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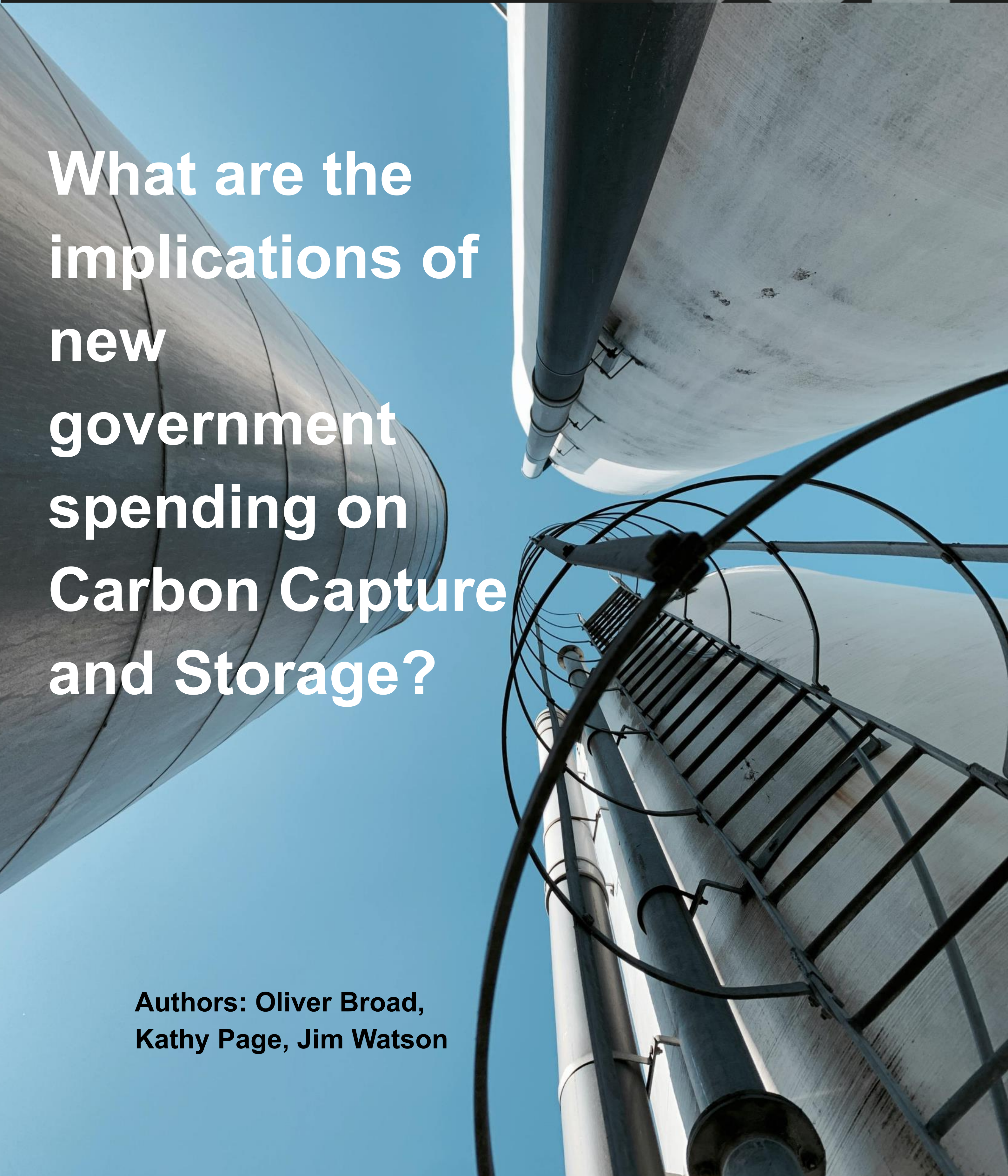
What are the implications of new government spending on Carbon Capture and Storage?



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Key Messages and Recommendations

On 4th October 2024 the government announced £21.7bn of funding to support five Carbon Capture and Storage (CCS) projects in the UK. We have examined the implications of this announcement for the government's Clean Power 2030 target, and for its broader emissions reduction goals. Our analysis leads to the following recommendations:

1. Focus on CCS outside of the power sector. Whilst CCS plants could help meet the Clean Power 2030 target, our analysis shows that this target can be met without significant CCS deployment in the power sector. Based on our results, the exception is likely to be retrofitting at least one unit of the Drax biomass plant with CCS.
2. Recognise the indirect role of CCS. Our analysis also shows that hydrogen could be required to help balance a decarbonised power sector. Whilst hydrogen can be produced from renewable electricity, our modelling indicates that hydrogen production from a mix of renewable electricity and gas with CCS could reduce costs.
3. Approach BECCS with caution. Current biomass supply chains are likely to have significant emissions associated with them. It is therefore sensible to limit reliance on BECCS, and to only scale up deployment if this can be achieved via sustainable supply chains that have low life-cycle emissions.
4. Insist that early CCS projects have high levels of monitoring and transparency. Due to the risk of biomass supply chain emissions and poor capture performance, intensive monitoring and learning is required for these projects. This will allow problems to be identified and addressed, and would help to drive further innovation.
5. Complement supply side decarbonisation with more action to reduce energy demand. This would reduce the amount of CCS required to meet emissions reduction targets.
6. Ensure value for money. The announced funding should be sufficient to support the first five projects, including spare pipeline capacity to connect further projects. However, the National Audit Office has highlighted a range of risks associated with contract negotiations, including the capacity of DESNZ to secure value for money.
7. Clarify plans for the next round of CCS projects. Follow-on projects in the UK or other countries will be required to realise wider economic benefits, including potential cost reductions. Given public spending constraints, it will be important to balance spending on CCS with other energy infrastructure funding - including for energy efficiency.

