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Institute for Energy Economics and Financial Analysis

The Runaway Cost of UK Carbon Capture and Storage Subsidies

Andrew Reid, Energy Finance Analyst, IEEFA

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Key Findings

Despite reduced carbon capture and storage (CCS) targets in the UK's most recent Carbon Budget, the reliance on this unproven and expensive technology remains a high-risk strategy.

Some £408 billion will be required by 2050 to install and operate CCS infrastructure in the UK.

More than £50 billion of subsidies has been earmarked to support projects that together only account for 8% of the UK's 2050 CCS target. About 75% of CCS subsidies will be paid by consumers through environmental levies.

Low UK carbon prices mean there is little incentive for polluters to install CCS projects.

Executive Summary

In the Seventh Carbon Budget, the UK Climate Change Committee (CCC) reduced the country's 2050 annual carbon capture and storage (CCS) target by 30% to 73 million tonnes of carbon dioxide ($MtCO_2$). CCS nonetheless remains a core pillar of the UK's net-zero pathway. The unproven and expensive technology is expected to support a 17% reduction of the UK's 2023 emissions by 2050.

The CCC forecasts that CCS will be used more for engineered removals – including biomass energy with CCS and direct air CCS – than any other sector. Engineered removals is expected to account for 45% of the UK's emissions capture and storage target by 2050, despite it being technically unproven and the highest-cost CCS solution.

Potentially £408 billion will be required over the next 25 years to install and operate CCS infrastructure within the UK. An average of £5 billion will be needed annually by 2030 to reach the CCC's 13 $MtCO_2$ CCS target for that year. This increases to an average of £19 billion per year between 2031 and 2050.

Enormous government subsidies will be required to support projects. There is little economic incentive for polluters to install CCS facilities as carbon prices in the Emissions Trading Scheme are too low. Over £50 billion of subsidies has been earmarked to support projects that together only account for 8% of the 2050 CCS target.

UK CCS subsidies will be paid for by consumers. Environmental levies that support Renewables Obligation and Contracts for Difference payments for CCS operators will be 75% financed through additional electricity bill charges. This is at a time when UK households and businesses are already struggling with high electricity prices.

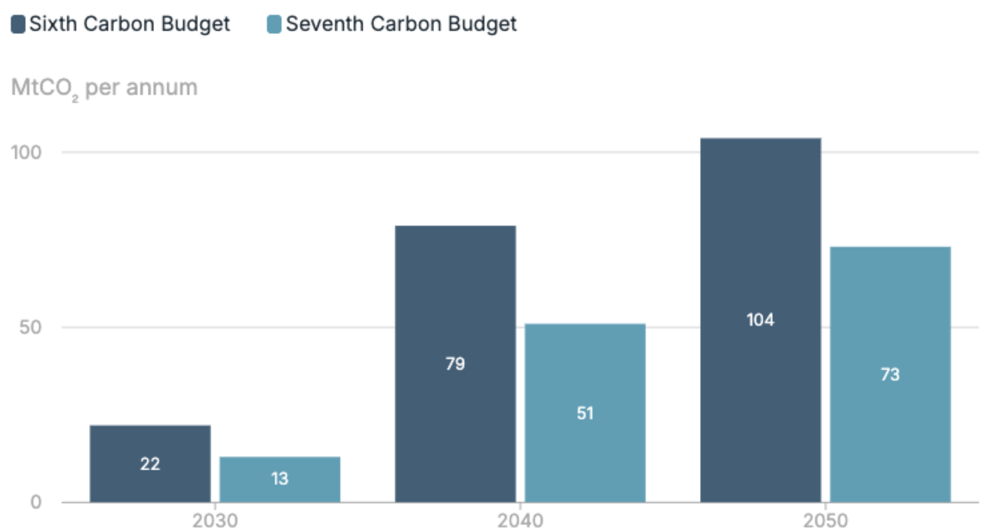
Meanwhile, polluters are being let off the hook. UK carbon prices are expected to remain low due to government-led distortions. UK Emissions Trading Scheme revenues are forecast to fall from £6 billion in the 2023-24 financial year to £1.8 billion by 2029-30. This constitutes £21 billion of lost revenues over the next six years if it had stayed at the 2023-24 price. Environmental levies are expected to increase by £23 billion over the same period.

