

A Comparative Analysis of Emissions Trading Scheme and Industrial Carbon Management in Developed Economies.

¹Lt Col Prabhat K Prasad (Retd), ²Dr Manish Gangil

¹PhD Research Scholar, RKDF University, Bhopal

²HOD Mechanical Engineering, RKDF University, Bhopal

DOI: <https://doi.org/10.51584/IJRIAS.2026.11090060>

Received: 18 September 2026; Accepted: 23 September 2026; Published: 10 October 2026

ABSTRACT

The integration of Industrial carbon management technologies, such as, carbon capture and storage (CCS) and carbon dioxide removal (CDR), within an emission trading scheme (ETS), offers a promising avenue for achieving net emissions reductions and lowering atmospheric concentrations of CO₂, which is the major contributors to GHG emissions. In this paper, we explore how various jurisdictions have approached this relationship across five key regulatory considerations: the treatment of CCS and CDR activities within ETS frameworks, allocates ETS revenues to support CCS and CDR technologies. The ETS in developed economies discussed in this paper are across five jurisdictions, activated at a regional (e.g., the European Union's ETS), or national (e.g., the United Kingdom's ETS, New Zealand's ETS or the ACCU Scheme (Australian Carbon Credit Unit) or at local levels (e.g., California's cap-and-trade program). The recognition of different CO₂ transport methods and the CO₂ storage jurisdictions possibilities, are not within the purview of this paper.

“Keywords” ACCU-Australian Carbon Credit Unit; BECCS- Bio energy with carbon capture and storage; CARB- California Air Resources Board; CCSA-Carbon Capture and Storage Association; CER-Clean Energy Regulator; CERF-Climate Emergency Response Fund; CRISP- Carbon Removal Innovation Support Program; DAC-Direct air capture; EEA-European Economic Area; EHR Enhanced hydrocarbon recovery; GGR-Greenhouse gas removal; GGRF-Greenhouse Gas Reduction Fund; LCFS Low Carbon Fuel Standard; MRV Monitoring, reporting and verification; NZU New Zealand emission unit; SB Senate bill; SGM Safeguard Mechanism; SMC-Safeguard Mechanism Credit

INTRODUCTION

By providing a financial incentive for reduction of CO₂ emissions ETSs can support the development of Industrial carbon management technologies like CCS and CDR. ETS is a market based incentive conceived to reduce GHGs such as CO₂ from the atmosphere, in a well-defined time lines. Entities participate in such a market, either on a compulsory or on volunteer basis. It includes thermal power plants, hard-to-abate industries, or, more lately in some ETSs, the maritime and domestic aviation sectors are also covered as they are the point source of emissions of CO₂.

There are two main approaches to emissions trading: cap-and-trade and baseline and credit. In a cap and-trade system, the regulatory authority caps the overall emissions allowed and allocates allowances to contributors, based on their predefined or allowable pollution levels. Each allowance represents the right to emit one tone of CO₂ equivalent. In case some participants need more allowances than allocated, they must purchase additional ones from those that have successfully reduced their emissions. In some ETSs, participants can also buy offset credits from companies that are not participating in the ETS and have generated such credits by evading or eliminating emissions. In a baseline and credit system, the governing bodies establishes emissions baselines for participating bodies. Those emitting below their baseline earn credits, which can be sold to entities exceeding their limits. In both approaches, the regulatory experts can gradually tighten emissions limits over time by reducing the number of allowances or the pre-defined

baselines to drive decarbonisation efforts further. By giving a monetary incentive for CO₂ release reductions, ETSs can support the development of industrial carbon management technologies, such as CCS or CDR. Approaches to integrate CCS vary globally, ranging from none or minimal interaction with CCS to direct and indirect mechanisms that facilitate its integration (La Hoz Theuer et al., 2023). As CCS deployment expands globally (Global CCS Institute, 2024b), jurisdictions are adapting their ETS frameworks for backing up emerging commercial prospects within the carbon management value chain.

In this paper we aim to provide a relative evaluation of the ETS in five key jurisdictions, namely the European Union (EU), the United Kingdom (UK), California, Australia, and New Zealand (NZ). Over and above scrutinizing their dissimilarities in design, we will focus on how the chosen ETS frameworks address regulatory challenges associated with industrial carbon management technologies, including:-

- I. The treatment of CCS activities,
- II. The treatment of CDR activities,
- III. The allocation of ETS revenues to support CCS or CDR deployment.

