

Challenges in Executing Carbon Capture Projects in the United Kingdom

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Summary:

Global temperatures are continuing to rise year-on-year, with 2024 being the first year to exceed the 1.5°C threshold set by the Paris Agreement. Carbon capture technology has emerged as a key strategy to mitigate emissions and support the UK on its journey towards Net Zero emissions. This paper examines the development of carbon capture projects within the UK, exploring their challenges and potential impact. It reviews key carbon dioxide capture methods, transportation methods, and storage techniques, alongside the UK government's Track 1 and Track 2 initiatives. Through qualitative research, including interviews and questionnaires, this study aims to identify the challenges faced by carbon capture project development, such as infrastructure limitations, costs, and stakeholder opinions.

Keywords: Climate emergency, Net zero, Carbon Capture, and United Kingdom.

Track 30: Sustainable and Responsible Business

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Introduction

Global temperatures have been increasing since records began in 1850, with the ten warmest years all occurring since 2015 (World Meteorological Organization, 2025). This has been determined to be directly influenced by greenhouse gases emitted from anthropogenic activities (Regufe et al., 2021). In December 2015, an internationally legally binding treaty, known as the Paris Agreement, was introduced. The agreement aims to limit the increase in global temperatures to well below 2°C and ideally to 1.5°C (UNFCCC, 2020). It was confirmed by the World Meteorological Organisation (2024) that 2024 was the hottest year on record and the first year to surpass the 1.5°C threshold (World Meteorological Organization, 2025). This indicates a worrying trend of a that could lead to a permanent increase above 1.5°C and the eventual exceedance of the 2°C limit.

As defined by the United Nations (UN), climate change refers to a shift in weather patterns and global temperatures that can be caused by natural factors, such as volcanic eruptions, or human-driven activities. Burning fossil fuels is an example of an anthropogenic that releases greenhouse gases (United Nations, 2023). Data sources show a year-on-year increase in atmospheric CO₂ levels, with 2023 recording a global average concentration of 419.3 parts per million (ppm). Records since 1958 have shown annual increases, but this is the twelfth consecutive year with a significant rise of more than 2 ppm (Lindsey, 2024).

To combat this, carbon capture has been identified as one of the crucial steps needed to limit the climate impact of human activities. Carbon capture projects aim to capture carbon dioxide (CO₂) that would otherwise be released into the atmosphere, typically from fossil fuel combustion (Wu et al., 2024). This paper focuses on understanding the development of these

projects within the UK and providing insight into the challenges faced in the early stages of a carbon capture development project.

Research Methodology

The chosen research methodology involves gathering data through interviews and questionnaires. Semi-structured interviews will be conducted with select professionals on the contractor's side and potentially with representatives of key project stakeholders. This approach will provide in-depth insights from individuals directly involved in the planning and execution of the project, and potentially insights into the assessed impact on the local area. Additionally, questionnaires will be used as a supplementary data collection method, distributed to a broader audience. These may include local stakeholders, members of the wider local population, and other employees of the contractor who are engaged in the project.

By utilising a combination of interviews and questionnaires, and by ensuring a diverse participant pool, the research aims to minimise bias. This approach avoids limiting the study to only include the perspectives of those who may directly benefit from the construction of the project. For instance, local stakeholders might perceive positively the economic advantages for their community and, along with the wider public, may also appreciate the broader environmental benefits carbon capture offers, such as reduced global emissions and mitigation of global warming. But they may also have negative views about the impact on local issues such as pollution in construction, additional traffic in the area, and seeing the project as a waste of funding.

The expected outcome of this research is a comprehensive set of qualitative data that will identify current challenges within the UK's carbon capture project implementation industry and highlight any potential future issues. This information can serve as a valuable resource for the implementation of future carbon capture projects by helping to avoid recurring problems and enabling proactive planning for potential obstacles. By addressing these challenges early, the research aims to support smoother execution and greater efficiency in future projects which ultimately benefits society as there will be a greater carbon saving and a more efficient project delivery costing less money.

Findings and Discussion

Carbon capture is a technology being advanced as a vital part of the world's Net Zero goals. It aims to reduce the amount of CO₂ released into the atmosphere from industrial processes. The carbon capture process removes CO₂ from emissions and either stores it in underground storage sites or repurposes it for use in other processes (BGS, 2023). There are two main applications of carbon capture technologies: Carbon Capture and Storage (CCS) and Carbon Capture, Utilisation, and Storage (CCUS). CCS focuses solely on removing and permanently storing CO₂, whereas CCUS involves additionally repurposing the captured CO₂ (Regufe et al., 2021).

Three main approaches are currently in use for carbon capture technology: Post-combustion - capturing CO₂ from flue gases released after fossil fuel combustion; Pre-combustion - capturing CO₂ before complete combustion has taken place; Oxyfuel combustion - using pure oxygen during combustion instead of regular air to reduce CO₂ emissions (Breeze, 2015; Hanson et al., 2025).

CO₂ is transported to storage sites via pipelines, which are purpose-built to carry liquid CO₂ under pressure in its supercritical state. However, these pipelines are subject to corrosion and require costly maintenance (Kim et al., 2024). Alternatively, CO₂ can be transported to specialist pumping facilities by ship, rail, or road, though these methods have a lower capacity than pipelines (Argüello and Bokareva, 2024).

