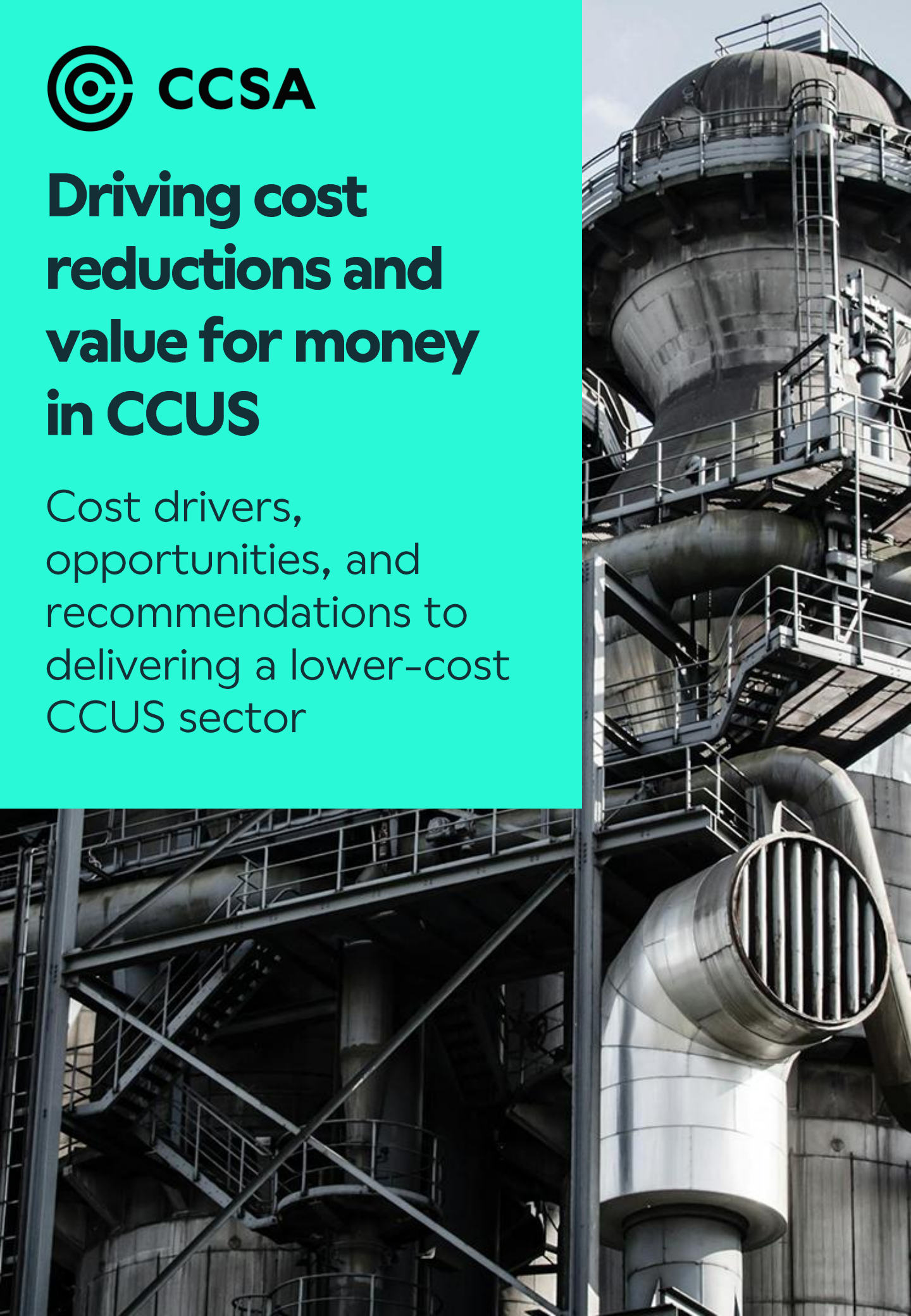
CCSA

Driving cost reductions and value for money in CCUS

Cost drivers, opportunities, and recommendations to delivering a lower-cost CCUS sector



Summary

The Carbon Capture, Storage, and Utilisation (CCUS) sector is on a commercialisation journey to create a competitive industry in international markets. The UK is playing its part in propelling the sector forward. The previous UK Government's CCUS Vision set out a pathway for this journey out to 2035, including working with industry to identify and adopt cost reduction opportunities.

The UK has a significant opportunity to be a global leader in CCUS by supporting technology development, supply chain scale up and creating clear long-term policy signals and market-based allocation rounds for industry to follow. The successful scale up of the UK's CCUS sector will depend on a combination of policy and market signals that will maximise the impact of investment in CCUS, bring down the costs to deploy, and reduce government subsidy.

The Government's recent funding commitment of £21.7bn, over 25 years, will support the development of the two Track-1 clusters, unlocking £8bn of private sector investment over the next five years and thousands of jobs in the industrial heartlands of the North of England[1]. Further support will be required to meet the UK's legally binding Carbon Budgets. Reducing the costs of deployment is critical to ensuring value for money and enabling the UK to continue to support the full scale of its CCUS ambitions.

The Carbon Capture and Storage Association (CCSA) and its members are leading on work to identify opportunities for cost reduction. This report aims to identify the main cost drivers for CCUS projects, highlight the opportunities to bring down costs and subsidy levels over time, and provide recommendations for the UK Government to realise these benefits.

The CCSA's previous recommendations for the CCUS sector remain pivotal. These include the need to take FIDs on Track-1 Cluster projects, and to provide a clear and decisive funding and action timetable for Track-2, Track-1 Expansion and the next clusters and projects that are ready. A clear longer-term route to market for subsequent projects and clusters is also essential. Continuing to deploy projects will be essential to generating the knowledge and learnings that will underpin future cost reductions. This work has identified the following additional recommendations for Government:

1. **Confirm the approach to funding allocation.** Learning from Track-1, the funding allocation process for the next immediate clusters should look to reduce the performance risk placed on emitters and drive greater full value chain optimisation, whilst ensuring no delay in the allocation process. This evolution should then also help inform the design of the regular funding allocation rounds that will be needed for longer-term projects and clusters that are necessary to give industry confidence to continue to invest.
2. **Accelerate delivery of comprehensive carbon markets both in the UK and internationally.** There are existing proposals for the expansion of the UK ETS, the implementation of a UK CBAM, and development of cross-border CO_2 transport and storage markets. These proposals should be implemented in an efficient, coordinated and timely manner across all related industries to give long-term economic signals, stimulating investment and accelerating commercialisation of the sector. A predictable UK ETS carbon price that aligns with net zero ambitions is a key signal for investors and developers. Strong support should also be given to protect sectors from carbon leakage, especially those that are not covered by the proposed UK CBAM.
3. **Deploy public finance through GB Energy and National Wealth Fund.** Targeted public finance mechanisms can help to overcome the commercial challenges facing first-of-a-kind projects, including to help mitigate risk and address public liability issues. This use of public finance can help optimise the use of government money for CCUS deployment, ensuring a sustainable funding approach that can be iterated over multiple allocation rounds. This, in turn, can help to derisk financial decisions and enable more private finance to enter the sector in the medium to longer term.

Implementing these recommendations would have wide-ranging impacts across the cost elements identified through this work. Given the importance of progressing quickly with the next round of project allocation for the next projects, the report highlights the recommendations that Government could implement now to realise the benefits as soon as possible. Additional supporting actions have been identified to implement these recommendations and drive cost reductions in the sector.

Underpinning many of the future potential cost reductions is the importance of knowledge sharing between stakeholders involved in the CCUS sector. It is essential that Government coordinate and drive the dissemination of the knowledge and insights from the Track-1 process, while not slowing government decisions on progressing projects. This is vital to enabling cost reductions for future CCUS deployment and will ensure that a greater range of developers can benefit going into future rounds.

Government can act now to bring down the cost to deploy CCUS and accelerate the commercialisation of the sector in line with the CCUS Vision. Timely action and decision-making on these recommendations is essential if cost reductions in the near term are to be realised.

1. DESNZ, *Government reignites industrial heartlands 10 days out from the International Investment Summit*, 2024

Introduction

The Carbon Capture and Storage Association (CCSA) and its members are leading on the work to identify and adopt cost reduction opportunities as set out in Department for Energy Security and Net Zero's (DESNZ) CCUS Vision published under the previous government. This work is being conducted through commissioned research, internal workstreams, and extensive member engagement.

The purpose of this analysis is to **identify cost drivers for CCUS projects, highlight opportunities for cost reduction, and provide recommendations for government to realise the benefit of these opportunities.**

Over **67** stakeholder organisations and more than **80** individuals from across the CCUS value chain were directly engaged in this analysis. This engagement included written input, multiple interviews with specific organisations, CCSA working groups, and three bespoke workshops.