Background

Carbon capture and storage (CCS) is often identified as a key component of strategies to reduce greenhouse gas emissions, and to meet net-zero targets. The 6th carbon budget report from the Climate Change Committee (CCC) states that 75-180 million tonnes of CCS and engineered greenhouse gas removals could be required by 2050.[1]

On 4th October 2024 the government announced £21.7bn of funding to support two carbon capture and storage (CCS) clusters. The funding will be available over 25 years to support five projects: two pipeline and storage networks, a gas power CCS project, an energy from waste CCS project, and a blue hydrogen project.

The HyNet and East Coast Cluster were announced as Track-1 Carbon Capture and Storage Clusters in October 2021, with the aim of being operational by 2030. There were a total of 8 CCS projects within Track 1, split between the two clusters. Three of these eight projects have been announced as recipients of further funding (see Table 1 below).

Table 1: Information about the three industrial carbon capture projects which received funding in the 4th October 2024 announcement.

Industrial CCS project	Capacity	Pipeline size (CO_2 captured per year)	CO_2 Capture rate	Timing
Net Zero Teesside Power (NZT Power)[2]	Up to 860 MW	2 million tonnes	>95%	First commercial operations from 2027
Protos ERF[3]	49 MW	>380,000 tonnes	95% (assumed)	Operational in 2024, CCS operational later
EET Hydrogen Production Plant 1 (HPP1)[4]	350 MW	600,000 tonnes	99%[5]	Expected production start date 2027

In addition to carbon capture projects, the new funding covers the two pipeline networks associated with the clusters. The government has stated that these two networks will, together, have an initial capacity to remove 8.5 million tonnes of CO_2 per year.[6] Unlike its predecessor, the government has not yet committed to a target for CO_2 capture and storage.

Combined, the three capture projects aim to capture and store approximately 3 $MtCO_2$ per year, once fully operational. These are mitigation technologies, rather than greenhouse gas removals: they prevent part of the release of fossil carbon dioxide from these high emission activities. Their use still results in a net increase in atmospheric carbon and does nothing to remove existing carbon dioxide from the atmosphere.

This briefing sets out our analysis of this policy announcement in the context of the government's mission for Clean Power by 2030. It examines the potential impacts and implications of these initial investments in CCS clusters, and focuses on four main questions:

1. Do these plans help us meet the target of Clean Power by 2030?
2. What are the implications for the cost of electricity for consumers and industry?
3. Is the amount of government funding available likely to be sufficient to deliver these projects?
4. What could the broader benefits be for the UK, including technological learning and cost reduction for future projects? How could these benefits be realised?

Policy Context

In their manifesto, the Labour Party committed to a mission on 'clean energy' by 2030, which requires greenhouse gas emissions from the power sector to be reduced so they are close to zero. They have continued to pursue this mission whilst in government, setting up a 'Mission Control'. A Clean Power 2030 Action Plan is expected later this year.

On the 5th November 2024 the National Energy System Operator (NESO) published Clean Power 2030[7] – advice on how to achieve this mission. Their key message was that 'Clean power is a huge challenge but is achievable for Great Britain by 2030'.

In this NESO report, the definition of Clean Power by 2030 is described as 'by 2030, clean sources produce at least as much power as Great Britain consumes in total and unabated gas should provide less than 5% of Great Britain's generation in a typical weather year.'

In the analysis for this briefing, we used a stricter definition of clean power by 2030, which requires power sector emissions to fall to net-zero in 2030. In this scenario emissions in the power sector must be compensated for by removals in the power sector.

In November 2020, the then government published the Ten Point Plan for a Green Industrial Revolution[8] which included a commitment to deploy Carbon Capture, Usage and Storage (CCUS) in a minimum of two clusters by the mid-2020s, and four clusters by 2030 at the latest, with an ambition to capture 10 $MtCO_2$ per year by 2030. By April 2023, the previous government's aim had changed to 'capture 20 - 30 $MtCO_2$ per year.'[9]

So far, the current government has not yet committed to a specific target for the capture and sequestration of CO_2.

It has, however, committed to other targets regarding the generation of electricity.

In the Labour manifesto, the pledges to quadruple offshore wind and doubling onshore wind would increase installed capacity to around 90 gigawatts.

Scenario based modelling

In this analysis we have used the UK TIMES model to look at different possibilities for what the energy system could look like in 2030, and in 2050.

