, etc.) [output]<br>- Number of people employed in CCUS projects directly / indirectly because of the programmes [output]<br>- Number of research centres (within universities, research orgs and industry) implementing projects (pre, during and post programme) applying the RI developed through the CCUS projects [outcome]<br>- Amount of new research and/or testing infrastructure built [output]<br>- Amount of new operational infrastructure built [output]<br>- Qualitative change in capabilities (e.g. new techniques employed) [output]<br>- Evidence of sustainability (i.e. ongoing investment/funding/job positions secured and/or duration of results) [outcome]<br>- Evidence of non-sustainability (e.g. evidence that the jobs / skills / infrastructure will end with the project) [outcome]<br><br>Mechanisms *[there is some overlap between the bottom 3 bullets below and the top 2 bullets here; I'm minded to say that the mechanisms should prevail; this would* | - secondary data analysis of employment<br><br>Mechanisms<br>- project reporting<br>- project participant interviews<br>- wider academia interviews<br>- wider industry interviews<br>- case studies<br><br>Contribution<br>- case studies<br>- wider academia interviews<br>- wider industry interviews | achievement (quantitatively and qualitatively) - this will be a matter of measuring jobs created, skills supported, infrastructure set-up, etc. directly through the projects. The evidence will be strengthened through triangulation of quantitative and qualitative data.<br><br>More challenging will be how to assess sustainability. We will measure the durability of results / benefits by measuring them post project close in the final phase of the evaluation (mid 2022). However, because many of the projects will have closed less than one year before the final phase of the evaluation takes place, insufficient time may have passed for us to measure whether results have / will be sustained. We will therefore take a case-based and theory based approach to assessing sustainability - i.e. understanding at baseline 'what sustainability is expected to look like for this project' and |

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| | | | | | *mean that all indicators of achievement would be output indicators, but I think this is fine?]*<br>- Extent to which the projects create new jobs or maintain them<br>- How skills are supported<br>- How infrastructure is used (beyond the project)<br>- How partnerships are created.<br><br><u>Contribution</u><br>- Project stakeholders can demonstrate exactly how the CCUS programme funding was spent on jobs / skills / infrastructure / partnership-building<br>- Project stakeholders demonstrate that factors other than the CCUS programme had a greater role in supporting jobs / skills / infrastructure / partnership-building | | what indicators would suggest that sustainability will occur in this way, as well as picking apart the contextual factors that may / may not support sustainability. |
| 3 | The ACT/ CCUD/ CCUS-I supported technologies advance closer to deployment | 1. Deployment barrier reduction ('solving' operational problems, creating shortcuts and standardised processes, cutting red tape, enabling capture, enabling transport; thus making them technologically 'readier' and reducing costs to industry (as closer to rollout/fewer inefficiencies). = EQ3.8 + EQ 3.4 | The technologies supported (or a large proportion of them) 'stagnate' or see no pathway to deployment / follow-on finance | The technologies get closer to deployment, but this change is catalysed or more notably driven by other factors<br><br>If the lead developer firms (grant recipients of CCUS innovation programmes) have an international portfolio, then part of the advancement will be due to IP gained from their project in other countries, rather than solely through IP developed through | <u>Achievement</u> *[from shorter to longer term]*<br>- The technologies have a higher TRL than they began with<br>- The projects have an investment / business model (are bankable)<br>- The projects achieve follow-on investment = EQ 3.1<br>- CCUS-I / ACT projects that focus on components of CCUS lead to a 'pipeline of projects' = EQ3.4<br>- Key blockages in deployment are addressed = EQ3.4<br>- Industry see a use for the | <u>Achievement</u><br>- Project reporting<br>- Project team consultation<br>- Case studies (consultation with investors, if relevant)<br>- Barrier analysis / mapping<br>- Industry consultation<br><br><u>Mechanisms</u><br>- Process evaluation (design relevance analysis)<br>- case studies (relevance and coherence analysis)<br>- Programme and project reporting on dissemination<br><br><u>Contribution</u><br>- Case studies<br>- Barrier analysis | The achievement of this will be challenging to prove / robustly measure. We understand that projects make their own assessment of 'readiness' (i.e. distance to deployment), but this is subjective (no matter how independent and/or detailed the analysis). The best way we can measure this is through triangulation of multiple perspectives and |