The UK's Seventh Carbon Budget: Continued Reliance on CCS

The Climate Change Committee (CCC), an independent body that advises the UK government on climate change, released its Seventh Carbon Budget on 26 February 2025. The report outlines potential pathways and carbon reduction targets across households, transport and industrial sectors in support of net zero by 2050.

In the Sixth Carbon Budget, released in 2020, the future requirement and use of carbon capture and storage (CCS) featured heavily. It modelled that 104 million tonnes of carbon dioxide ($MtCO_2$) would need to be captured and stored annually by 2050, accounting for 20% of the UK's 2019 emissions.[1]

Figure 1: Sixth and Seventh Carbon Budget Annual CCS Targets



Source: Climate Change Committee.

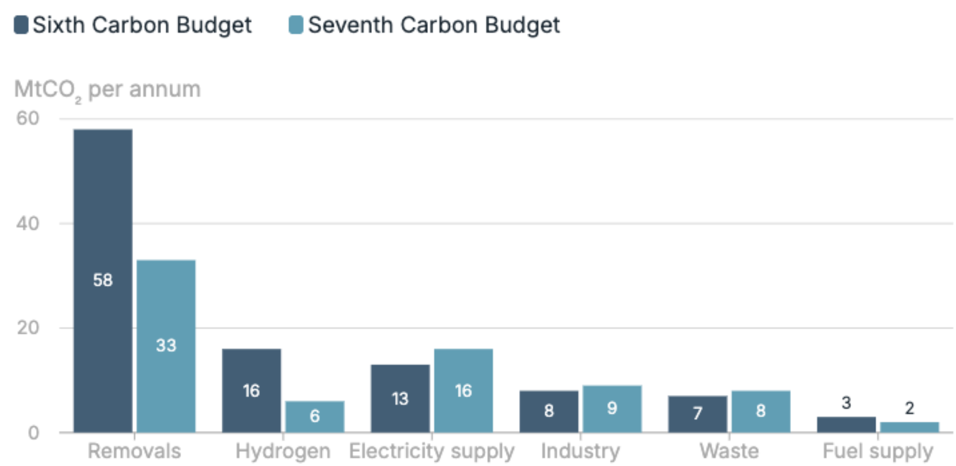
While the Seventh Carbon Budget still features CCS as a "critical solution" to meet net zero, the quantum is lower. The 2050 target has decreased by 30% to 73 $MtCO_2$ per year, which equates to 17% of the UK's 2023 emissions.[2] Shorter-term targets have also been lowered. The 2030 goal has reduced by 41% to 13 $MtCO_2$, and the 2040 target is down by 36% to 51 $MtCO_2$.

The CCC says carbon capture should be used in areas where other abatement mechanisms are unlikely to be available: chemicals, cement and lime manufacture. Targeting polluting facilities where alternative low-carbon solutions are unlikely to be available provides some justification for CCS use. The CCC classifies these sectors as "industry". Their combined capture and storage target has increased marginally from the Sixth Carbon Budget to 8.6 $MtCO_2$ per year by 2050. However, their

[1] Climate Change Committee. Sixth Carbon Budget. December 2020.
[2] Climate Change Committee. Seventh Carbon Budget. February 2025.

contribution towards overall CCS objectives is minor. They equate to only 2% of the UK's 2023 emissions and 12% of the 2050 CCS target.

Figure 2: 2050 Annual CCS Targets by Sector in Sixth and Seventh Carbon Budgets



Source: Climate Change Committee, IEEFA analysis.

CCS is also earmarked for long-term dispatchable power, low-carbon hydrogen manufacturing and to underpin engineered removals.[3] Since the last carbon budget, the reductions in CCS targets are primarily from two areas: engineered removals and hydrogen production.

The 2050 CCS target for engineered removals – comprising bioenergy with CCS (BECCS) and direct air CCS (DACCS) – has reduced by 45% compared with the Sixth Carbon Budget to 33 $MtCO_2$ per year. Despite this, it remains the largest sector for CCS use, accounting for 45% of the technology's targeted emissions reduction by 2050. The 2050 target for hydrogen (blue hydrogen, which uses fossil gas with CCS) has fallen by 59% to 6 $MtCO_2$, while that for electricity supply has increased by 25% to 16 $MtCO_2$, making it the second-largest sector, accounting for 22% of the 2050 CCS objective.