The analysis covered a comprehensive list of topics set out in the diagram below. These topics examined the opportunities to either reduce costs, create a supportive policy environment, or prevent costs from rising as quickly as they might otherwise. A full description of the topics can be found in Appendix A.

Organisations directly engaged in the analysis[a]

21 Capture organisations	**12** T&S organisations	**18** EPC & technology
6 Support services[b]	**3** Academia	**7** External non-members

This report presents the findings of the engagement and analysis in three parts:

1. Cost drivers for CCUS deployment

The analysis identified cost drivers that are having an impact on current CCUS projects. These were grouped into cost drivers for project deployment, and cost drivers from policy frameworks supporting deployment.

These insights are particularly important as Track-1 allocation concludes and highlights important areas for knowledge sharing and learning for subsequent allocation rounds.

2. Opportunities for cost reductions across the CCUS value chain

The analysis identified opportunities to directly address cost drivers, reduce costs, and consider how these opportunities can be achieved. External factors such as commodity costs, energy costs, inflation etc. are significant cost drivers but are out of direct control.

The impact of these opportunities was quantified based on an aggregation of expert inputs from across the CCUS value chain. These estimates provide initial input assumptions for the CCSA's funding envelope analysis as part of its 2025 Spending Review submission.

3. Recommendations for government to deliver these cost reductions

Building on previous recommendations that the CCSA has made to government, the report arrives at three recommendations to bring down costs in the near term:

1. Refine the approach to funding allocation
2. Accelerate delivery of comprehensive carbon markets both in the UK and internationally
3. Deploy public finance through GB Energy and the National Wealth Fund

These recommendations should be supported by knowledge sharing from the Track-1 process to help drive cost reductions in the sector. A set of actions to support their implementation are outlined in Appendix C.

Analysis approach

1. Scope of study

Carbon capture

Gas power CCS | Industrial capture | Removals | Hydrogen

Transport and storage

Transport & storage

2. Identification of cost drivers and opportunities

	Topic
Reducing cost to deploy CCUS	Strengthening UK supply chains
	Research and innovation
	Contracting and procurement
	Permitting and planning
	Finance and insurance
	Funding allocation frameworks
	Skills
Level of subsidy	Carbon market frameworks
	Cross-border markets
	Other supporting markets

3. Outputs

1. **Cost drivers** for CCUS deployment
2. **Opportunities** for cost reductions across the value chain
3. **Recommendations** for government to deliver these cost reductions

Notes: a) The numbers only reflect each organisation category and should be considered non-additive; some organisations covered multiple categories; b) Includes law, consultancy, project management and other support services to the energy sector

Summary of findings and recommendations

1. Cost drivers for CCUS deployment and total cost of UK Government Subsidy

Cost drivers for project deployment

- Risk allocation in supply chain contracting
- Cliff-edge payment suspensions under capture business models
- Uncertainty and delays in permitting & planning

Cost drivers from policy and market frameworks

- Lack of predicable carbon price and market frameworks
- Barriers to full value chain collaboration
- Limited access to T&S networks
- Uncertainty in the negative emissions market

These were identified as the main drivers contributing to commercial risk and CCUS deployment costs (pages 5-6)

2. Opportunities for cost reductions across the CCUS value chain

CAPEX

- Collaborative contracting
- Cross-value chain collaboration
- Technology improvements
- Equipment specifications

OPEX

- Technology improvements
- Cross-value chain collaboration

Cost of finance

- Sector maturity and delivery at scale
- Improved risk allocation frameworks
- Collaboration with insurers

Certain CAPEX and OPEX can be reduced by up to 30% and 25% from current cost estimates by 2035 by addressing cost drivers through these opportunities (pages 7-9)

3. Recommendations for government to deliver these cost reductions

Refine the approach to funding allocation

- Incentivise value chain collaboration
- Reduce the performance risk placed on emitters

Accelerate delivery of carbon markets both in the UK and internationally

- Ensure the carbon price remains predictable
- Allow for negative emission trading
- Continue working towards a cross-border carbon market

Deploy public finance through GBE and NWF

- Reduce initial project risk
- Increase the number of projects supported
- Support development of novel technologies

Three primary recommendations are presented here as the most significant ways to realise the benefit of these opportunities and bring down costs in the near term (pages 10-12)

Supporting actions

Detailed primary and secondary actions identified to support the implementation of the recommendations for government and to drive cost reduction in the sector (see Appendix C)

Allocation of project risks are key cost drivers for project deployment

The analysis identified cost drivers that are having an impact on current cost of CCUS projects in the UK. These have been grouped into drivers for project deployment and drivers from policy and market frameworks.

These drivers largely focus on how project and commercial risks are costed in, through the project delivery approaches and policy frameworks. The focus of the analysis was also on cost drivers that can be **directly addressed**. External factors such as commodity costs, energy costs, inflation etc. are significant cost drivers but are out of direct control.

The Government's Cluster Sequencing programme and various business models enable a bankable framework that allows investors and stakeholders to share and overcome key commercial risks. However, the stakeholders involved in this process have highlighted how the framework presents certain challenges that, if overcome, could drive cost reductions and support a self-sustaining CCUS industry in the UK.

These cost drivers are highly interdependent. The greatest reductions will be achieved through addressing these simultaneously, rather than through independent selective measures.

Cost drivers for project deployment

Industry identified a need for better understanding, allocation and sharing of risks across all stakeholders involved in project development. These aspects have a significant impact on project costs, project delivery timelines, and financing.

- **Risk allocation in supply chain contracting:** CCUS projects are largely first-of-a-kind (FOAK) in nature in the UK and have a significant degree of risk as a result. The current Track-1 process can drive projects to create competitive tension in their procurement processes as a way to demonstrate value for money. This incentivises traditional competitive and fixed-cost contracting approaches. However, stakeholders outlined two potential cost drivers associated with this approach:
    - Agreeing fixed cost contracts at early stages of project development require each element of the supply chain to cost in for the uncertainty in project design and delivery timelines. These risks will be costed by each party, creating a cumulative effect.
    - Fixed fee approaches limit collaboration between parties as the project is developed. This prevents information sharing that could deliver efficiencies in how the project is designed and developed.
- **Cliff-edge payment suspensions under capture business models:** Project performance risks are largely placed on the project/facility under several of the capture business models (see Appendix B). Breaches in performance conditions can result in cliff-edge payment suspensions and contract terminations, placing additional commercial risk on projects. Whilst it is important to ensure that the government support is provided to projects that can successfully deliver CCUS, this can also result in significant risk and cost increases for developers. Projects can over-design equipment and processes to reduce performance risk and face increased financing costs due to the increased commercial risk. These issues have increased project costs across the board and inhibited the range of potential capture technologies that could be considered, as developers are only likely to take forward the lowest risk options at this stage.
- **Uncertainty and delays in permitting & planning**: Projects across the CCUS value chain (including offshore developments) face extensive challenges in securing the required permitting and planning approvals. A complex and uncertain planning, permitting and regulatory landscape creates significant delays. Projects can face up to three-year lead times to receive a Development Consent Order (DCO) or permitting approvals (see the stakeholder insight on page 6). This can impact FID and commissioning dates for many projects and add significant development expenditure (DEVEX) costs. To maintain a scheduled FID date, projects may need to submit DCOs before the concept selection process has been completed. This can result in costly DCO preparation and/or inadequate front-end loading in project design. Projects may also be encouraged to over-design process elements to ensure regulatory approval due to a lack of clear and specific goals for assessment. Permitting and planning timelines may also get worse not better, due to the high volume of energy infrastructure projects expected over the next few years.

Contracting and commercial risks are important challenges to be addressed

Cost drivers from policy and market frameworks

The UK Government has a central role to play in supporting CCUS cost reduction, and in creating markets that reduce and eventually remove the need for subsidy. The CCSA has previously highlighted the importance of UK Government providing greater certainty on funding and future allocation rounds. The CCSA's cost reduction workstream has identified further challenges for government policy that are impacting costs.