By evaluating these ETS structures, this paper seeks to recognize best practices to support large-scale industrial carbon management to drive decarbonization in line with climate targets.

Overview of Nominated ETSs

Developed countries of EU, UK, California, Australia and NZ, are having a well-established ETS frameworks, its own discrete design features, as given in Table 1. This section lists out an overview of the ETSs in these five jurisdictions, emphasizing their significant features and latest advances.

(a) EU ETS - The EU ETS, is the world's first large scale carbon market launched in 2005, within European Economic Area (EEA). Membership in the system is referred to as ETS 1, and is mandatory for sectors listed in Annex I of the updated EU ETS Directive¹ which applies to carbon intensive industries, like power and heat generation, aviation and, more recently, shipping is also added. As a cap-and-trade system, the EU ETS sets a limit on total emissions from all covered sectors, which is reduced over time to encourage decarbonization. Businesses receive free allowances or purchase them at auctions. EU ETS members which emit less than their allocated allowances are allowed to sell their surplus while participants exceeding their limits must purchase additional allowances or reduce their emissions to comply with the system. With the European Green Deal and the Fit-for-55 package, the EU ETS emissions cap is now being reduced at a faster pace in order to meet the EU's target of cutting net emissions by at least 55% by 2030 compared to 1990 levels (European Commission, 2019, 2021). This cap is expected to reach zero by 2039, effectively ending EU ETS allowance auctions and containing the use of previously issued quotas. The Clean Industrial Deal, released in February 2025, confirmed that the European Commission would revise the EU ETS Directive in 2026 (European Commission, 2025b). Public consultation took place from April to July 2025, covering key topics such as the expansion of maritime emissions, the inclusion of CDR technologies and the integration of municipal waste incineration installations (European Commission, 2025d). In parallel, starting in Oct 2027, a new, separate ETS for road transport and building fuels, referred to as 'ETS'-2 is set to be introduced. However, in this paper our primary focus is on the existing ETS-1 and not on storage and transportation aspects.

(b) UK ETS - The UK ETS was established in January 2021 following the UK's departure from the EU ETS. Although it now operates independently, its structure closely mirrors its predecessor in many respects. The system covers activities listed in Schedules 1 and 2 of the Greenhouse Gas Emission Trading Scheme Order 2020, which includes carbon-intensive industries, power and heat generation, as well as domestic aviation. Future changes include expanding coverage to domestic maritime emissions from Oct 2026 and incorporating energy-from-waste and waste incineration from 2028 (UK Department for Energy Security & Net Zero, 2023a). Additionally, ongoing policy discussions explore the inclusion of greenhouse gas removal (GGR) technologies in the UK ETS as a means to drive emission reductions further (UK Department for Energy Security and Net Zero, 2024). Like the EU ETS, the UK ETS operates on a cap-and-trade basis, with a progressively decreasing emissions cap to align with the UK's net-zero by 2050 target.

(c) California Cap and Trade Program - California's cap-and-trade program was launched in 2013, is one of the most well-known ETSs in North America. It establishes a state-wide emissions cap, covering approximately 75% to 80% of California's total GHG emissions across large industrial plants, electricity generators, electricity importers, and upstream suppliers of transportation fuels and natural gas. Threshold is decided by direct mandatory obligations to the facilities emitting $\geq 25,000$ metric tons of CO₂ per year. The Allowances are distributed through a combination of auctions and free allocations to regulated industries.

Each year, the cap is progressively lowered to reduce the number of available allowances and drive decarbonization. A discrete aspect of California's cap-and-trade program is its experience as the first system to establish a formal linkage with another ETS. Since January 2014, it has been linked with Quebec's cap-and-trade system, permitting for the combined trading allowances between the two jurisdictions. Dialogs have also begun on expanding this linkage to include Washington State's cap-and-invest program (Washington State's Department of Ecology, 2024). California's ETS undergoes periodic reviews to assess its efficiency and implement necessary updates.