Understanding the quantum of each sector's contribution to the CCC's targets is critical in analysing the risks involved. The term "CCS" is often used holistically and suggests that all carbon capture projects are the same or similar. As CCS projects have been in operation within the oil and gas sector since the 1970s, the implied assumption is that the technology and its application are mature. Nothing could be further from the truth. In reality, the carbon capture technologies used across each sector are different, have wildly differing cost structures and are at various stages of technological maturity.

[3] Climate Change Committee. Seventh Carbon Budget. February 2025.

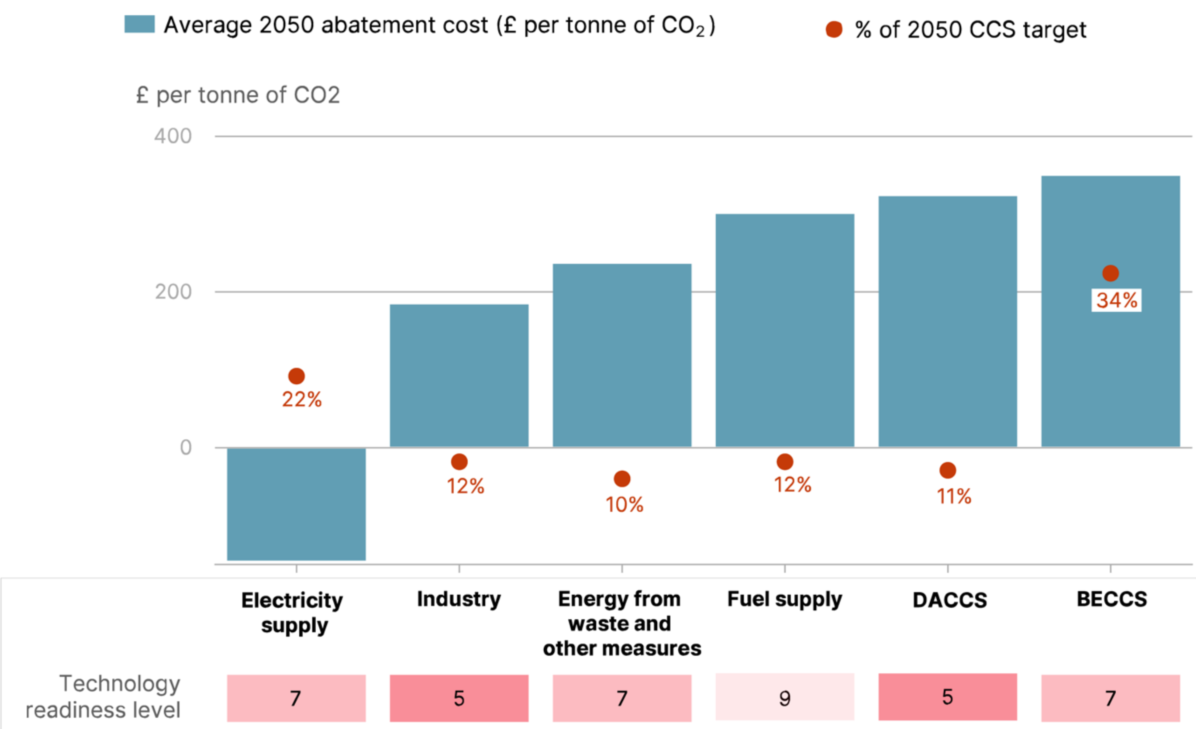
Low Technology Readiness and High Costs

The technology and cost of implementing carbon capture across sectors differ due to the quantity of CO_2 in the exhaust gases. CO_2 is generally easier to capture in sectors with high concentrations of the gas, making CCS on a relative basis more effective and lower cost as less infrastructure and energy is required. This is the case for ammonia, ethanol and natural gas processing, which have exhaust gas CO_2 concentrations of 98% after processing and associated capture costs of US$29 per tonne.[4] It is these high-concentration, lower-cost sectors that dominate existing global CCS projects supporting oil and gas extraction.