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| | | 2. Incentivisation (identifying uses for CO2 and the technologies / processes for utilisation, demonstrating profitability).<br><br>3. 'Fundamental research' is translated into 'pilot-scale demonstration' - practical application / 'bridge-making' = EQ3.8 | | these funded projects. | technologies supported (indicated by partnerships formed, investments made, next stage of testing initiated / set-up) = EQ3.8<br><br><u>Mechanisms</u><br>- Project relevance (i.e. extent to which project design reflects needs of industry - i.e. those who will actually deploy the technology(s))<br>- Project external coherence and connectedness (e.g. ongoing consultation with industry)<br>- Dissemination / awareness-raising<br><br><u>Contribution</u><br>- The project support is critical to the observed advancement.<br>- Other factors appear to have been more critical. | | sources of data and analysis:<br>- The internal perspective from project monitoring and interviews with project teams,<br>- The external perspective from analysis of industry data on investments and consultation with industry / investors,<br>- Theory-based analysis which looks in detail (through the case studies) at the specific market barriers the projects are trying to address and then judges whether these have / have not been addressed.<br>For this particular causal link, a mini process tracing framework or alternative strength of evidence framework might provide value in strengthening the evidence. |
| 4 | The ACT/ CCUD/ CCUS-I projects contribute to stimulating wider investment in RD&I (industry, supply chain, academic) in the UK = EQ3.3 | 1. The projects derisk CCUS processes / aspects of deployment making CCUS more investable.<br><br>2. The projects demonstrate the value of investing in CCUS R&D.<br><br>3. The projects | Investment in CCUS RD&I plateaus / shows little change in the UK | There is a general trend towards greater investment in CCUS RD&I which cannot be clearly linked to the activities of the programmes AND/OR any notable increase in CCUS RD&I investment appears to be more notably driven by other factors. | <u>Achievement</u><br>'- Value (in £) of follow-on funding secured to take project further forward (KPI 6ii)<br>- Number of follow-on projects<br>- Wider investment in carbon capture, utilisation and storage over the evaluation period (and the year following the programmes' close) - as | <u>Achievement</u><br>- Programme reporting<br>- Project reporting<br>- Project team consultation<br>- Case studies (consultation with investors, if relevant)<br>- Barrier analysis / mapping<br>- Industry consultation<br>- Pitchbook and analysis in literature - e.g. https://i3connect.com/tags/carbon-capture-utilization-and-storage-ccus/757/activity<br><br><u>Mechanisms</u><br>- Process evaluation (design relevance analysis) | As with the above-described causal link, we foresee that the contribution of the programmes and projecs will be challenging to prove / robustly demonstrate, as there are so many other policies, cultural shifts, contextual factors and activities of key stakeholders |

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| | | create an infrastructure (people, research centres, R&D depts, partnerships) that is investable / stimulates / supports investment.<br><br>4. The projects bring together project developers and investors (through non-direct / direct matchmaking). | | Programmes set up by e.g. the UK Infrastructure Bank are more significant in driving change. | reported in media or via stakeholders consulted (there is no central database on such investment data)<br>- Investment trends in firms developing CCUS technologies - if projects are successful we may expect to see an increase in the volume of investments in UK firms developing CCUS, as well as in plants development through SPV project finance.<br>Projects become successful recipients of e.g. UK Investment Bank financing<br><br><u>Mechanisms</u><br>- Project effectiveness<br>- Project relevance<br>- Project results around acceleration and cost reduction<br>- Project results around infrastructure<br>- Project stakeholder / beneficiaries' views on the investability of the infrastructure created through the programmes<br>- Evidence of developers and investors being brought together through the programmes / projects<br><br><u>Contribution</u><br>- Causal links between project activities, outputs and outcomes and broader trends in CCUS RD&I investment can be traced.<br>- Non-participating industry and investors point to the programme-supported | - Project results reporting<br>- BEIS delivery team interviews<br>- Project team consultation<br>- Case studies (relevance and coherence analysis)<br><br><u>Contribution</u><br>- Case studies<br>- Contribution analysis<br>- Interviews with non-participating stakeholders<br>- LIterature on other relevant programmes - e.g. https://www.gov.uk/government/publications/policy-design-of-the-uk-infrastructure-bank and (where possible) interviews with representatives of these funds / investors | that are influencing CCUS RD&I investment decisions. The interviews with industry and other investors will explore these factors and try to discern the most / least important ones to build a narrative that will be compared to the causal chains in the theories of change. For this particular causal link, a mini process tracing framework or alternative strength of evidence framework might provide value in strengthening the evidence. |