The UK TIMES model[10] uses linear programming to optimise the UK's future energy system evolution and future investment choices to meet energy service demand at least cost. UK TIMES is also used by the Department for Energy Security and Net Zero to inform their energy strategies and decisions about carbon targets. It is a technology rich, long-term, whole system planning model. As such it is best suited to compare long-term dynamics and trends across the full energy system, and their implications for energy supply including the power sector. It does not analyse power-sector dispatch decisions or system balancing in detail. Such analysis requires models with much higher temporal resolution than UK TIMES.

In the analysis for this briefing, we have focussed purely on engineered removal and mitigation technologies. There are additional carbon removal and storage solutions which are nature and land based, such as reforestation, the roll out of energy crops, or soil remediation. While these play a significant role in reaching net-zero by 2050, assumptions about these options is not varied across our analysis.

In order to align model baseline results, where appropriate, with what the energy system is currently expected to look like in 2030, plans for new capacity investment have been included across the full set of scenarios. This means that nuclear capacity, including the phase out of existing power plants and the planned additions of Hinkley Pont C (2030) and Sizewell C (2035) are consistently included. Similarly, we assume that Drax units are operational until their phased end of life between 2035 and 2040, and that one unit is retrofitted with carbon capture and storage (as 'Power BECCS') in 2030.

More broadly, power sector investment options across all scenarios include the technologies discussed in this briefing, and limit the availability of more speculative options until 2035 and beyond. For example, considering the current and future role that Drax is expected to play, it is unlikely that additional biomass power with CCS will be built in the UK before 2030.

The other scenarios are then compared to this baseline to analyse what has changed.

Scenario	Label	Description
Baseline	Base	Includes legislated carbon budgets and targets.
Net-zero by 2030	NZ	We have required the model to make the power system net-zero by 2030. The announced CCS projects are available in the model, but not required.
Net-zero by 2030, and CCS is inefficient	NZ ccs	We have required the model to make the power system net-zero by 2030, and we have added the constraint that CCS plants have a capture rate of 75% in 2030 (as opposed to 95% in other scenarios). The announced CCS projects are available in the model, but not required.
Net-zero by 2030, and the CCS projects are used	NZ pol	We have required the model to make the power system net-zero by 2030, and it is also required that the announced CCS projects are operational and used by 2030.
Net-zero by 2030, and the CCS projects are used, and CCS is inefficient	NZ pol ccs	We have required the model to make the power system net-zero by 2030, and it is also required that the announced CCS projects are operational and used by 2030, and we have added the constraint that CCS plants have a capture rate of 75% in 2030 (as opposed to 95% in other scenarios).

1. Will the recently funded Carbon Capture and Storage projects help us meet the target of clean power by 2030?

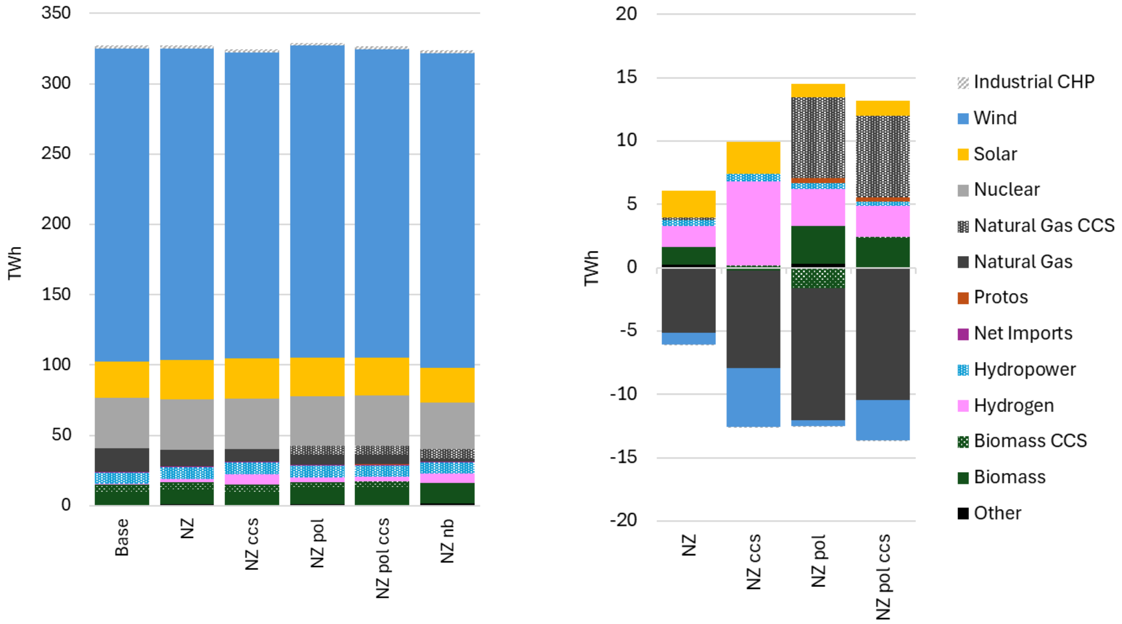

Figure 1: On the left, the electricity mix for five scenarios is shown. On the right, electricity generation in the four alternative scenarios is compared to the Baseline scenario. Areas of the bar above 0 represent technologies for which generation increased compared to the Baseline scenario; areas below 0 represent technologies for which generation decreased compared to the Baseline scenario.