All other sectors, including those targeted by the CCC, are by comparison technologically immature, very high cost and presently unproven. There are currently no CCS projects in operation or under construction in the UK. There are few, if any, CCS projects in operation globally across the sectors targeted by the CCC for decarbonisation.[5] By its own admission, the CCC highlights that "uncertainties associated with CCS capture rates grow steadily from 2035, in line with the rollout of CCS, and become a significant source of uncertainty in 2050".[6] This presents significant risks to the CCC's net-zero pathway, as there remain doubts about whether capture technologies will actually work as intended and over total implementation costs.

[4] National Petroleum Council. Meeting the Dual Challenge: A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage. Chapter 2. 2021 update.
[5] IEEFA analysis using the International Energy Agency CCUS Projects Database.
[6] Climate Change Committee. Seventh Carbon Budget. Page 133. February 2025.

Figure 3: 2050 CCS Abatement Costs and Proportion of 2050 Target by Category



Note: Electricity supply includes benefits from renewable energy and does not represent the specific low-carbon dispatchable value, which we expect will be significantly higher.

Source: Climate Change Committee, Statista for UK ETS price, International Energy Agency.

According to the CCC, the average abatement cost per tonne of CO_2 captured and stored across the sectors ranges from -£145 for electricity supply to £349 for BECCS. As this represents an average over 2025-2050, it assumes that costs reduce over time as technology improvements and economies of scale are realised. In the short term, the implication is that the abatement costs will be much higher.

The average abatement cost of CCS across industry – which has fewer alternative low-carbon solutions than other areas – is £184 per tonne. As with all CCS cost estimates, they are more theoretical than actual, given the infancy of the solution. The sector-specific capture technology and application for industry has a low technology readiness level (TRL) of five out of 11.[7] This indicates it is at the large prototype stage, which is the least mature of the sectors targeted for CCS in the UK. Despite CCS for industry being far from proven or a cost-effective solution for hard-to-abate emissions, it could be argued that the further development of CCS for industry should be encouraged for a lack of alternatives.

Progressing CCS for other sectors highlighted by the CCC is considerably higher cost and risk. BECCS and DACCS collectively form the engineered removals category and represent 45% of the

[7] International Energy Agency. CCUS technology innovation. 2020.

CCC's 73 $MtCO_2$ 2050 target. The TRL levels of these applications are between five and seven, at best the demonstration phase. The costs are also astronomical. Average per-tonne abatement costs are £323 for DACCS and £349 for BECCS, a consequence of the extensive capture infrastructure and high energy requirements, which make them the highest-cost CCS solutions.

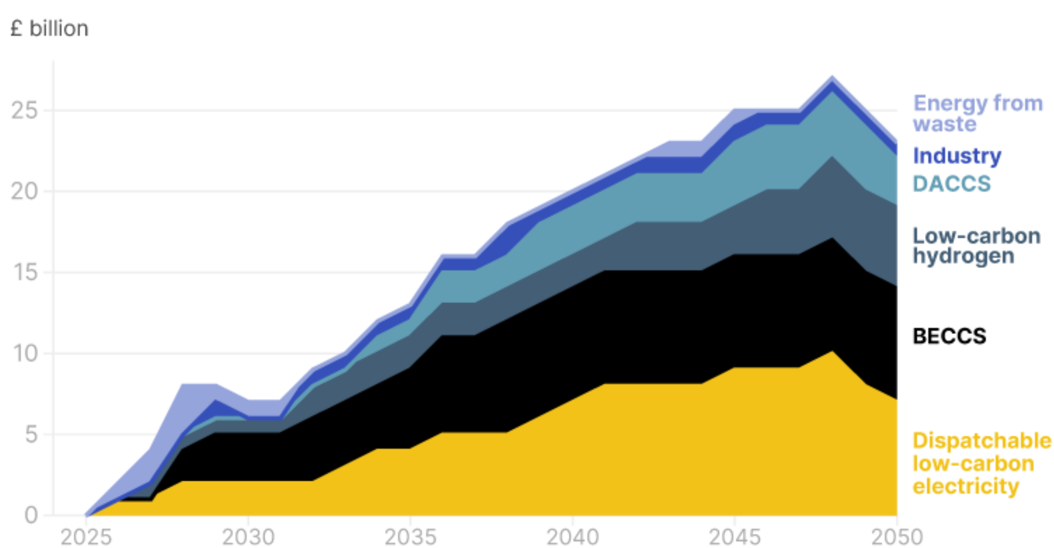
Other sectors targeted for CCS have a similar profile. They are expected to have a high net cost and are technically immature and unproven at scale. Electricity supply is the exception, with a negative abatement cost estimate. This is because the calculation includes the benefits of lower-cost renewable power generation, which dilutes the higher cost of gas-fired power with CCS (or "dispatchable low-carbon electricity", as per the CCC nomenclature). This has a low TRL of seven and will most likely have a positive abatement cost, albeit this sub-sector is not made available in the CCC model.