Captured carbon is often stored underground to prevent its release back into the atmosphere. Raza et al. (2019) presented a comparison of geological formations used for carbon storage (Table 1).

Table 1: geological formations used for carbon storage (Raza et al., 2019)

Geological medium	Advantage	Disadvantage
Unminable coal seams	• Large capacity • Enhanced methane production	• High cost • Not available in all region
Mined salt domes	• Custom design • Storage integrity	• High cost • Not available in all regions
Deep saline aquifers	• Large capacity • Widespread availability	• Unknown storage integrity
Active or depleted oil and gas reservoirs	• Proven storage integrity • Enhanced hydrocarbon recovery • Established infrastructure	• Not available in all regions • May not be available for immediate injection • Multiphase flow complications associated with residual hydrocarbon

Current projects planned within the UK are split into two development categories, Track 1 and Track 2. These projects were initially outlined within the government's '10 point plan' published in 2020 (UK Government, 2020).

The Track 1 category includes the HyNet Cluster and the East Coast Cluster, these are located around the northwest of England and Wales, and Teesside and Humber respectively. The Track 1 developments are planned to be operational by the mid-2020's. The Track 2 category includes the Acorn and Viking transportation and storage projects. These are sites identified off the coast of Scotland and the Lincolnshire coastline respectively. These are currently just storage sites and will be linked to future carbon capture projects (Department for Energy Security & Net Zero, 2023).

Within Figure 1, the Track 1 projects are shown with their constituent facilities. It can be seen in Figure 1 the range of carbon producing facilities that will be part of the carbon capture projects.

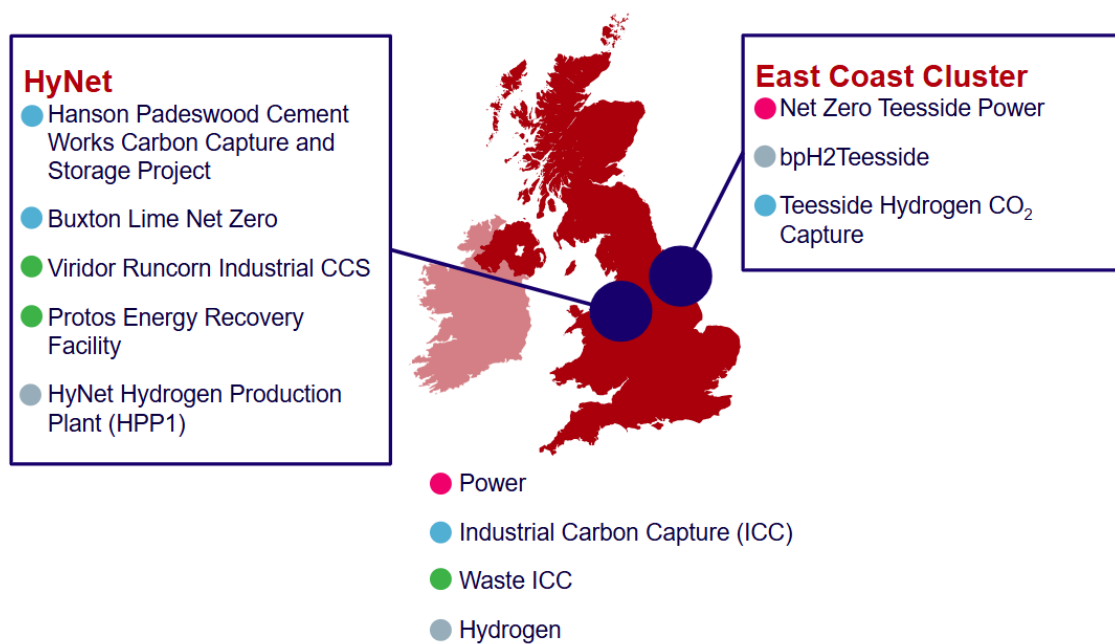


Figure 1: map showing Track 1 clusters (Department for Energy Security & Net Zero, 2023)

Current active carbon capture pilots within the UK include: Enfinium Ferrybridge: A waste burning energy production site trailing post-combustion CO₂ capture. Designed to capture 1 tonne of CO₂ each day for 12 months before scaling up the project (Enfinium, 2024). Drax power station hosted several trials in partnership with the: University of Nottingham, C-Capture, and Mitsubishi Heavy Industries. These have all been testing different post-combustion technologies (Drax, 2024, Stephenson, 2022). At present, no commercial scale projects have reached construction phase. Net Zero Teesside power is the most developed project, having announced financial close and entry into the execution phase in December 2024 (Net Zero Teesside Power, 2024).

Conclusion

In conclusion, this research aims to stress the critical role that carbon capture projects will play in reducing the amount of anthropogenic greenhouse gas emissions and achieving global climate targets. The UK government's phased approach, including Track 1 and Track 2 projects, signals a strong commitment to developing large-scale carbon capture and storage solutions. A particular focus of this paper will be the development of Net Zero Teesside in its early pre-construction stages. This research to be completed for this paper will be analysed and collated to provide a unique insight into the challenges faced by the contractor over the course of the initial project stages and bring into focus concerns stakeholder have surrounding the project. Together, this aims to provide a holistic guide on suggested best practice when establishing these projects in the future and provides insight into the UK's first experience of these projects on a large commercial scale.

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