Our baseline scenario includes an electricity system that generates 325 TWh in 2030, as shown in Figure 1, with the majority of the generation from wind. There is also a portion of solar, nuclear and a small amount of unabated natural gas. It includes 5 TWh of BECCS generation, but no other generation with CCS. Emissions from fossil fuel generation in this scenario are 1.6 million tonnes of CO_2 in 2030. This is lower than the 5.2 - 5.4 million tonnes emitted from fossil generation in the NESO scenarios.

The first scenario on the right of Figure 1, ‘NZ’ forces the model to achieve net-zero emissions from the power sector in 2030. This changes the least from the Baseline, but removes some of the unabated gas and a small amount of wind power, and adds a mix of other technologies, mainly solar and gas power plants burning hydrogen.

Reducing the carbon capture rate of CCS to a maximum of 75% whilst still needing to meet net-zero emissions (the second scenario, ‘NZ ccs’), reduces the amount of generation from unabated gas and wind. This time generation from gas plants burning hydrogen is added, with some additional hydropower and solar.

In the third and fourth scenario on the right hand side, we have forced the model to use the newly announced CCS projects (Table 1). They were available for the model to use in the first two scenarios, but their use was negligible – including in the ‘NZ’ scenario. This means they were not considered cost-efficient by the model, and there were cheaper ways of meeting the net-zero goal. As expected, forcing the model to use the CCS projects leads to the addition of some natural gas CCS generation (6.4 TWh) and some generation from the Protos Energy from Waste project. This causes a further reduction in unabated gas generation. In the case where capture rates are as expected (the 'NZ pol' scenario), there is also a reduction in BECCS generation. If carbon capture is less efficient than expected (the 'NZ pol ccs' scenario), BECCS generation is higher – mainly at the expense of wind generation.

An important question is whether any additional CCS projects will be needed to meet net-zero power in 2030. **Our analysis suggests that the government's target of clean power by 2030 can be met without the CCS projects that have been announced, while restricting the use of BECCS for power equivalent to (at most) one unit of the Drax plant**. There is no or negligible generation from gas CCS in the Baseline and 'NZ' scenarios, and no generation from the other government-backed CCS generation project – Protos.

Looking further ahead to 2050, all of our scenarios have some gas CCS generation in them, but the share of the generation mix is small (0.5-1%). The capacity of gas CCS plant in 2050 ranges from 600-900MW. The upper end of this range is similar to the capacity of the Teesside gas CCS plant that will be funded.

Whilst it is not the main focus of this briefing, **our scenarios suggest a more significant role for the production of hydrogen from gas with CCS**. The share of hydrogen production in 2030 ranges from 16% to 46%. In each case, a larger share is produced through electrolysis (i.e. as 'green' hydrogen). In 2050, the share of hydrogen production from gas with CCS ranges from 36% to 71%. In scenarios where CCS works less effectively, the share of green hydrogen increases.

It is also important to challenge the assumption that power-BECCS technologies will be up and running by 2030. As stated above, some BECCS generation is deployed across all five scenarios. If BECCS is not deployed, significant changes may be required elsewhere, as currently this is the only technology which compensates for unabated emissions in 2030.

Additionally, the extent to which BECCS provides negative emissions is subject to significant controversy, including about the sourcing of sustainable biomass, and accounting for supply chain emissions. Research by our ISR colleagues looked at the role of BECCS for net-zero, including modelling various efficiency levels for carbon capture and storage. From a review of existing literature, the authors found that over the BECCS supply chain stages there were expected CO_2 losses between 50 and 80%.[11] If this occurs, and supply chain emissions are not accounted for in the resulting carbon capture, **there is a risk that carbon removals will be significantly lower than expected**.

Another important consideration if CCS technologies are deployed as part of the UK strategy to meet net-zero is their performance. If they don't work as well as we expected, then more carbon capture will be required to make up the short fall, not less. This may not mean building more CCS capacity, but it would mean running these plants more.