- **Lack of predictable carbon price and market frameworks**: The significant uncertainty in carbon pricing and market frameworks impacts investor confidence in the sector and directly effects the level of subsidy required to deploy CCUS. The carbon price established through the UK Emission Trading Scheme (ETS) has been particularly volatile, reaching highs of almost £100/t in 2022 before dropping sharply to just over £30/t in 2024. The price is expected to remain uncertain and volatile throughout the 2020s as further policy changes and market developments are implemented with uncertain impacts on the long-term price (see Appendix B for additional detail). Carbon leakage also remains a significant risk. Whilst several key sectors are included in the UK CBAM from 2027, several other sectors that need to deploy CCUS are not within scope. For example, decarbonising the refining sector will depend heavily on CCUS, but its products are at significant risk of carbon leakage due to its exclusion from the UK CBAM.
- **Barriers to full value chain collaboration:** The Cluster Sequencing process has limited full value chain cluster optimisation as projects were developed and negotiated independently after Phase 1 cluster selection. This has prevented knowledge sharing and collaboration between different parts of the value chain. This can result in potentially higher costs as individual project designs cannot include efficiencies from system level choices (see the case study on page 10).
- **Limited access to transport and storage (T&S) networks:** Storage access is currently limited to emitter projects connected via pipeline and selected through the Cluster Sequencing process. This small user base creates significant network utilisation risk and liabilities for UK Government. The lack of merchant access to stores, and clear policy for broadening the user base (i.e. non-pipeline transport and cross-border trading) will miss an opportunity to lower overall levelised cost of abatement for UK Plc by spreading infrastructure costs across the widest range of users. Access to a cross-border CO_2 market will be essential to enabling higher network utilisation revenues, safeguarding and creating skills and jobs, increase value for money of T&S infrastructure, and add non-subsidised revenue streams to decrease cost to government.
- **Uncertainty in the negative emissions market**: The value of negative emissions remains uncertain to developers until business model designs and ETS policy is progressed. Negative emissions present a potentially significant source of revenue for emitter projects. UK Government needs to rapidly progress its policy in this space, likely through both inclusion of negative emissions in the UK ETS and further enabling participation in voluntary markets, which will significantly reduce subsidy and help stimulate growth of new markets.

Stakeholder insight: permitting & planning

Permitting:

- Permitting processes can take up to **three years** for many projects across the value chain. Causes of delay include underdeveloped and contrasting policies between agencies, stringent emissions criteria, time to collate baseline data, and maturity of development.
- As a result, projects begin the permitting process at an early stage of project development, with potentially unrealistic or overly conservative design assumptions. Emitters are procuring increasingly complex and costly processes to reduce the risk of approval delays and meet strict emission criteria.

Planning:

- Similarly, DCO processes can take over three years for many projects and can result in significant costs. This often becomes the critical path for many developers to achieving FID.
- Although the UK Government has committed to planning reform to support housing development, there remains uncertainty around potential planning policy changes for major infrastructure projects in the UK.

Learning:

- Streamlining the planning and permitting processes can unlock significant time and resource efficiencies for projects, and enable direct and indirect cost reductions. There are several supporting actions for government and other relevant bodies to enable this (see Appendix C).

Opportunities for reducing deployment costs exist across the CCUS value chain

Building on the cost drivers identified above, the analysis also considered the potential opportunities to address these drivers, reduce costs, and identify how these opportunities can be achieved. Whilst this section focuses on the opportunities to reduce the cost of deployment, addressing these measures will also result in significant reductions in government subsidy. Specific recommendations on policy and market levers to reduce these costs is addressed in the next section.

The opportunities identified here may drive a certain level of cost reductions compared to the costs of deployment today. However, there are other external factors that may result in an overall increase in costs. For example, exposure to commodity costs, supply chain constraints, and other key market drivers.

To achieve potential cost reductions, **government will need to move quickly to deliver the next immediate clusters and projects** and provide certainty for a long-term allocation framework. Delays in project delivery will delay the learning and experience that can be generated and, therefore, the realisation of cost reductions. Policy delays will put a significant number of projects at risk of closure, relocation, and exposure to high commodity costs.

The opportunities identified are based on the experiences of the CCSA membership, both in CCUS and across similar sectors (such as oil and gas), and the analysis carried out for this report.

The analysis also reviewed the assumptions for different policy and market frameworks that support the CCUS industry (such as carbon pricing and cross-border markets). These assumptions will be discussed further as part of the 2025 Spending Review submission.

CCUS deployment costs

Potential cost reductions for capital expenditure (CAPEX), operational expenditure (OPEX), and the cost of finance were identified for different parts of the CCUS value chain. The opportunity for cost reduction was quantified at a high level for each component based on an aggregation of expert inputs from across the CCUS value chain.

The potential cost reductions that can be achieved are also highly specific to each individual project. All cost reductions are relative to current deployment cost estimates. Reduction timelines are based on projects achieving FID in either 2030 or 2035. **This largely assumes and is dependent on Track-1 and Track-2 (and other projects on the same timeline) having already been delivered by 2030.** Cost reductions for any projects post 2035 will depend on the level of future deployment and policy environment.

Driving down CAPEX

Research suggests that CAPEX currently accounts for 46% of total project spend and may increase to over 70% by 2040[2]. The analysis found that CAPEX costs for deploying capture projects in the UK can potentially decrease by 10-25% for projects achieving FID in 2030, and 15-30% for projects achieving FID in 2035 for certain cost elements.

This estimate was reached based on an aggregation and consensus of stakeholder inputs from the membership engagement process. The range in estimates reflect how cost reductions will vary according to individual project characteristics including different technologies, processes, and locations. CAPEX reductions can potentially be achieved from the following opportunities (noting that estimates for individual opportunities should not be considered as additive):

- **Collaborative contracting measures**: such contracting presents a significant opportunity to address the costs associated with passing risk down the supply chain as seen in traditional competitive contracting approaches. Potential benefits such as improved risk sharing and early information sharing between parties are seen as well suited to the FOAK nature of CCUS deployment in the UK and key to driving cost reductions. This approach to contracting is well understood in parts of the oil and gas (O&G) sector, with knowledge and toolkits that are applicable to a broad range of major infrastructure projects[3].
- **Cross-value chain collaboration:** collaboration across the value chain allows projects to share knowledge and to make cost-efficient design choices with the full value chain system in mind. For example, decisions around the condition of the CO_2 at different stages of the value chain will have implications on equipment design and corrosion control. Determining this on a collaborative basis can drive the lowest overall system cost. Industry is currently investigating the potential efficiencies and cost reductions that can be enabled through this (see the case study on page 10).
- **Technology improvements and innovation:** there are opportunities to reduce capital costs from a combination of new technologies (e.g. solvent and membrane innovation) and improvements to existing technologies (e.g. modularisation, heat networks, fully utilising existing infrastructure), particularly for capture projects. These measures can enable more efficient capture processes, equipment size reduction, and reduce supply chain costs. The applicability of novel technologies will be highly specific to individual projects and may not always lead to cost reductions.

2. Rystad Energy & OEUK, *UK oil and gas supply chain and opportunities in the energy transition*, 2024
3. ECITB, *Project Collaboration Toolkit (Edition 3)*, n.d.

- **Learning by doing**: deploying a pipeline of CCUS projects across the portfolio of project types, is essential to enabling cost reductions through generating knowledge and learning, reducing risk, and allowing the supply chain to benefit from economies of scale. Case studies identified through the Global CCS Institute show that CAPEX reductions of approximately 20% could be achieved in different capture projects by applying lessons learned from developing their projects[4]. Knowledge generated through T&S development will also be essential, although some learnings may be specific to individual stores and networks.
- **Using appropriate equipment specifications**: engineering, procurement and construction (EPC) providers for the international CCUS industry have identified the significant costs that developers are incurring by adhering to legacy equipment standards from the O&G and other sectors, that may not be required for CCUS. Differences in cost between O&G-ready and 'standard' equipment can be significant, with more than an 8-fold difference in cost for certain equipment items (see the stakeholder insight on page 9).
    - To support the development and implementation of industry standards, Government should drive the sharing of the latest R&D information and make it readily available to projects and developers (e.g. in a central repository). The sharing knowledge and information from Track-1 should be a key government focus.

Reducing OPEX

CAPEX generally contributes the largest portion of project cost, but certain OPEX will remain a significant area for potential cost reductions.

The opportunity for OPEX reductions is estimated at 5-10% by 2030, and 5-25% by 2035 for capture projects, with a lower potential reduction for T&S. This opportunity is largely driven by improvements in efficiency and process design to reduce energy consumption and feedstock costs. However, total OPEX will be highly sensitive to feedstock and energy price fluctuations.

- **Technology improvements and innovation:** the development of next generation solvents and capture technologies are expected to bring potentially significant cost reductions for different capture projects. For example, advanced solvents with lower regeneration energy and higher degradation resistance could achieve significant operational savings. Estimates on the potential OPEX savings are highly project and process specific, with estimates ranging from 5-25%. Improvements to existing processes through heat integration and enhancing process design are also key levers that are expected to enable significant operational efficiencies and cost savings.
- **Cross-value chain collaboration:** design efficiencies enabled through value chain collaboration will also allow reduction of operating costs. Removing redundant or over-specified equipment or processes will reduce both the capital and operating cost of project deployment.