Significant Investment Required for CCS Infrastructure

The CCC's investment analysis identifies additional costs and associated savings in pursuit of net zero. Savings come in the form of lower-cost electricity from additional renewable power, which has zero fuel costs, and increased electrification of surface transport as fuel and maintenance costs are lower. As electrification and renewable power generation increases, the CCC estimates that achieving net zero will lead to a net saving of £35 billion by 2050.

While savings are made, additional investments and costs will be constantly required by 2050. These include all CCS applications, as the average abatement costs are positive. Total UK CCS investment over the next 25 years will be about £408 billion, according to the CCC. In the short term, annual expenditure will average £5 billion per year and total £30 billion by 2030 to reach the CCC's 13 $MtCO_2$ target. As the CCS requirement increases over the following decades, the annual investment continues to rise to an average of £19 billion per year between 2030 and 2050.

Figure 4: Additional CCS Investment Requirements by Sector



Source: Climate Change Committee, IEEFA analysis.

As the highest-cost sector, engineered removals requires the largest investment of £179 billion across DACCS and BECCS by 2050, accounting for 44% of the capital allocation. Despite electricity supply being offset by lower renewable power costs and reductions in unabated gas-fired power generation, dispatchable low-carbon electricity provision – including hydrogen-based electricity and gas-fired power with CCS – accounts for 33% of expenditure by 2050 at £136 billion. A lower capital requirement is expected across the industry sector and energy from waste. Collectively they require £35 billion of investment, accounting for 9% of expenditure, albeit capturing 22% of the 2050 emissions target.

Subsidies Supporting CCS Rollout

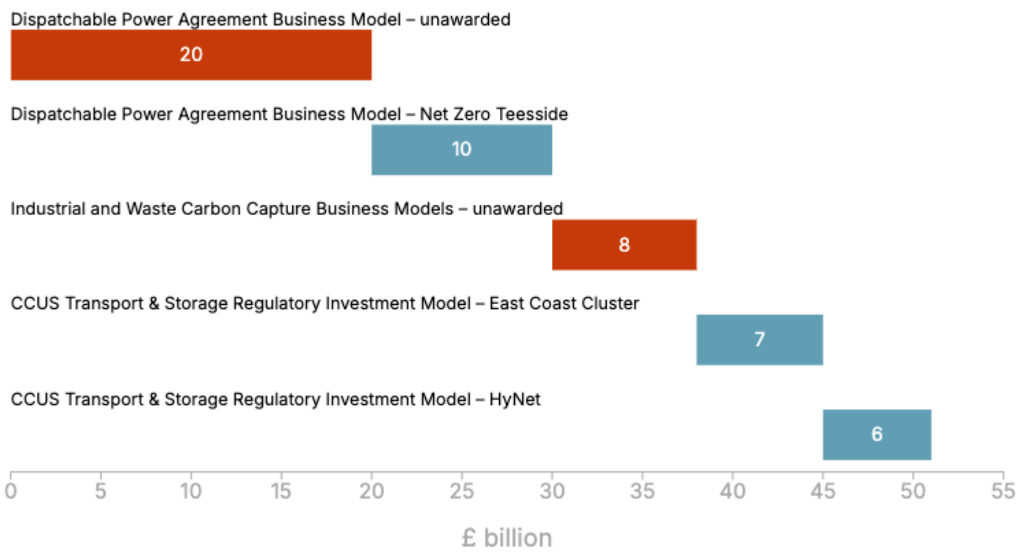
The investment cost to support CCS deployment is huge. As UK Emissions Trading Scheme (ETS) prices are too low to incentivise industrial emitters to implement decarbonisation solutions, government subsidies are needed to support CCS implementation. In March 2023, the UK earmarked £20 billion to support the country's CCS sector.[8] The funding package would be allocated over 20 years at ~£1 billion per year and would support four CCS clusters, aiming to capture and store 20-30 $MtCO_2$ per year by 2030.[9]

Since the initial announcement, the UK government has increased the funding allocation to £21.7 billion over 25 years[10] and decided to focus on two Track 1 cluster projects, the East Coast Cluster in northeast England and HyNet in northwest England and north Wales. A combined target of 6 $MtCO_2$ per year is expected to be captured and stored during the initial project phases,[11] for which the majority of the £21.7 billion in subsidies will be used.