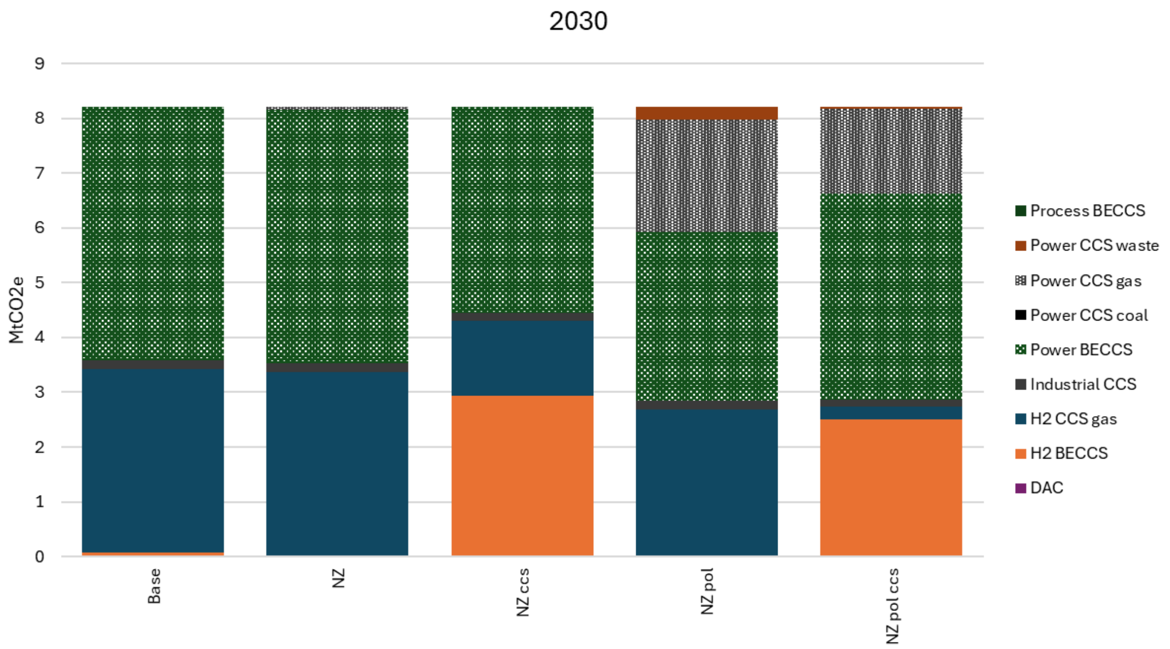

Figure 2: The amount of carbon captured and stored through engineered solutions across the scenarios. All the scenarios use the full capacity of the pipelines (limited in the model to 8.2 Mt CO_2)

Figure 2 encompasses both mitigation and removal technologies. Carbon dioxide removal technologies capture atmospheric CO_2 and return it to long-term geological storage, thus reducing CO_2 concentrations. For example, Direct Air Capture technologies, or Bioenergy with Carbon Capture and Storage (BECCS) which takes biomass and uses it to produce electricity (or another product such as hydrogen) whilst capturing the carbon used. As biomass used carbon dioxide in the air during growth, BECCS essentially 'fixes' this atmospheric carbon into longer term storage whilst producing power as a by-product.

Mitigation technologies on the other hand reduce the amount of carbon dioxide being emitted at source, capturing part of the CO_2 produced during high emission processes. For example, a gas power plant with CCS fitted produces electricity, but a share of the emissions from burning the gas are captured, making it a cleaner generation option.

The figure shows that enforcing a net-zero power sector in 2030 could have little effect on the mix of engineered removals. However once there is a limitation on the efficacy of CCS, BECCS used to make hydrogen increases at the expense of hydrogen production from gas with CCS. This is because, on the generation side, a system which has to meet net-zero power with limited efficiency of CCS increases the use of hydrogen for power at the expense of unabated gas. Producing hydrogen with BECCS, when the biomass feedstock is produced sustainably, is a negative emissions technology, where producing hydrogen with gas CCS is a net emitter.