Mitigating risk to reduce the cost of finance

The cost of finance is a key driver of the cost of CCUS projects. Risk and uncertainty driven by the FOAK nature of the sector is making it difficult for financiers to participate and invest, resulting in high costs of capital and overall project costs. Addressing these risks is key to driving down the cost of finance for emitters and the weighted average cost of capital (WACC) for T&S companies (T&SCos)[c]. This will also have a significant effect on the revenue support required from government.

As the sector matures, industry and government are largely aiming to bring down financing costs to that of core-plus infrastructure rates of 5-10% for CCUS projects reaching FID post 2030[d]. This target is generally applied to the sector as a whole, including both T&SCos and emitter projects. Financing costs for emitter projects are expected to achieve rates at the higher-end of the target range (compared to T&SCos), with an additional degree of variability in rates between emitter asset classes.

While financing costs for emitter projects are determined by the market's view of the relevant project risks, the T&SCos WACC will be determined by the Regulator under the T&S business model for each regulatory period. Government will have a key role to play in ensuring risks are effectively managed and allocated to help drive down the cost of finance under these business models.

A significant driver of this reduction will be the learning and experience from projects deployed from the Track-1 process. Many of these learnings will require the projects to be operational, meaning that reductions in risk will start to be seen in time for projects deploying in 2030 and beyond.

Other opportunities to help reduce the cost of finance may be realised sooner. For example, improving collaboration and risk sharing within supply chain contracts and across the value chain will drive better understanding and managing of projects risks. Addressing the challenges in policy and market frameworks can also have a significant impact on investor confidence, driving down the cost of finance.

Collaboration with insurers is also a critical part of reducing financing costs. The CCSA's engagement with the insurance community has identified the importance of early engagement and sharing information with insurers to address challenges to insurance and financing.

Notes: c) WACC represents the cost of capital where debt and equity are proportionally weighted according to what a project/company uses. Under the T&S business model, WACC is be determined by the regulator; d) Core-plus rates can be considered in the 5-10%+ range (See source 5)

4. Global CCS Institute, *Technology readiness and costs of CCS*, 2021
5. UBS, *Infrastructure: Private market education*, 2023

Cost reduction estimates against current costs across the CCUS value chain for projects achieving FID in 2030 and 2035[e]

Value chain segment

Industrial capture

Gas power CCS

Removals

Hydrogen

Cost area	Opportunities for cost reduction	2030 FID	2035 FID
CAPEX	• Collaborative contracting • Cross-value chain collaboration • Technology improvements and innovation • Learning by doing • Equipment specifications	~10-25%	~15-30%
OPEX	• Technology improvements and innovation • Cross-value chain collaboration	~5-10%	~5-25%
Financing costs	• Sector maturity and delivery at scale • Improved risk allocation frameworks • Collaboration with insurers	Aim is to bring down the cost of finance to that of core-plus infrastructure rates[f]	

Transport & storage

Cost area	Opportunities for cost reduction	2030 reduction (%)	2035 reduction (%)
CAPEX	• Collaborative contracting • Cross-value chain collaboration	~5-20%	~10-25%
OPEX	• Learning by doing • Cross-value chain collaboration	~5-10%	~5-10%
WACC	• Sector maturity, delivery at scale, and increased utilisation • Improved risk allocation frameworks • Collaboration with insurers	Aim is to bring down WACC to that of core-plus infrastructure rates[f]. This will be determined by the Regulator for each regulatory period	

Stakeholder insight: Equipment specifications

- Initial evidence from EPC providers to CCUS projects indicate that adhering to oil and gas (O&G) equipment standards can result in significantly higher costs compared to equivalent equipment with standard specifications.
- For example, EPC providers are seeing an **8-fold difference in cost** between Marine and O&G sector pumps with equivalent flow and use. Other estimates suggest that a **savings of up to 90%** on certain equipment can be achieved by avoiding legacy O&G specifications. Large variances are also being seen with more complex equipment including compressors and larger pumps.
- The National Infrastructure Commission has also identified the benefits of clear standards to enable efficiencies.[6]

Learnings:

- There is a significant opportunity for industry to reduce equipment costs by avoiding legacy equipment specifications in favour of more applicable standards, where possible. Projects should engage early with their supply chains to understand the potential cost efficiencies that can be enabled here.
- Government has an additional role to play in facilitating the sharing of the latest R&D information. This can inform the design of subsequent projects and support the implementation of industry standards and specifications in the long term.
- Traditional competitive contracting approaches limit this type of learning and knowledge sharing within the supply chain. The implementation of collaborative contracting measures will also be essential in sharing knowledge on equipment specifications and reducing costs in the future.

Notes: e) The cost reductions presented here should be considered exclusive of potential increases in commodity costs, energy prices, and other market drivers that may result in an overall increase in costs. Cost reductions are bused on assumption that Track-1 and Track-2 clusters have been delivered by 2030; f) Core-plus rates can be considered in the 5-10%+ range (See source 5)

6. National Infrastructure Commission, *Cost Drivers of major infrastructure projects in the UK*, 2024

Government should focus on three key areas to reduce costs

The CCSA continues to recommend that the UK Government **provide long term certainty and commit funding to deliver the selected Track-1, Track-2 and Track-1 Expansion projects, alongside other CCUS projects delivering on the same timescales. A clear longer-term route to market for subsequent projects and clusters is also essential**. These remain the primary recommendations to achieve cost reductions. The long-term certainty and greater levels of project deployment will generate knowledge and experience, give the supply chain the confidence to invest in CCUS, and reduce the risk in the sector. Delays to future funding allocation and policy delivery can impose significant risks on the CCUS project pipeline in the UK. This includes closure, relocation to other jurisdictions, and exposure to higher commodity costs. The implications of this will be discussed further in the CCSA 2025 Spending Review submission.

Three additional recommendations for the UK Government have been identified that can help maximise the impact of investment in CCUS, bring down the costs of deployment, and reduce government subsidy. A full set of actions to support the implementation of these recommendations is outlined in Appendix C.

Overall, the current approach to deployment is providing a bankable and deliverable path for CCUS. **Government should identify ways to action these recommendations and evolve its approach, without impacting the allocation and delivery timeline for Track-2 and Track-1 Expansion.**

The learnings presented in this report also highlight the importance of knowledge sharing between stakeholders involved in the CCUS sector. **We strongly recommend Government share the collective experiences from Track-1 to ensure that a greater range of developers can benefit from this knowledge in future rounds.**

1. Confirm the approach to funding allocation

Insights from Track-1 have identified opportunities to improve the approach to funding allocation and reduce costs. The approach to funding allocation for these next immediate projects should remain consistent with Track-1 to avoid any potential delays but be updated to improve the risk sharing between parties and drive greater full value chain optimisation. This can be achieved by:

- **Incentivising value chain collaboration**: Full value chain collaboration should be supported among project developers through all allocation stages. This will help optimise the system design and reduce the levelised cost of capture. Once clusters have been selected, there is limited opportunity for competition between the networks and emitter projects. UK Government could set clear objectives at a cluster level and then allow the cluster developers to collaboratively develop an optimised full value chain system at lowest cost.
- **Reducing the performance risk place on emitters**: Make small changes to the current CCUS business models to allow for a sliding scale of revenue support rather than cliff-edge payment suspensions in the case of unmet performance standards or delivery timelines. This would reduce the commercial risk that are placed on projects and the need for developers to over-engineer project designs. This would also reduce the risk embedded in the supply chain contracts, reducing equipment costs, financing costs, and allow for a greater range of capture technologies to be considered by developers.

The improvements made to the process for the next immediate projects will also help inform the design for the regular funding allocation rounds needed for longer-term deployment to deliver on the Government's climate ambitions.

Case study: Full Value Chain Collaboration Cost Benefits – Corrosion control

Overview

- There are currently tight specifications on the level of contaminants in CO_2 streams to control corrosion of equipment, notably for pipelines fabricated from carbon steel.
- Existing corrosion control methods include energy-intensive drying and dehydration systems at the capture facilities which have material impacts on the cost of the process.
- Several CCSA members are currently working collaboratively with the supply chain to identify suitable alternative control methods such as pipeline coatings and non-metallic liners.
- If implemented, these measures could have significant benefits for the CAPEX and OPEX at the capture facilities, and an OPEX benefit for the pipeline and reduction in leakage risk profile.