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| | | | | | projects as being influential / catalytic in their decisions to (further) invest in RD&I technologies. | | |
| 5 | The ACT/ CCUD/ CCUS-I projects influence policy thinking on CCUS = EQ3.2 | - The projects inform Government on what works / doesn't work<br>- The projects generate data which enables Government to model scenarios more accurately<br>- The projects are effective and increase Government confidence that CCUS is worth supporting / funding<br>- The programmes bring Government closer to key stakeholders / experts who can inform their policy thinking | The programmes have no influence on Govt. There is no correlation between policy development on CCUS and the activities and/or results of the programmes. | Policy thinking moves in the direction condoned by the programmes, but this is driven by events other than the programmes.<br><br>See also cell H4 | Achievement<br>- Mentions of the programmes / projects in key policy documents / press releases<br>- Take-up of project data within Govt systems / analysis<br><br>Mechanisms<br>- Extent, scale and nature of programme and project dissemination (events, press releases, case studies, etc.)<br>- Partnerships and relationships between delivery teams and ministers (investigated through the process evaluation)<br><br>Contribution<br>- Policymakers mentions particular projects, pieces of information, and/or ways of thinking which (as evidenced elsewhere within the evaluation) have been developed through the programmes.<br>- Policymakers identify programme activities, outputs or projects as catalysing their thinking on a particular aspect of current CCUS policy.<br>- Policymakers have a low awareness of the projects / programmes and are clearly much more influenced by other programmes / events / contextual drivers. | Achievement<br>- Interviews with policymakers<br>- Review of policy and programme documentation<br><br>Mechanisms<br>- Process mapping<br>- Portfolio analysis<br>- Monitoring data (on outputs and activities)<br><br>Contribution<br>- interviews with policymakers (e.g. members of the CCUS Advisory Body, IDC Challenge Lead, etc.) | We consider that it will be possible to robustly demonstrate evidence of programme and project contribution to this outcome as long as we are able to speak to relevant policy stakeholders (ideally senior people / decision makers). Critical will also be the design of the topic guides for interview to ensure that we are collecting evidence of policymaker awareness of the CCUS programmes and projects with limited bias (e.g. by asking them more generally about the factors that are influencing them / have influenced their decision making around CCUS - similar to an outcome harvesting approach - rather than first mentioning the programmes / projects and asking about effects). We will consult with our Qualitative Research Methods team at Ipsos MORI to support quality in topic guide development. |