(d) ACCU Scheme - The Australian Carbon Credit Unit (ACCU) arrangement functions as a baseline-and-credit system, differentiating it from the other ETS frameworks has been discussed in this paper. Launched in 2016, the system includes both voluntary and compulsory components. Under the voluntary component of the ACCU Scheme, registered companies can generate ACCUs by undertaking activities that reduce or avoid emissions in line with legislated ACCU methods, provided their projects are registered with the Clean Energy Regulator (CER). Among the portfolio of approaches to reduce carbon, reforestation and afforestation, savanna fire management, energy efficiency improvements or waste reduction activities are undertaken by the companies. For each tonne of CO₂ equivalent emissions that these ventures store or avoid, they earn one ACCU. These credit units are then purchased by the CER at a fixed contract price, providing an additional income for companies.

On the other hand, the registered companies can sell these credits on the secondary market to entities taking part under the Safeguard Mechanism (SGM) or other industry players who wish to offset their emissions. The SGM applies to Australia's 219 biggest emitters (Australian Department of Climate Change, 2024a). Emissions baselines have been established for Safeguard Facilities in 2023, requiring them to remain within their allocated limits. Under the SGM, facilities emitting more than 100 kilo-tons of CO₂ equivalent annually must reduce their emissions according to predefined baselines, which progressively tighten over time to align with Australia's climate targets.

Baselines decline by 4.9% per annum between 2023 and 2030 and in predictable 5-year blocks thereafter, until 2050. Facilities emitting less than their baseline by design generate Safeguard Mechanism Credits (SMCs), which can be saved for future compliance periods or sold to other Safeguard Facilities exceeding their limit. Conversely, Safeguard Facilities that exceed their baseline emissions must offset the surplus using banked SMCs, purchase ACCUs or acquire SMCs from other facilities emitting below their baselines.

(e) NZ ETS - It was established in 2008, the NZ ETS is broadly deliberated as one of the most complete ETSs globally due to the wide-ranging and varied array of areas it covers. These areas comprise of forestry, maritime, waste, domestic aviation, transport, buildings, industry, power and agriculture. If we leave agriculture, all covered sectors must account for New Zealand Units (NZUs) to calculate their emissions.

In this respect, the NZ ETS operates as a cap-and-trade system, similar to the EU ETS, the UK ETS, and California's cap-and-trade system, where the total number of units are restricted to, and the contributors must buy or trade allowances to comply with their NZUs through afforestation and reforestation activities, where landowners earn one NZU for each tonne of carbon sequestered. After earning these NZUs can then be sold on the carbon market, creating an economic incentive for landowners to invest in carbon sequestration. On the flip side, landowners are also liable for purchasing and surrendering NZUs if they engage in deforestation, reflecting the emissions released when trees are removed from the land.

TABLE 1. Comparison of The Design of Selected ETSs

	EU ETS	UK ETS	CALIFORNIA CAP & TRADE PGME	ACCU SCHEME	NZ ETS
Regulatory Authority	European Commission & competent authorities in EU Member States	UK ETS Authority	California Air Resources Board (CARB)	CER(Clean Energy Regulator)	Ministry for the Environment and Environmental Protection Auth
Start of operation	2005	2021	2013	2016	2008
Geographical Scope	European Union, Iceland, Liechtenstein and Norway	UK	California& USA	Australia	New Zealand
Link with other systems	Switzerland since 2020	NA	Quebec since January 2014	NA	NA
Type of Approach	Cap and trade	Cap and trade	Cap and trade	Baseline & credit	Cap and trade
Covered Emissions	Around 40% of EU's GHG emissions (European Commission, 2024b)	Around 25% of UK's GHG emissions (UK Government et al., 2024a)	Around 80% of California's GHG emissions (California Air Resources Board, 2024a)	NA for ACCU Scheme; around 60% of Australia's GHG emissions under the SGM2 (Parliament of Australia, 2024)	Over 50% of New Zealand's GHG Emissions (New Zealand Ministry for the Environment, 2022)
Covered sectors	Industry, power, maritime, domestic aviation and waste ³ (ETS 1)	Industry, power, domestic aviation (including from the UK to the EEA & Switzerland)	Transport, buildings, industry and power	Electricity genmining, oil and gas extn, manufacturing & waste	Forestry, maritime, waste, domestic aviation, transport, buildings, industry, power & agriculture