Due to the infancy of CCS technology and the high costs of supporting first-of-a-kind projects, subsidy costs will likely be higher. The UK government subsidy scheme database[12] indicates the potential real costs to support initial Track 1 projects. The Dispatchable Power Agreement Business Model, which supports gas-powered generation and CCS, has a £30 billion budget, while the CCUS Transport & Storage Regulatory Investment Model could cost £13 billion. Two further schemes – the Industrial and the Waste Carbon Capture Business Models – each have a potential budget of £8 billion. Collectively, these subsidies alone amount to a £50 billion exposure to the UK taxpayer to capture and store just 8% of the 2050 CCS target.[13]

[8] HM Treasury. Spring Budget 2023. 21 March 2023.
[9] Department for Energy Security and Net Zero. Carbon capture, usage and storage: a vision to establish a competitive market. 20 December 2023.
[10] Department for Energy Security and Net Zero. Government reignites industrial heartlands 10 days out from the International Investment Summit. 4 October 2024.
[11] International Energy Agency. CCUS Projects Database. April 2025.
[12] GOV.UK. Subsidy database.
[13] These budget figures are calculated in accordance with the Subsidy Control Regime Statutory Guidance.

Figure 5: UK CCS Subsidies by Category and Award



Source: UK government subsidy schemes.

The Department for Energy Security and Net Zero is at pains to point out that these budget figures represent a “hypothetical maximum in a high-cost scenario” and that they “should not be read as an expected budget or create any legitimate expectation of spend”. Given the technical immaturity and track record of project cost overruns across the CCS industry,[14] these worst-case scenarios should realistically be treated as a more than likely. This is further evidenced by CCS subsidy awards to date. All £13 billion from the CCUS Transport & Storage scheme has been allocated to the HyNet and East Coast Cluster projects.[15,16] £10 billion from the Dispatchable Power Agreement scheme has been awarded to Net Zero Teesside Power, a proposed gas-fired power station with CCS that is part of the East Coast Cluster.[17] Collectively £23 billion of subsidies has been assigned to support around 2 $MtCO_2$ of capture per year. This presents a worrying signal around future costs and subsidy requirements, given that the UK’s 2050 CCS target is 73 $MtCO_2$.

Subsidies supporting the UK’s CCS ambitions go beyond those backing the capture, transportation and storage of greenhouse gases. BECCS relies on there being sufficient emissions to capture from biomass facilities. The UK’s largest and most material facility, the wood pellet-fuelled Drax Power Station, is thought to have secured £6.5 billion in public funding since 2002, of which £539 million was received in 2023 alone.[18]

Somewhat perversely, the Drax Power Station is the highest CO_2 emitter in the UK. A review of the country’s largest emitters in 2023 by Ember identifies the facility as having 11.5 $MtCO_2$ of

[14] IEEFA. Carbon capture and storage: Europe's climate gamble. 10 October 2024.
[15] GOV.UK. Subsidy award number 37471.
[16] GOV.UK. Subsidy award number 25025.
[17] GOV.UK. Subsidy award number 25026.
[18] National Audit Office. The government’s support for biomass. 24 January 2024.

emissions.[19] These emissions are not counted by the UK government, as it is assumed that the emissions created by combustion are theoretically reabsorbed by forest regrowth from sustainably sourced pellets. The carbon neutrality of BECCS is increasingly challenged by independent authorities such as the European Academies Science Advisory Council, which suggests that it's not effective in mitigating climate change and may even increase it.[20] This is due to wood not being from sustainable sources and the emissions consequences of marine and road transportation from forests to power stations.