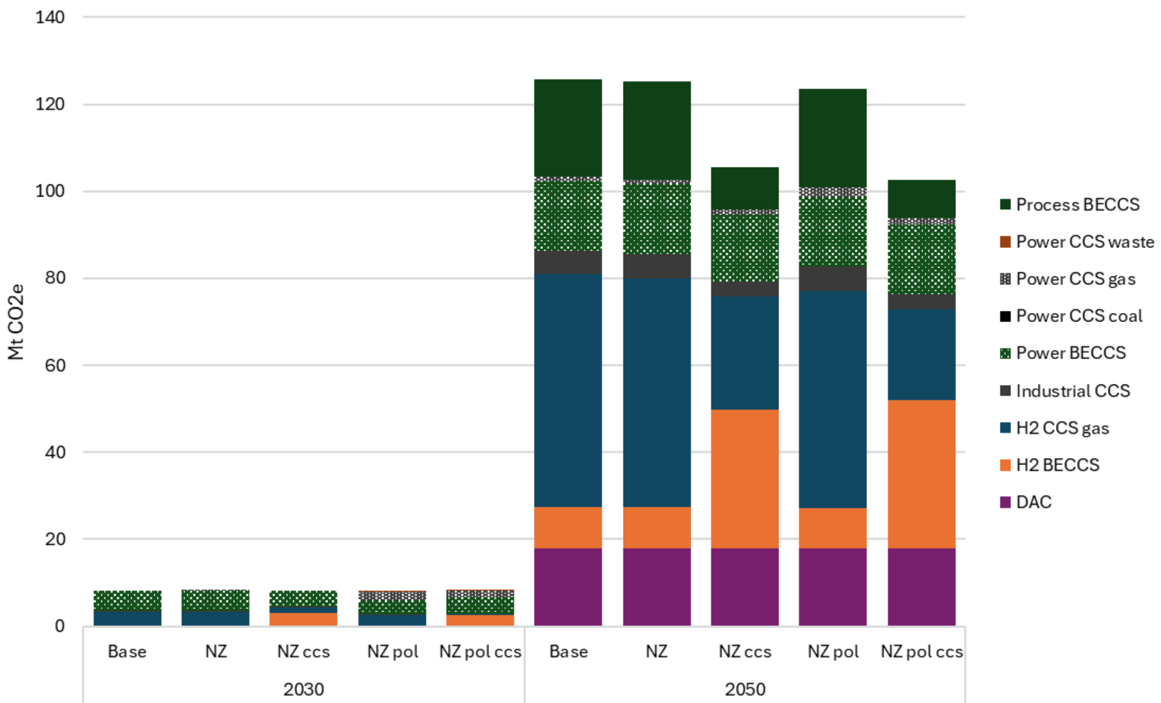

Figure 3: The amount of engineered removals per year across the modelled scenarios in 2030 (left) and 2050 (right).

In all scenarios between 100 – 130 $MtCO_2e$ of engineered carbon capture is needed by 2050 to meet net-zero. It is worth noting that this doesn't show the level of land-based solutions for removing carbon, such as reforestation, which will also help us meet net-zero.

The most used technologies across all scenarios in 2050 are hydrogen production using steam methane reforming of gas with CCS ('H2 CCS gas'), H_2 BECCS (hydrogen production from biomass with CCS), Direct Air Capture, Power-BECCS and Process BECCS (for the production of synthetic fuels). Notably, Direct Air Capture goes from zero in 2030 to 18 $MtCO_2e$ across all scenarios, making it a potentially very valuable technology if it can be successfully scaled up.

There is no real difference by 2050 between the base scenario, and the scenario where net-zero power is reached in 2030. When the CCS efficiency is limited, there is a flip from hydrogen production using gas with CCS, to hydrogen production using BECCS. This mirrors the change seen in the 2030 scenario in Figure 2. In the scenarios where CCS is less efficient, the system captures much less carbon overall by 2050.

It is clear that massive increases in CCS capacity are required in our scenarios, using a combination of technologies. The current government hasn't set any targets for the total amount of CO_2 captured and stored, either for 2030 or 2050. However, the CCC's Sixth Carbon Budget report,[12] published in December 2020, has 5 scenarios which include 75-180 million tonnes of CO_2 per year of CCS and removals by 2050.

One way to reduce the amount of engineered CCS needed is to reduce energy demand as part of a system wide transformation towards more sustainable practises. The Centre for Research into Energy Demand Solutions (CREDS) analysed various scenarios where there was a reduction in demand for energy.[13] A key finding was 'that energy demand reduction can reduce reliance on high-risk carbon dioxide removal technologies'. Their 'Steer' scenario adopts net-zero by 2050 and implements a wide range of energy efficiency options, ‘Shift’ has an additional significant shift in the attention given to energy demand strategies with an ambitious programme of interventions across the whole economy, and ‘Transform’ considers transformative change in technologies, social practices, infrastructure and institutions.

Figure 4: A graph showing the amount of carbon captured and stored using engineered removal technologies across three scenarios ‘Steer’, ‘Shift’ and ‘Transform’ over time. Taken from the Centre for Research into Energy Demand Solutions paper ‘Energy demand reduction options for meeting national zero-emission targets in the United Kingdom’

In the ‘Steer’ scenario there is an emissions gap by 2050, shown here in pink. The size of this gap suggests that even if Direct Air Capture was working at an optimistic estimated level of 29 $MtCO_2$ (as suggested in the previous government’s Net Zero Strategy[14]), it wouldn’t be enough to meet net-zero. Overall, between the least and most ambitious of the scenarios the amount of engineered CCS needed to reach net-zero ranges from just under 120 $MtCO_2$ to around 40 $MtCO_2$. Compared to both the CCC estimates and our own modelling this is a significant reduction in the need for engineered removals.

It is worth noting that particularly in the ‘Transform’ scenario, there is an increase in CO_2 sequestered through nature based solutions. This is partly because a reduction in energy demand and other changes in behaviour (such as dietary change) free up land to be utilised for carbon capture through afforestation, energy forestry and soil sequestration.

Even with all currently planned technologies working well in 2030, our scenarios include a massive step up in the total amount of carbon capture needed in 2050. **One way to reduce the amount of engineered carbon capture required in 2050 is to reduce the size of the energy system by reducing energy demand.**

2. What are the implications of the Carbon Capture and Storage projects for the cost of electricity for consumers and industry?

This is an important question that applies to many policy announcements. It is particularly relevant at a time when energy prices remain high. Determining the impacts of this announcement on consumer bills is challenging due to the number of variables and uncertainties involved. These include how the deployment of CCS would affect wholesale power prices, how regulated pipeline network charges will be paid for, and whether the costs of carbon capture contracts will be paid from taxes or levies on consumer bills.