Number of ETS participants	Over 11,000 (European Commission, 2024b)	Around 1,000 (UK Govt et al., 2024a)	Around 350 (California Air Resources Board, 2024b)	633 facilities as of January 2024 (Aus Nat Audit Office, 2024).	4,796 (NZ Environmental Protection Authority, 2025)
Future reviews	EU ETS review confirmed for 2026, which could include the following: • Potential full inclusion of municipal waste incineration in 2028 • Potential inclusion of carbon dioxide removals	Inclusion of Domestic maritime from 2026 • Inclusion of energy from waste & waste incineration from 2028 • Potential inclusion of CO ₂ removals upon further consultation	Next review of scoping plan scheduled for 20275	Review of safeguard Mechanism baselines in 2026- 2027 • Review of various policy settings (treatment of international units, suitability of arrangements for emissions-intensive and trade-exposed activities, etc.) in 2026-2027	Potential inclusion of CCS

(i) Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 Amending Directive 2003/87/EC Establishing a System for Greenhouse Gas Emission Allowance Trading within the Union and Decision (EU) 2015/1814 Concerning the Establishment and Operation of a Market Stability Reserve for the Union Greenhouse Gas Emission Trading System (Text with EEA Relevance), 2023.

(ii) According to the National Greenhouse Gas Inventory Quarterly Update: June 2023, total emissions for the 2022–23 financial year were 465.2 million tonnes of CO₂-e (Mt CO₂-e). In the 2022-23 year, covered emissions from safeguard facilities were 138.7 Mt CO₂-e, while emissions from grid-connected generators were 137.2 Mt CO₂ e.

(iii) As of 1 January 2024, municipal waste incineration installations above a specified threshold are required to monitor and report their emissions under the EU ETS. However, they are not yet required to surrender allowances. By July 2026, the Commission is expected to assess and report on its feasibility starting in 2028.

(iv) The agriculture sector reports its emissions through the NZ ETS but does not need to surrender NZUs to

the Government.

(v) The scoping plan was last reviewed in 2022 and is updated every five years.