Learnings:

- Collaborative design across the value chain can enable more cost-efficient design decisions that can reduce costs for the system overall.
- Enabling and incentivising collaboration will be essential to identifying and implementing cost reductions at the early stages of sector development.

2. Accelerate delivery of comprehensive carbon markets both in the UK and internationally

A strong and comprehensive carbon market is essential for driving CCUS deployment and moving towards a commercial market. UK Government has already set out proposals for the expansion of the UK ETS, the implementation of CBAMs, and the development of cross-border CO_2 transport and storage markets. These proposals should be implemented in an efficient and timely manner to realise the benefits and to give investors the long-term economic signals to invest in CCUS deployment.

- **Ensure the UK ETS carbon price remains predictable and aligns with net zero ambitions**: Greater certainty on the trajectory of the UK ETS carbon price is needed to create a predictable long-term signal for investors and developers. This can be achieved through delivery of current planned expansions of the UK ETS, and accelerating ongoing considerations of how the scheme maybe further expanded. It is essential that the growth of the UK ETS is also supported by effective policy mechanisms to protect UK industrials from carbon leakage. In addition to the proposed CBAM in 2027, additional measures such as low carbon product standards and an emissions reporting frameworks should be implemented, as consulted on under the previous government[7]. Consideration should also be given to protect sectors that not are covered by the CBAM, such as refining, ceramics, and glass.
- **Allow for negative emission trading in the ETS and support a robust voluntary carbon market (VCM):** Unlock value from negative emissions trading through inclusion in the UK ETS and supporting use of voluntary carbon markets. UK Government has already made progress on integrating negative emissions into the UK ETS through its recent consultation. The Power BECCS and GGR business models need to be developed at pace, and CCS energy from waste projects could also reduce subsidy costs by allowing sale of the negative emissions from biogenic waste.
- **Continue working towards a cross-border carbon market with Europe**: Align with the recommendations outlined in the CCSA's report on *"Accelerating a Europe-wide CO_2 storage market"* to unlock significant benefits and cost savings for the UK[8]. Increasing the user base for UK storage networks by enabling non-pipeline transport and cross-border carbon markets would help lower the levelised cost of storage for UK emitters, mitigate network utilisation risk, and maximise network revenues, especially for infrastructure that is already committed. Cross-border markets could add non-subsidised revenue streams for UK storage networks and help support greater scale up at pace. The UK has a huge strategic asset in its carbon storage capacity that will deliver significant value beyond capturing UK-based emissions, including job creation and increase tax receipts.

7. DESNZ, *Addressing carbon leakage risk to support decarbonisation: Summary of consultation responses and government response*, 2023
8. CCSA & Xodus, *Accelerating a Europe-wide CO2 storage market*, 2024

3. Deploy public finance through GB Energy and the National Wealth Fund

The cost of finance is a significant challenge for first of a kind projects. The targeted application of public finance can play a significant role in overcoming these challenges by reducing risks taken by developers on initial investments.

The UK Government has demonstrated a clear interest in public sector investment in the energy sector. The creation of GB Energy and the National Wealth Fund (NWF) demonstrate a greater appetite going forward to leverage public finance to deliver value for money for the taxpayer and drive deployment in new energy technologies, including CCUS.

The use of public finance can optimise the use of public funds for CCUS deployment, ensuring a sustainable approach that can be iterated for regular allocation rounds and potentially provide improved value for money for the public relative to supporting projects through subsidy only. This will also help to reduce the revenue support burden, allowing UK Government to support more projects over time and mobilise more private capital to enter the sector as it develops.

There are several ways that have been identified through this work that the deployment of public finance could help deliver cost reductions and maximise the investment in CCUS over the coming years.

Reduce initial project risk

Performance standards add significant risk, especially for FOAK CCUS projects. The NWF has proposed to help mitigate this risk through financial instruments such as underwriting performance guarantees and new blended finance solutions that can help absorb some of these risks and reduce overall cost to government[9]. Given the challenges highlighted earlier that the performance standards create, this offer could have a significant impact on project development and costs.

Public liability during the initial years of operations also presents a significant barrier for the UK Government. Public finance could help de-risk projects during this first period by underwriting this liability through a variety of products (financial guarantees, first loss guarantees, mezzanine debt etc.), reducing overall project risk and catalysing deployment. To support this, government should deliver on the recommendations from the NWF Taskforce to empower the NWF to deploy catalytic capital with higher levels of risk appetite[10].

Explore how public finance can best be used to increase the number of projects supported

The UK's CCUS developers, which includes large multinational energy companies, do not face challenges in securing private capital for projects. However, the FOAK risks mean that initial projects can have high cost of finance and WACC.

High finance costs increase the required revenue support and total funding envelope required from government. This revenue support is likely to be the limiting factor for further CCUS deployment, given the fiscal constraints and competing priorities facing government.

The NWF and HMT recently set out recommendations for how NWF will deliver on its ambitions with a wide range of products and financial instruments available such as equity stakes and various forms of guarantees and debt[9].

The NWF should continue to work alongside the CCUS sector and other government departments to deploy products and blended finance solutions to either (i) reduce financing costs and the revenue support envelope for initial deployment rounds and/or (ii) facilitate long-term returns to the NWF, allowing government to support more projects overall.

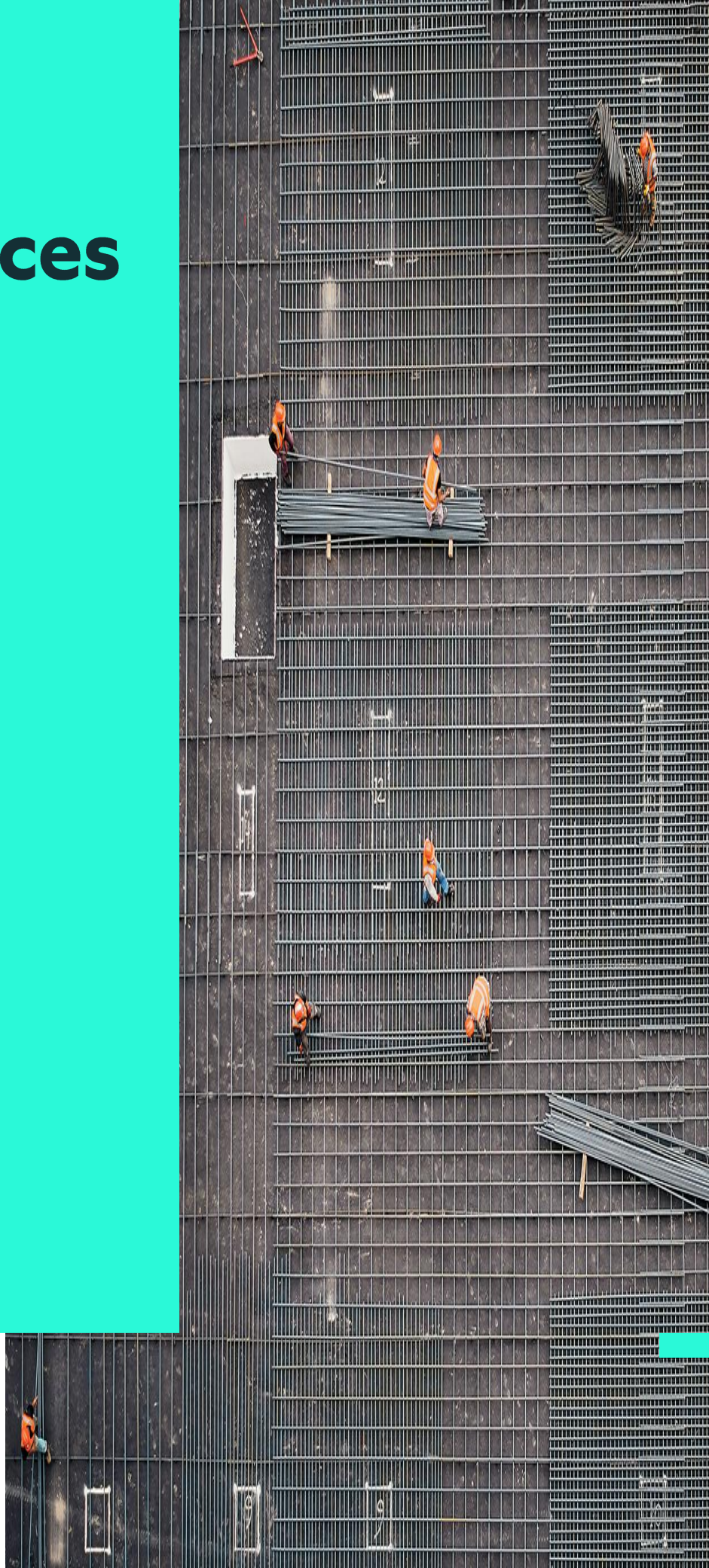
Support development of novel technologies and research hubs:

CCUS capture technology has a significant potential to reduce costs and improve capture efficiency as the sector develops. UK Government should work with industry and existing public bodies such as UK Research and Innovation (UKRI) to identify how public funding can best be used to support new capture technologies to be demonstrated, along with early-stage help with research and innovation.