It is possible to provide some insights about the relative costs of different scenarios:

- The total capital and operating costs of the five scenarios are very similar, though they have significant differences in the mix of CCS technologies deployed.
- Ensuring that power sector emissions reach net-zero by 2030 and requiring CCS projects to be deployed increases costs marginally
- If CCS projects are required and they operate with significantly lower capture rates, costs increase by around 0.3% compared to the baseline

It is also possible to compare the abatement cost profiles of the five scenarios over time (see Figure 5 below). This shows similar profiles over time, with slightly lower abatement costs in 2030 and 2035 for scenarios in which CCS technologies don't perform as well as expected. This is because of investment in BECCS for hydrogen production in those scenarios, to compensate for the poorer performance. Whilst this slightly reduces abatement costs in 2030 and 2035, it leads to higher abatement costs in the longer term, after 2035. It is also important to bear in mind the significantly lower volumes of carbon removal required in 2030 when compared to later time periods.

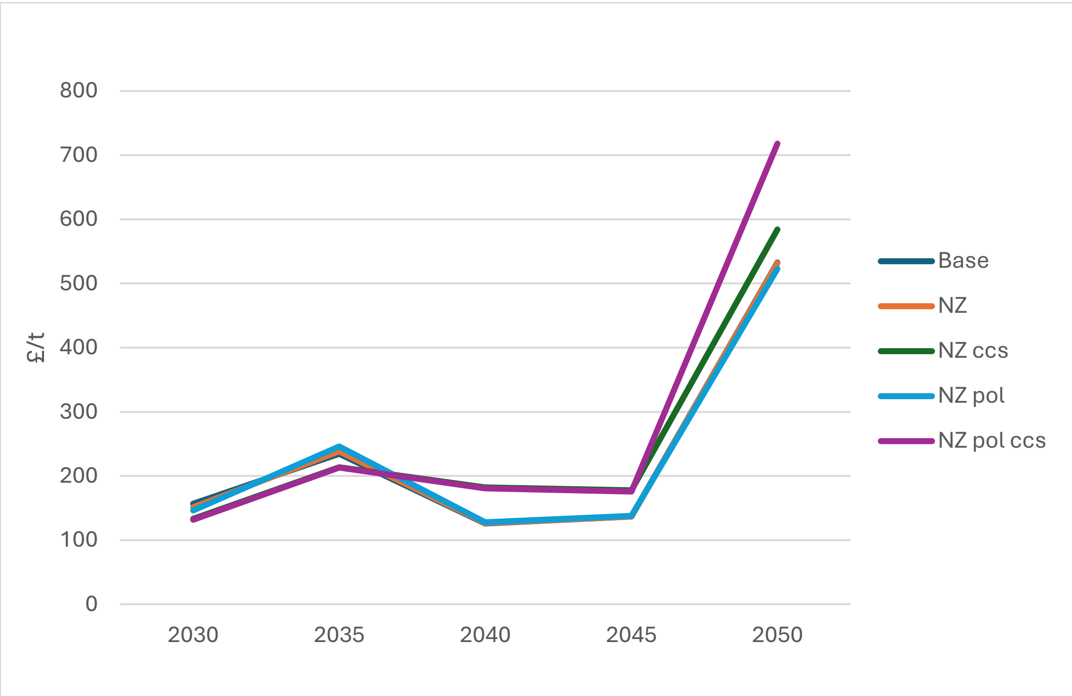

Figure 5: Marginal abatement costs of the five scenarios (£/tonne of CO_2)

3. Is the amount of government funding available likely to be sufficient to deliver these projects?

Since the original announcement, further clarification has been provided in the Autumn Budget 2025[15]: £3.9bn of the £21.7bn commitment will be spent in 2025/26. This confirms that some funding will be for a share of construction costs of capture projects and CO_2 transport and storage networks. The extensive preparatory work carried out by the last government suggests that the majority of funding would be for long-term contracts for CO_2 captured and stored[16]. Current carbon prices are not high or certain enough to pay for these costs. Licensed transport and storage networks are likely to cover their operating costs via regulated connection and use of system charges.

It is difficult to provide a precise assessment of the sufficiency of government funding due to the number of variables and unknowns involved. The costs of the three capture projects and two pipeline and storage networks will not be clear until they have been built. Whilst estimates for some of these costs are available, very few similar projects have been implemented world-wide – so any estimates need to be treated with caution.

- The Teeside gas-fired CCS power plant (NZT Power) has an estimated capital cost of £1.5bn[17].
- The Protos waste to energy plant is already under construction, without CCS. According to one estimate, retrofitting CCS could cost £150/tonne of CO_2[18].
- The developer estimates that the 'EET1' hydrogen plant will cost almost £500m[19].
- According to the developers, the first pipeline for the Hynet CO_2 pipeline and storage network could cost £121m to build, with annual operating costs of around £40m[20].
- Teeside pipeline network costs are unclear. Some news sources have quoted a cost of £4bn for the Teeside CCS power plant and CO_2 network combined[21].