Funding CCS: The Consumer Pays

CCS subsidies and support are mostly provided under Contracts for Difference and Renewables Obligation schemes. These two mechanisms are collectively referred to as environmental levies. They are funded by consumers as additional payments on electricity bills to support the buildout of solar and wind electricity capacity and other low-carbon energy generation. About 75% of the costs of CCS will be passed onto customers through such schemes, according to the Public Accounts Committee (PAC).[21]

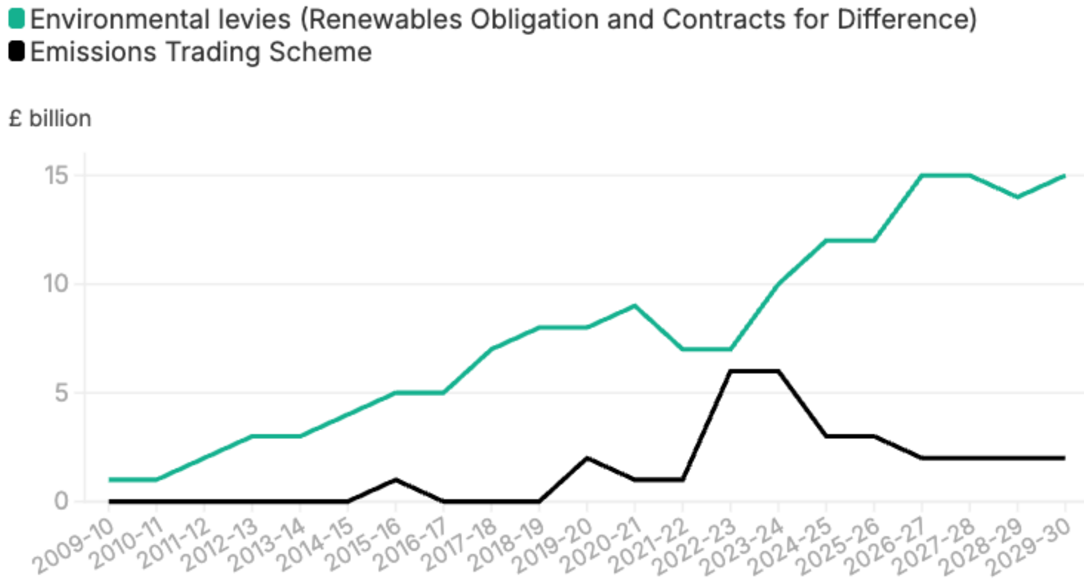
As increased investment is required for low-carbon energy and CCS, additional financial burden will be placed on UK consumers. Tax revenues for environmental levies are expected to increase by 49% from the £10 billion raised in the financial year 2023-24 to £15 billion by 2029-30, according to Office for Budget Responsibility forecasts.[22] Collectively, an additional £23 billion is expected to be required over the next six years to support a mixture of low-carbon investments, putting ever-increasing pressure on UK households and businesses.

At the same time, forecast UK ETS contributions are considerably lower than historical revenues from the scheme. The UK ETS is a carbon pricing mechanism that effectively makes polluters pay for their emissions by putting a price on each tonne of carbon released into the atmosphere. The logic is that polluters are economically incentivised to reduce their carbon emissions as the ETS price is higher than the cost of carbon reduction initiatives, such as CCS.

At the time of writing, the UK ETS price is £39 per tonne, much lower than CCS costings. Previous IEEFA research found that lost revenues due to low ETS pricing limit the UK government's ability to fund climate change mitigation.[23] In essence, the low pricing is partly down to government mismanagement and excess free allowances. UK ETS revenues are expected to fall from £6 billion in the 2023-24 financial year to £1.8 billion by 2029-30. This constitutes £21 billion of lost revenue over the next six years if it had stayed at the 2023-24 price. The shortfall is assumed to be paid for by consumers through environmental levies – when in fact, the cost of low-carbon initiatives should be placed on polluters.

[19] Ember. The largest emitters in the UK: annual review. 9 August 2024.
[20] European Academies Science Advisory Council. Climate impact of woody biomass. 21 January 2021.
[21] Public Accounts Committee. Carbon Capture, Usage and Storage. 7 February 2025.
[22] Office for Budget Responsibility. Public Finances Databank – March 2025. 26 March 2025.
[23] IEEFA. The UK Emissions Trading Scheme: Leaking value. 6 March 2025.

Figure 6: Historical and Forecast UK Environmental Levies and ETS Revenues



Source: Office for Budget Responsibility.