COMPARATIVE ANALYSIS

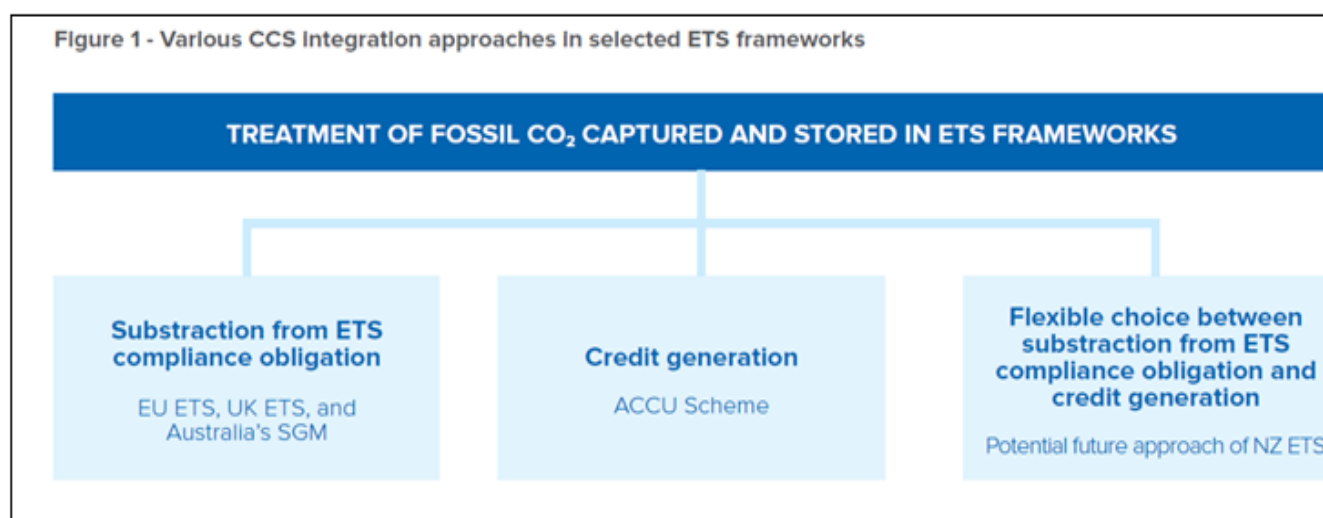
Different ETS handlings of CCS activities - By bringing in CCS into emissions trading schemes has several economic and legal benefits. Firstly, as brought out earlier companies can reduce their ETS compliance obligation or earn tradable carbon credits by capturing CO₂ and storing it permanently. Permanent storage refers here to the long-term sequestration of CO₂ in geological formations, such as depleted oil and gas fields or saline aquifers, in order to effectively isolate CO₂ from the atmosphere. This approach contrasts with methods like enhanced hydrocarbon recovery (EHR) where CO₂ is injected into oil and gas reservoirs to increase production. Through EHR, CO₂ is utilized to extract more fossil fuels. Second, the inclusion of CCS in ETS frameworks often relies on robust monitoring, reporting and verification (MRV) rules, which helps to enhance the environmental integrity of CCS activities by ensuring accurate accounting of emissions reductions. Authorities have adopted various approaches to integrating CCS into their ETS frameworks, reflecting differing regulatory priorities, economic considerations, and local contexts, as demonstrated by Figure 1. Given their shared origins, the EU ETS and the UK ETS share noteworthy similarities in their treatment of CCS. Both schemes consent ETS participants to subtract from their designated emissions, the CO₂ that has been captured, transported and permanently stored in geological storage sites, provided these sites are permitted in accordance with the relevant CCS regulatory frameworks⁶. This mechanism enables participants in the EU ETS or UK ETS to reduce their compliance obligations through CCS, thereby improving the financial attractiveness of CCS projects. Additionally, both ETS frameworks cover the entire CCS value chain, including CO₂ capture, transport and storage. Operators of such facilities are held responsible for their operational and potential leakage emissions. Like any other ETS participants, they must surrender the appropriate amount of EU ETS or UK ETS allowances for any emissions linked to CCS activities. Australia has adopted a distinct approach to CCS through its ACCU Scheme. This scheme allows a wide range of GHG sequestration activities to earn ACCUs/ACCUs, issued for each tonne of CO₂ avoided. In September 2021, after CCS was identified as one of Australia's priority low emission technologies, the government introduced a new methodology determination for CCS (Australian Department of Climate Change, 2021; Australian Department of Industry, 2020). Since then, projects that satisfy eligibility criteria under this method can earn ACCUs for the CO₂ that is captured and injected for permanent underground storage, provided they are not located on site of a Safeguard Facility⁷. These credits can be purchased by the government or private buyers, including Safeguard Facilities. Changes to the SGM in 2023 made CCS operations that reduce covered emissions on site at a Safeguard Facility ineligible to generate ACCUs. With emissions baselines under the SGM declining by 4.9% per year until 2030, CCS may be the only viable solution to meet these increasingly stringent targets, aside from reducing production with associated carbon leakage risks. New Zealand is currently considering amendments to its ETS framework to better support CCS deployment and has explored a 'third way'. In July 2024, the government launched a public consultation seeking input on the potential expansion of CCS inclusion beyond the geothermal sector⁸, currently the only sector under the NZ ETS where emission reductions from CCS are recognised⁹ (New Zealand Ministry of Business, 2024). While the consultation presented the various options for incorporating additional forms of CCS in the NZ ETS, the government proposed approach would provide (non-geothermal) ETS participants engaged in CCS activities with two possibilities:

- I. Participants would be allowed to subtract the emissions captured and stored through CCS from their reported emissions when estimating their ETS liability, which would mirror the treatment of CCS currently applied to the geothermal sector.
- II. Additionally, businesses deploying CCS could earn NZUs for CO₂ captured and stored, similar to the approach adopted by the NZ ETS in the forestry sector.

To prevent double counting, participants subtracting emissions captured and stored by CCS from their ETS liability would not be eligible to receive NZUs for the same captured and stored emissions. These options