Based on the available information, and taking into account uncertainties in gas, electricity and carbon prices, our judgement is that **the amount of funding available should be sufficient to cover the capital and operating costs of these projects**. However, this depends on how these uncertainties play out – and how extensive the funded networks end up being.

Investing in more extensive networks with a higher capacity for transporting and storing CO_2 would help to 'future proof' them – and enable more CO_2 to be captured and stored from subsequent projects in these two clusters. Balanced against this is the risk that networks and stores are over-sized, and that too much money is spent up front that could have been spent on other energy priorities.

A key question is whether the government has made the right choices with respect to funding capital investment to reduce UK emissions. Is the CCUS funding likely to be good value for money? This is hard to assess at this stage, but it is useful to compare the £21.7bn pledge with other announcements in the recent Autumn Budget. For example, the Budget allocated £3.4bn to heat decarbonisation and household energy efficiency schemes over three years as part of the government's Warm Homes Plan[22]. Whilst this funding could be additional to some other schemes (e.g. the Energy Company Obligation), the annual spend is not much higher than the likely annual government funding for CCS contracts.

4. What could the broader benefits be for the UK, including technological learning and cost reduction for future projects?

Despite being under development for many years, deployment of CCS at full scale is still rare. According to the latest status report from the Global CCS Institute (GCCSI), there was 50 MtCO_2e of CCS capacity in operation world-wide in 2023, plus a further 30 MtCO_2e under construction[23]. Most of this capacity is for industrial applications such as gas processing and fertiliser production. The majority of operational projects use the CO_2 captured for enhanced oil recovery, which means that they are using the CO_2 to produce more oil, which will lead to more CO_2 emissions. According to the GCCSI, current projects only provide around 11 MtCO_2e of permanent storage per year.

The new CCS projects that have been announced in the UK will have very few precedents world-wide. Given that CCS technologies are still at the early deployment stage, there should be scope for significant 'learning by doing' and cost reduction as more projects are implemented. However, this process is unlikely to be entirely smooth. It is common for the costs of early-stage technologies to rise during this stage of deployment as problems are encountered and resolved. This was the case for Flue Gas Desulphurisation technology (which has similarities to some variants of carbon capture technology) and offshore wind technology. In both cases, costs eventually fell significantly as designs standardised and the level of deployment increased[24].

The scope for CCS learning and cost reduction in the UK will also be limited by the diversity of the projects that have been chosen for funding. All three capture projects are different in scale and application. They include a power plant, a hydrogen production plant and a retrofit of a waste to energy facility. **To realise potential cost reductions, it is important that these early projects have high levels of monitoring and transparency.** This will allow problems to be identified and addressed, and would help to drive further innovation. Support for subsequent projects of a similar type in the UK and/or other countries will be required to benefit from standardisation and replication.

With respect to CO_2 pipeline and storage networks, there may also be some scope for learning and cost reduction. The UK has significant relevant capabilities in the oil and gas industry that would be applied to the deployment of these networks. These capabilities also highlight the potential for wider economic and societal benefits through the transfer of skills, and the creation of jobs and new industrial capacity. The previous government's Energy Innovation Needs Assessment for CCS concluded that the UK could benefit from up to £4.3bn of gross value added (GVA) per year by 2050. That depends on there being a large global CCS market[25]. Around half of this would come from engineering, procurement and construction management services.

[1] https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf (page 81, 'Total amount of CO_2 captured in 2050 in the scenarios')
[2] https://www.netzeroteesside.co.uk/project/
[3] https://www.protoserf.co.uk/about-the-facility/
[4] https://eethydrogen.com/projects/
[5] https://matthey.com/products-and-markets/energy/hydrogen/ccs-enabled-blue-hydrogen
[6] The Secretary of State for Energy Security and Net Zero's statement to the Commons, Monday 7th October 2024 https://hansard.parliament.uk/Commons/2024-10-07/debates/B6C03540-3DF0-4CFB-9858-8CD26B53C69F/CarbonCaptureUsageAndStorage
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[11] https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/ecf_beccs_final_report.pdf
[12] https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf
[13] https://www.nature.com/articles/s41560-022-01057-y
[14] Net Zero Strategy, page 320, Table of Illustrative characteristics in 2050, range for DACCS is 18 – 29 $MtCO_2e$ https://assets.publishing.service.gov.uk/media/6194dfa4d3bf7f0555071b1b/net-zero-strategy-beis.pdf
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[19] https://www.eetfuels.com/news/essar-project-chosen-by-the-uk-government/
[20] Cadent (2021) HyNet North West: From Vision to Reality.
[21] For example: https://www.constructionenquirer.com/2024/10/04/work-to-start-on-teesside-and-merseyside-carbon-capture-schemes/
[22] The Labour party manifesto promised £6.6bn for the Warms Home Plan over this Parliament
[23] Global CCS Institute (2023) Global Status of CCS 2023. Melbourne, Australia: GCCSI.
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[25] Vivid Economics et al (2019) Energy Innovation Needs Assessment Sub-theme report: Carbon capture, utilisation and storage. Report for BEIS.