Public Accounts Committee CCS Scepticism

Several issues regarding UK government CCS support were raised in a February 2025 report from the PAC.[24] The PAC is an independent parliamentary body that includes cross-party members of parliament working alongside the National Audit Office, with a mandate to review the value for money of UK government projects, programmes and service delivery. The report highlighted several technical, commercial and timing risks associated with supporting CCS projects:

- **Technical.** Carbon capture utilisation and storage (CCUS) remains an unproven technology at scale, raising concerns about performance. Regarding BECCS, there are sustainability issues and a lack of verified CO_2 reduction. CCUS is not supporting sectors that would benefit from the technology, namely cement and steel, with few if any such projects backed by the initial Track 1 clusters.
- **Commercial.** The £21.7 billion in subsidy funding announced in October 2024 is for initial pilot projects. About 75% of the costs of supporting these projects will be financed by electricity customers through levies, raising concerns about affordability amid high UK energy prices. There are also contingent liabilities of up to £34 billion to date on government-backed projects. Profit-sharing mechanisms, which would allow taxpayers and consumers to benefit from successful projects, are not in place. Importantly, the report noted that the Department for Energy Security and Net Zero and the Treasury had yet to assess the full financial impact of the CCUS

[24] Public Accounts Committee. Carbon Capture, Usage and Storage. 7 February 2025.

programme on taxpayers and consumers, suggesting significant additions will be required over and above current funding programmes.

- **Timing.** Previous governments had CCUS failures in 2011 and 2016. The initial 20-30 $MtCO_2$ target for 2030 has been abandoned due to slow progress. The first two cluster projects are behind schedule. The earliest operational date for Track 1 projects is 2028, pushing back carbon reduction targets and threatening net-zero goals.

The PAC raised numerous concerns about the viability and value for money of CCUS programmes. As well as the technical and financial feasibility, further issues were noted relating to potential timing delays. The report warned that the UK government "needs to avoid over reliance on the programme at the expense of other routes to net zero, such as renewable energy".[25]

Conclusions

Despite the lowering of CCS targets in the most recent CCC Carbon Budget, the reliance on this unproven and expensive technology in pursuit of net zero remains a high-risk strategy. The costs to the UK taxpayer and electricity consumer are enormous. In the short term, over £50 billion may be required to support Track 1 projects and finance only 8% of the 2050 CCS target.

The investment required between 2030 and 2050 will be much higher, with an average of £19 billion needed annually to build and operate CCS-related infrastructure. The Department for Energy Security and Net Zero and the Treasury have yet to assess the full financial impact of CCS support on taxpayers. Given the scale of investment required and the low carbon prices, the outline subsidy exposure of £50 billion for initial projects is likely the tip of the iceberg.

In addition to the financial exposure and commercial risks involved, the technical immaturity of CCS across the target sectors outlined by the CCC is a real concern. All the proposed CCS sector applications are far from technically proven at scale. There is a risk that projects do not work or fail to capture the volume of proposed emissions. This is the experience of the small number of pilot projects globally to date. An IEEFA review of eight CCS projects across the industrial and power sector found that two were suspended or failed outright, three missed their capture targets by 20-50%, two had no data available and only one was capturing close to capacity.[26]

UK consumers will shoulder the majority of the enormous costs and risks associated with CCS. The government's mismanagement of the ETS is driving carbon pricing and receipts lower, at a time when increased investment and subsidy support is required. Polluters are being let off the hook while environmental levies are about to increase significantly. This puts increased pressure on UK consumers and businesses in support of a high-risk and potentially catastrophic net-zero initiative.

[25] Public Accounts Committee. Carbon Capture, Usage and Storage. 7 February 2025.
[26] IEEFA. Fact Sheet: Carbon Capture and Storage (CCS) has a poor track record. 8 February 2024.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

About the Author

Andrew Reid

Andrew Reid is a partner at NorthStone Advisers and a guest contributor at IEEFA Europe, providing research and editorial support to offshore related topics and reports. Andrew has worked for over two decades across the global upstream industry in research and consulting roles with a leading investment bank, a big four advisory firm, and an independent boutique. A graduate of both Aberdeen universities, Andrew holds an MA (hons) in Economics from the University of Aberdeen and an MBA from the Aberdeen Business School.