This could be particularly helpful for CCUS technologies at lower levels of maturity, which will struggle to get selected by large projects due to the importance of meeting capture targets. Public finance support for demonstrators and selection of novel technologies could bring a greater range of technology choices forward, increasing the UK's knowledge base and supply chain, and potentially reducing capture costs.

10. NWF, *National Wealth Fund: Mobilising Private Investment*, 2024

Appendices



CCSA

Appendix A: analysis approach

An extensive stakeholder engagement exercise was undertaken with CCSA membership and other relevant parties to inform the outputs of this report. This analysis builds on insights from CCSA members project experience to date, as well as research carried out by members and publicly available evidence.

Analysis approach

Over 30 stakeholder organisations and more than over 50 individuals from across the CCUS value chain were directly engaged in this analysis through a combination of written input, targeted interviews, and workshops.

Stakeholders were engaged on a wide range of topics to identify comprehensive outputs on 1) cost drivers for CCUS deployment, 2) opportunities for cost reduction, and 3) recommendations to deliver these cost reductions. An overview of these topics is provided below.

Detail on the cost drivers and opportunities for cost reductions can be found on pages 7-9 in the report, and in Appendix B.

Based on this analysis, three recommendations for the UK Government were identified to address these cost drivers and achieve cost reductions in the sector (see pages 10-12). Additionally, a detailed list of supporting actions to deliver these recommendations was developed. These actions have been categorised into primary and secondary actions:

- **Primary actions:** actions that are key to implementing the recommendations outlined for government to reduce costs in the near term.
- **Secondary actions:** actions that will support the recommendations for government, but which may be achieved in the longer term or require a more mature sector.

A detailed overview of the primary actions for government can be found in pages 10-12 of the report. A full list of the actions recommended by stakeholders can be found in Appendix C.

List of topics used to identify cost drivers and opportunities with stakeholders

	Topic	Description
Reducing cost to deploy CCUS	Strengthening UK supply chains	Cost drivers, opportunities, and recommendations focused on driving cost reduction in the CCUS supply chain and positioning the UK to play a leading role in supply chain development
	Research and innovation	The role of innovation in developing new technologies and improving existing processes to drive efficiencies and cost reductions
	Contracting and procurement	Alternative contracting and procurement approaches looking to improve risk and knowledge sharing between developers and the supply chain
	Permitting and planning	The current feedback and challenges that projects are experiencing with permitting and planning and opportunities and recommendations to address them
	Finance and insurance	The cost of finance is a significant driver of the cost of CCUS projects. Identifying the challenges, opportunities and recommendations to reducing the cost of finance
	Funding allocation frameworks	Identifying potential areas for improvement in future allocation frameworks and ways to support future deployment of CCUS
	Skills	Identifying potential bottlenecks, challenges, and solutions to ensuring sufficient availability of labour and appropriate skills to fulfil deployment targets, keep costs competitive and low, and allow for further cost efficiencies
Reducing level of government subsidy	Carbon market frameworks	Frameworks and levers to support a strong, comprehensive, and international carbon market required to support the growth of the sector and a future self-sustaining CCUS market
	Cross-border markets	Building on the opportunities and recommendations outlined in the CCSA's report on "*Accelerating a Europe-wide CO_2 storage market*", engagement was undertaken looking to identify opportunities for cost reduction enabled through a cross-border market[11]
	Supporting low carbon power	Identifying potential electricity market reforms (through REMA) or other policy requirements to create market incentives and confidence for CCUS-enabled low carbon flexible power generation
	Hydrogen markets	Frameworks and levers to support a liquid and mature hydrogen market to support CCUS-enabled hydrogen producers and reduce reliance on government subsidy

11. CCSA & Xodus, *Accelerating a Europe-wide CO_2 storage market*, 2024

Appendix B: deep-dive on selected cost drivers

This section provides additional detail and context surrounding the cost drivers identified in this analysis, where relevant. This focuses on cost drivers for both project deployment and from policy and market frameworks.

Cost drivers for project deployment

Cost driver	Details	Impacts
Cliff-edge payment suspensions	Project performance risks are largely borne by the project/facility under the different CCUS business models. Performance conditions are maintained through Operational Conditions Precedents (OCPs) and Minimum Capture Rate requirements under the Industrial Carbon Capture (ICC) and Dispatchable Power Agreement (DPA) business models[12,13]. Failure to meet OCPs and performance standards around CO_2 capture rates, flow rates, and metering & measuring obligations (and several other metrics and obligations) mean that projects may only start the payment schedule late, have payments suspended, or have the contract terminated. The government intend to include similar requirements in the Power BECCS business model[14]. OCPs are also required under the Low Carbon Hydrogen Production business model, which include meeting the requirements of the Low Carbon Hydrogen Standard (LCHS). Illustrative examples of performance standards and implications of the failure to meet them are outlined in the table below.	Delayed payments, payment suspensions, and contract termination place a significant level of commercial risk on projects. This has several impacts that can increase cost including: • Over-designed equipment and processes to reduce performance risk, • Increased project risk and financing costs, • Disincentivised deployment of novel technologies

An illustrative example of capture rate performance conditions and the implications of a capture rate breach in the ICC and DPA business models (non-exhaustive)

Business model	Capture performance conditions	Implications of a Minimum CO_2 Capture Rate Breach
Industrial Carbon Capture (ICC) business model[11]	**OCP:** The emitter CO_2 capture rates must be equal to or greater than the higher of i) 85% and ii) 5% lower than the CO_2 capture rate included in the Emitter's Phase 2 application. A Minimum CO_2 Capture Rate Breach arises when the project capture rate is less than the Minimum CO_2 Capture Rate for a pre-determined number of Billing Periods[g].	**Pre-Start date:** • The emitter will not receive contractual payments until the OCPs are met (including capture rate) **Prolonged breach:** • Once a breach occurs, **payments can be suspended** if the emitter fails to submit a rectification plan, or submits an invalid rectification plan within 6 months • The **contract can be terminated** under one of a several circumstances including continued breaches or failure to implement a rectification plan
Dispatchable Power Agreement (DPA)[12]	**OCP:** The generator must demonstrate a CO_2 Capture Rate which is equal to or greater than the higher of: (i) 10% lower than the Generator's CO_2 Capture Rate Estimate; and (ii) 80%. Generators must then demonstrate a capture rate of at least 85% by the Longstop Date (one year after the end of the Target Commissioning Window). A Capture Rate Breach arises when the project capture rate is less than the Minimum CO_2 Capture Rate Average for a pre-determined number of Billing Periods[h].	**Pre-Start date:** • The generator will not receive contractual payments until the OCPs are met (including capture rate) **Prolonged breach:** • In the event of a breach the generator may be issued with a notice of termination • Failure to achieve a capture rate of **at least 85%** for three consecutive billing periods or implement a rectification can result in the **suspension of payments** or the **termination of the contract**

Note: g) The Minimum CO_2 Capture Rate is a CO_2 capture rate which is equal to or greater than the higher of (i) 10% less than the CO_2 capture rate demonstrated during OCP acceptance tests and (ii) 80%; h) The Minimum CO_2 Capture Rate Average is a CO_2 capture rate which is equal to or greater than 70% for three consecutive billing periods or three non-consecutive billing periods within 6 rolling billing periods