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| 6 | The ACT/ CCUD/ CCUS-I programmes strengthen / increase the UK's position as a global leader in CCUS = EQ4.2 | - International partnership-building<br>- The sharing of UK IP overseas<br>- The sharing of UK research and knowledge overseas<br>- Marketing of UK projects and/or infrastructure (transport, storage and capture and use technologies) to other countries | International perspectives on the relationship between UK and CCUS does not change over time and/or all of the advancements in CCUS over the time period / supported by the programme have an effect on the UK only. | It is other factors (e.g. policies, major events, large investments outside of the programmes) which drive the UK's position. | Achievement<br>- Volume of CO2 captured / used / stored (over time)<br>- Volume of research outputs / publications / knowledge outputs / events<br>- Number / % of businesses (per sector) participating in CCUS in the UK<br>- Number of 'flagship projects' supported<br>- Number of new technologies / technological advancements (compared to other countries) supported<br><br>Mechanisms<br>- Evidence of programme and project activities to make links between the UK and other countries (academics, companies, policymakers) to increase take-up of UK IP, knowledge, technologies and services linked to CCUS<br><br>Contribution<br>- All / most stakeholders are able to trace / demonstrate the causal link between the project activities and the indicators of the UK's position as a global leader.<br>- When international stakeholders / those with an international perspective comment positively on the UK's position as a CCUS leader, they are also aware of and mention the programmes as part of this.<br>- There is high/low awareness of the programmes amongst | Achievement<br>- Project monitoring<br>- Bibliometric analysis<br>- ONS data<br>- Landscape analysis<br>- Expert panel<br>- Industry consultation<br><br>Mechanisms<br>- programme reporting<br>- project reporting<br>- consultation with academia<br>- consultation with industry<br>- expert panels' views<br>- secondary data sources (on economic / financial indicators) | We are fairly confident that we will be able to find large volumes of evidence that we can triangulate to evidence achievement of this outcome.<br><br>We are also fairly confident that we will be able to demonstrate contribution, as we think it will be possible to trace direct actions of the programmes and projects to the outcome indicators.<br><br>The main limitation we foresee is the international perspective. Obviously, this outcome is about how the UK is perceived overseas, so there needs to be some consultation of CCUS stakeholders based in other countries (e.g. Norway, USA, Germany, etc.). This was not considered within the initial evaluation scoping study, but we have now added this in as a research strand. We consider that it would be valuable to consult with members of the ACT Board (if possible). We then |

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| | | | | | international actors who do not participate directly in the programmes. | | consider that our expert panel, one of whom is based in NL will be able to provide expert insights and possibly identify some other international stakeholders to speak to. We also consider that stakeholders with an international perspective (e.g. those working for global organisations - many of which are behind CCUS deployment in the industrial clusters in the UK - will be able to provide helpful insights. Nonetheless, as for causal link #1 above - i.e. we won't be able - within the scope of the study - to speak to all relevant international stakeholders - thus there will be a challenge of completeness. |

# Our standards and accreditations

Ipsos' standards and accreditations provide our clients with the peace of mind that they can always depend on us to deliver reliable, sustainable findings. Our focus on quality and continuous improvement means we have embedded a "right first time" approach throughout our organisation.

## ISO 20252

This is the international market research specific standard that supersedes BS 7911/MRQSA and incorporates IQCS (Interviewer Quality Control Scheme). It covers the five stages of a Market Research project. Ipsos was the first company in the world to gain this accreditation.

## Market Research Society (MRS) Company Partnership

By being an MRS Company Partner, Ipsos endorses and supports the core MRS brand values of professionalism, research excellence and business effectiveness, and commits to comply with the MRS Code of Conduct throughout the organisation. We were the first company to sign up to the requirements and self-regulation of the MRS Code. More than 350 companies have followed our lead.

## ISO 9001

This is the international general company standard with a focus on continual improvement through quality management systems. In 1994, we became one of the early adopters of the ISO 9001 business standard.

## ISO 27001

This is the international standard for information security, designed to ensure the selection of adequate and proportionate security controls. Ipsos was the first research company in the UK to be awarded this in August 2008.

## The UK General Data Protection Regulation (GDPR) and the UK Data Protection Act (DPA) 2018

Ipsos is required to comply with the UK GDPR and the UK DPA. It covers the processing of personal data and the protection of privacy.

## HMG Cyber Essentials

This is a government-backed scheme and a key deliverable of the UK's National Cyber Security Programme. Ipsos was assessment-validated for Cyber Essentials certification in 2016. Cyber Essentials defines a set of controls which, when properly implemented, provide organisations with basic protection from the most prevalent forms of threat coming from the internet.

## Fair Data

Ipsos is signed up as a "Fair Data" company, agreeing to adhere to 10 core principles. The principles support and complement other standards such as ISOs, and the requirements of Data Protection legislation.

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