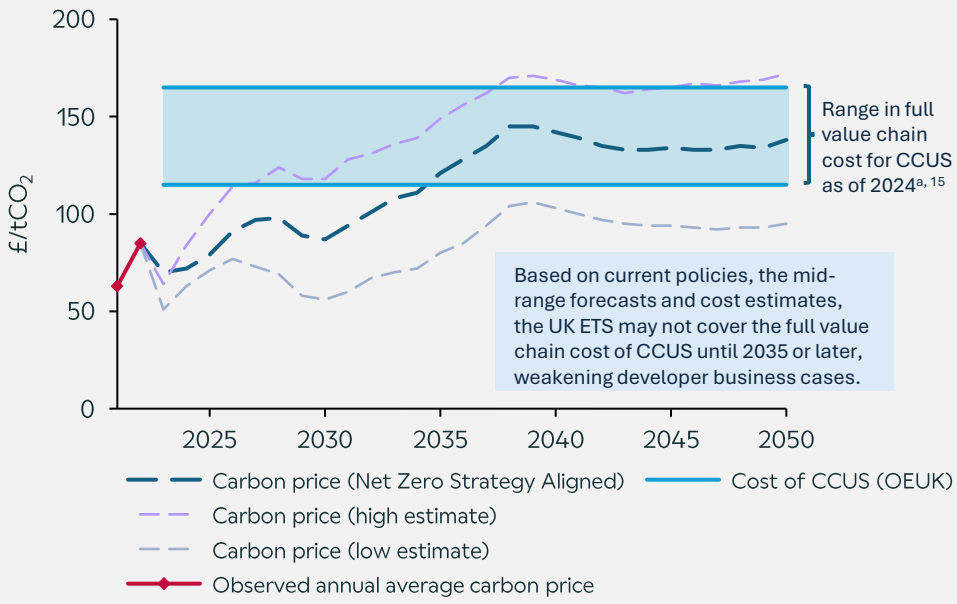
12. BEIS, *Industrial Carbon Capture business models summary*, December 2022
13. BEIS, *Dispatchable Power Agreement business model summary*, November 2022
14. BEIS, *Government response to consultation on the power Bioenergy with Carbon Capture and Storage business model*, March 2023

Appendix B: deep-dive on selected cost drivers

Cost drivers from policy and market frameworks

Cost driver	Details	Impacts
Lack of predictable carbon price and market frameworks	The long-term value of carbon capture is dependent on a carbon market that can drive commercialised deployment. The UK ETS has been highly volatile with prices fluctuating significantly since 2021. Investors and developers of CCUS projects must navigate this uncertainty alongside significant policy changes that are expected in the next few years. Measures such as the expansion of the UK ETS to include negative emissions and removing free allowances are expected to help drive CCUS deployment by ensuring coverage across the economy. UK industrials will also need to navigate the risks and uncertainties of carbon leakage. The proposed UK CBAM will help to protect several sectors from carbon leakage from 2027. However, some key sectors that will rely on CCUS for decarbonisation such as refining, glass, and ceramics are excluded from the scope of the initial UK CBAM, significantly exposing them to carbon leakage. Additional measures such as low carbon product standards and an emissions reporting frameworks should also be implemented, as consulted on under the previous government. The faster government can firm up its plans and timelines for these changes, the greater confidence industry will have on the future carbon pricing signals.	The carbon price is a key market signal to developers and investors on the long-term viability of investment in the sector. Uncertainty in trajectory of carbon pricing and market frameworks impacts investor confidence in the sector and directly effects the level of subsidy required to deploy CCUS. As outlined in the example below, a predictable carbon price is essential to driving commercialised deployment of CCUS and reduce government subsidy.

UK ETS annual average carbon price forecasts compared to indicative current estimates for the cost of carbon capture[15,16]



Overview

Current estimates of the full value chain cost of CCUS range between £115-£165/t[15].

Uncertainty and volatility in the carbon price mean that projects face significant uncertainty on when the UK ETS will support the business case for investment.

A predictable carbon price that aligns with net zero ambitions is required to support projects to deploy and help cost reductions in the sector.

Notes: a) indicative range based on OEUK estimates as of 2024; the levelized cost forecast is indicative and does not consider the effect of cost increases/decreases

15. DESNZ, *Traded carbon values used for modelling purposes*, 2023
16. OEUK, *Carbon Capture Utilisation and Storage (CCUS) Insight*, 2024

Appendix C: supporting actions

Topic	Actor	Recommendation
Strengthening UK supply chains	UK Government (DESNZ, HMT)	**Publish a clear long-term funding allocation framework for CCUS.** The government should work closely with industry to publish a clear funding allocation framework for CCUS, with a vision to 2050 and beyond. This would need to include detailed plans to incentivise investment now in the development of CO_2 stores and capture projects required post-2030, in addition to support for the projects under the Cluster Sequencing Programme. This is essential in maintaining investor confidence, preventing the loss of manufacturing jobs and meeting net zero targets.
	UK government, Public finance	**Work with industry and regulators to support high value opportunity areas in the UK supply chain**. UK industry is well placed to take advantage of several high value opportunity areas in the CCUS supply chain, identified in Arup's report on '*A Remarkable New Infrastructure System*'[17]. Supporting these areas remain highly relevant to mitigating potential supply chain constraints, supporting growth for UK industry, and enabling cost efficiencies. Key recommendations include 1) mitigating risk of EPC & engineering design constraints, 2) developing UK column assembly & heat exchanger supply chains, 3) ensuring procurement opportunities are accessible and transparent to UK companies, 4) develop UK monitoring & controls system capabilities for CCS, and 5) mitigating planning constraints.
	UK Government	**Defend and transition established supply chains to CCUS and other net zero vectors.** The UK's established supply chains and manufacturing base are well positioned to transition to CCUS and support the domestic CCUS programme. The UK Government could look to focus and tailor intervention strategies, such as the GIGA fund, on protecting and enabling the UK's existing manufacturing base and supply chain capabilities[18]. Utilising existing capacity represents a significant potential cost saving and an ability to defend and create jobs.
	UK Government Trade associations (CCSA)	**Implement Supply Chain Guiding Principles.** The CCSA has begun identifying supply chain guiding principles for the CCUS sector and are looking to work with other sectors and trade associations (e.g. OEUK, Hydrogen UK) to deliver and embed these. These guiding principles can explicitly embed a focus on sectoral cost-reduction strategies and opportunities. Backing and promotion by government of these principles will help solidify the practices that support cost efficiencies as the sector develops.
	UK Government	**Promote sector-wide initiatives**. The CCSA Good Practice Guidance Document set out a CCUS industry ambition of 50% local content target, over the project lifespan, by 2030[19]. The Government needs to add its weight to initiatives such as these and demonstrate that industry action to invest holistically in the domestic supply chain, is matched by supportive Government action.
	UK Government	**Develop supply chain bonuses and initiatives that cut across the energy landscape**. For the offshore wind sector, the recent announcement of the Clean Industry Bonus shows Government's ability to provide incentives to reward businesses who invest in local and sustainable supply chains[20]. Progress should be made towards initiatives such as these for wider sectors such as CCUS and hydrogen.
	Industry	**Engage with suppliers early in the development process.** Early engagement and negotiations with suppliers will limit the risk of cost overruns or incurring additional cost and allow suppliers to plan and invest appropriately. Undertaking a more collaborative approach to contracting suppliers will also support in reducing costs (see Contracting and Procurement).

17. Arup, *A Remarkable New Infrastructure System: Opportunities for economic growth in the UK's Carbon Capture & Storage Industry*, 2023
18. DESNZ, *Green Industries Growth Accelerator: hydrogen and CCUS supply chains*, 2024
19. CCSA, *Carbon Capture and Storage Association CCUS Supply Chain Good Practice Guidance Document*, 2023
20. DESNZ, *Contracts for Difference (CfD) Allocation Round 7: Clean Industry Bonus framework and guidance*, 2024

Key: Primary action Secondary action

Appendix C: supporting actions

Topic	Actor	Recommendation
Strengthening UK supply chains (cont.)	Industry	**Implement individual business strategies focused on driving cost reductions.** Cost reduction/optimisation can also be strongly led by individual business strategies. Companies can focus on cost reduction as a key development goal, set ambitious targets, focus on innovation, and foster a culture of cost optimisation. These strategies can be enabled by policy and wider Government initiatives and can potentially trickle into wider sectoral and supply chain costs through competition and best practice sharing.
Research and innovation	UK government (DESNZ)	**Disseminate learnings gained through the cluster sequencing process.** DESNZ is uniquely positioned to share and disseminate key knowledge and insight from the Track-1 process with the rest of the sector. DESNZ currently holds the key information and learning from Track-1. These learnings will be essential to enabling efficiencies and cost reduction in subsequent deployment rounds. This, however, should not slow decisions on delivery of the selected Track-2 and Track-1 expansion projects.
	UK Government	**Continue to provide R&D funding to support technology improvement and development.** Public funding such as through UK Research and Innovation (UKRI), the Net Zero Innovation Portfolio (NZIP) are essential to driving R&D and deployment of innovative and nascent CCUS technologies. The development of new technologies and improvements to existing processes will accelerate the adoption of more efficient projects and drive down costs. The government should work with industry and existing public bodies to identify how public funding can best be used to support new capture technologies to be demonstrated and deployed, as well as help with early-stage research and innovation.
	UK government, Public finance	**Provide early intervention support for developing technology providers and high value opportunity areas.** Providing funding or financing support to providers or developers with lower technology readiness level (TRL) technologies will accelerate the development and uptake of novel technologies. Public finance can have a potentially important role to play in supporting low-TRL providers and to focus innovation in specific areas and capture first mover advantage in the UK supply chain.
	Industry	**Avoid using legacy equipment standards from other sectors for CCUS applications.** Initial evidence from EPC providers for the international CCUS industry have identified the significant equipment costs that developers are incurring by adhering to legacy equipment standards from the O&G and other sectors, that may not be required for CCUS. Industry should engage early with the supply chain to align on equipment requirements and specifications for CCUS applications and understand the potential cost efficiencies that can be enabled here.
Contracting and procurement	UK Government (DESNZ) Industry	**Incentivise and implement collaborative contracting to optimise delivery and reduce costs.** The government should consider aligning funding frameworks with alliance contracting models, making contract templates publicly available, clarifying which contracts projects will be negotiated under, and collaborating with engineering and project management bodies to educate stakeholders on government contract types. Industry players should focus on collaborative project delivery models with shared goals, transparent communication, and monitoring of key performance indicators to mitigate risk and optimise delivery.
Allocation frameworks	UK Government (DESNZ)	**Incentivise value chain collaboration.** Full value chain collaboration should be supported among project developers to optimise the system design and reduce the levelised cost of capture. Once clusters have been selected, there is limited opportunity for competition between the networks and emitter projects. UK Government could set clear objectives at a cluster level and then allow the cluster developers to collaboratively develop an optimised full value chain system at lowest cost.

Key: Primary action Secondary action

Appendix C: supporting actions

Topic	Actor	Recommendation
Allocation frameworks (cont.)	UK Government (DESNZ)	**Reduce the performance risk placed on emitters**. Take an improved approach to risk sharing under the current business models to allow for a sliding scale of revenue support rather than cliff-edge payment suspensions in the case of unmet performance standards or delivery timelines. This would reduce the commercial risk that are placed on projects and the need for developers to over-engineer project designs. This would also reduce the risk embedded in the supply chain contracts, reducing equipment costs, financing costs, and allow for a greater range of capture technologies to be considered by developers.
Permitting and planning	UK Government (DESNZ, HMT)	**Appropriately resource planning and permitting bodies (PINS, EA, NRW, NE, etc.) to streamline planning and permitting processes.** The government should collaborate with industry and regulators to address technical permitting challenges and resource limitations. This includes accelerating DCO timelines, expanding the fast-track DCO program to relevant projects, streamlining compulsory purchase powers, including CCUS infrastructure in NSIPs for fast-tracking, conducting engagement sessions and publishing clear guidance, developing an accelerated planning route for CCS and GGR projects, and reducing excessive evidence requirements for EIA.
	Industry Permitting bodies	**Collaborate with permitting bodies to streamlining permitting processes.** Industry players should collaborate with the relevant environmental regulators, like the Environment Agency (EA) in England, to explore batch processing of applications for projects within the same cluster or using similar technologies to avoid delays to the CCUS cluster program. Additionally, streamlining the development of national Environment Assessment Levels (EALs) for use in permit applications will expedite the review process by the EA and HSA. Permitting bodies are also well-placed to develop a repository of shared environmental baseline information that could be made accessible to developers to shorten the duration of the required studies and the overall consenting cycle.
Finance & insurance	NWF UK Government	**Deploy public finance to reduce initial project risk.** Public liability during the initial years of operations presents a significant barrier for the UK Government. Public finance could help de-risk projects during this first period by underwriting this liability, reducing overall project risk and catalysing deployment.
	Industry	**Engage with insurers.** Industry players should engage insurers early in the development process (TRL 6) to overcome hurdles related to funding gaps, technical challenges, and data scarcity. Collaborating with insurers and in cross-sectors will bridge and translate data gaps to create a more attractive investment environment for CCUS projects. Additionally, analysing details on the costs of T&S connection, recurring monthly payments, and penalties for breaching the Network Code can enable project financing and insurance and accelerate the deployment of CCUS technology.
Skills and workforce	UK Government (DESNZ) Industry	**Balance the expected demand and supply of skilled labour.** To address skill shortages, the government should prioritise identifying and promoting critical areas, strategically phasing projects, targeting investments for high-demand occupations, and upskilling the workforce for seamless technology adoption. Industry players should focus on widening the recruitment pool, leveraging technology to minimise labour requirements, and collaborating with training providers on targeted training programs that provide clear career paths for trainees.
Carbon markets	UK Government	**Ensure the UK ETS carbon price remains predictable.** Greater certainty on the UK ETS carbon price is needed to create a predictable long-term signal for investors and developers. This can be achieved through delivery of current planned expansions of the UK ETS, and accelerating ongoing considerations of how the scheme maybe further expanded.

Key: Primary action Secondary action

Appendix C: supporting actions

Topic	Actor	Recommendation
Carbon markets (cont.)	UK Government	**Drive demand side action to prevent carbon leakage**. In addition to the introduction of the CBAM in 2027, government should continue to work with industry to explore the role of mandatory and voluntary product standards to grow the market for low carbon products, as outlined in government's consultation response in 2023[21]
	UK Government	**Allow for negative emission trading in the ETS and support a robust voluntary carbon market (VCM).** Unlock value from negative emissions trading through inclusion in the UK ETS and supporting use of voluntary carbon markets. UK Government has already made progress on integrating negative emissions into the UK ETS through its recent consultation. The Power BECCS and GGR business models need to be developed at pace, and CCS energy from waste projects could also reduce subsidy costs by allowing sale of the negative emissions from biogenic waste.
Cross-border markets (for full detail on recommendations, see the CCSA's recent report[22])	UK Government	**Establish a bilateral agreement between the EU & EEA and UK under the Trade and Cooperation Agreement (TCA).** Mutual recognition of each jurisdiction's CCS regulatory regime would provide a number of supporting mechanisms for cross-border trade and help establish a cross-border CO_2 market.
	UK Government	**Amend EU and UK legislation to accommodate CO_2 storage outside the EU and EEA.** Amending this legislation will help define how CO_2 stored in the UK is accounted for under the EU and UK ETS respectively.
	UK Government	**Explore the other legislative changes required to facilitate cross-border CO transport and storage**. These include arrangements for monitoring, standards, liabilities, third party access and infrastructure development
	UK Government	**Make notifications and agreements under the London Protocol**. This comprises three key requirements, including: 1) notify the International Maritime Organisation (IMO) of the intention to provisionally apply the Article 6 amendment to the London Protocol, 2) enter into bilateral agreements or arrangements on the provisional application of the above amendment, and 3) notify such an agreement or arrangement to the IMO
	UK Government	**Integrate non-pipeline transport (NPT) into the commercial and regulatory frameworks.** This will support and facilitate a greater user base for UK storage sites from both UK and European emitters which can offer network resilience and enable efficiency gains.
Supporting low carbon power	UK Government	**Finalise the updated design of capacity market under REMA**. An updated capacity market that supports low carbon flexible power generation (from CCUS, hydrogen to power, and Power BECCS), will reduce the subsidy required through the DPA.
	UK Government	**Confirm support for relevant sites beyond the end of the Renewable Obligation (RO).** Confidence also needs to be provided through confirmation of transitional support for low carbon power generation assets coming to the end of their existing Renewable Obligation contracting arrangements to help derisk further investment in such sites. This applies for generators at all sizes as they come to the end of the RO.
Hydrogen markets	UK Government	**Drive the delivery of a commercialised hydrogen sector.** Continue to drive the creation of a robust and commercialised hydrogen market through delivering the actions and milestones outlined in the Hydrogen Delivery Strategy Update under the previous government[22].

21. DESNZ, *Addressing carbon leakage risk to support Decarbonisation: Summary of consultation responses and government response* , 2023
22. CCSA & Xodus, *Accelerating a Europe-wide CO_2 storage market*, 2024
23. DESNZ, *Hydrogen Strategy Update to the Market*, December 2023

Key: Primary action Secondary action

CCSA

The Carbon Capture and Storage Association (CCSA) is the trade association focused on accelerating the commercial deployment of carbon capture, utilisation and storage (CCUS).

We work with our members, governments and other organisations to ensure CCUS is developed and deployed at the pace and scale necessary to meet net zero goals and deliver sustainable growth across regions and nations.

The CCSA has over 100 member companies who are active in exploring and developing different applications of carbon capture, CO_2 transportation by pipeline, ship and rail, utilisation, geological storage, and other permanent storage solutions, both end-users of the technology and those in the supply chain, as well as members from management, legal and financial consulting sectors.

www.ccsassociation.org