are mutually exclusive, aiming to provide NZ ETS participants engaged in CCS activities with flexibility while maintaining the integrity of the ETS framework. Building on the outcomes of the consultation, the New Zealand government announced key decisions in February 2025 regarding the development of its CCS regulatory framework, with legislation expected to be introduced later in 2025 (New Zealand Government, 2025). As part of this announcement, the government confirmed that CCS will be fully recognized within the NZ ETS; however, the specific mechanism for incentivizing CCS within the scheme has yet to be confirmed. Finally, California's cap-and-trade program currently does not explicitly recognize CO₂ reductions achieved through CCS. However, such reductions may be credited under the Low Carbon Fuel Standard (LCFS), a separate regulatory mechanism that applies exclusively to the transportation sector. The LCFS establishes lifecycle carbon intensity targets for all transportation fuels sold in the state of California, aiming to support decarbonization and diversification goals. In 2018, the LCFS was revised to include a CCS protocol that enables CCS projects that reduce emissions associated with the production of transport fuels sold in California, as well as projects that directly capture CO₂ from the air, to generate LCFS credits (Low Carbon Fuel Standard, 2020). However, while CCS has been confined to the transportation sector, the passage of Senate Bill (SB) 905 in September 2022 mandated CARB, in collaboration with other state agencies, to create a program for accelerating the deployment of carbon management technologies in the state of California (Senate Bill No. 905, 2022). In particular, according to SB 905, by 2025, CARB must establish regulations governing the construction and operation of CCS projects. Once these regulations are in place, California's caps and trade program may inform the integration of CCS as an emission reduction technology across multiple sectors within its compliance framework.

Fig-1 CCS Integration Approaches in Selected ETS Framework



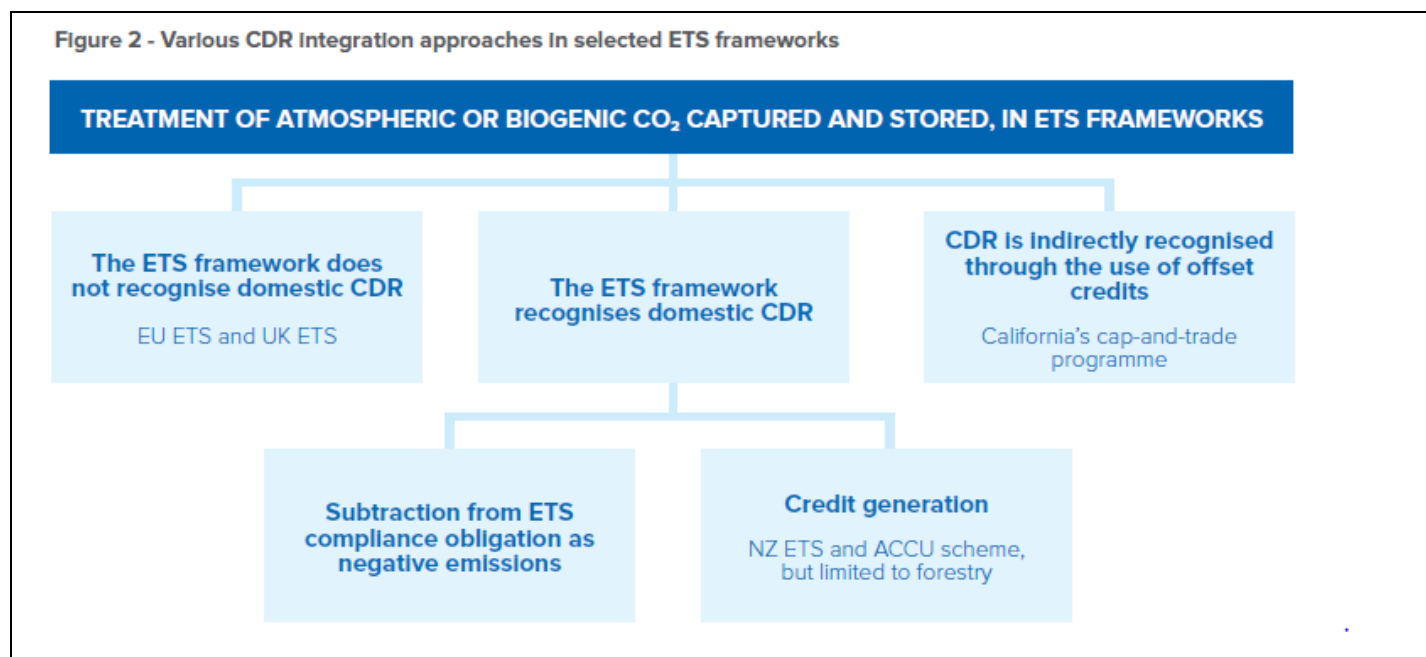
Different ETS treatments of CDR Activities - Jurisdictions worldwide are increasingly exploring the possibility to include CDR activities in their ETS frameworks. CDR encompasses a variety of solutions, from nature-based solutions like forestry to technology-based ones such as direct air carbon capture and storage (DACCS) and bio energy with CCS (BECCS). Integrating CDR into ETS frameworks can boost market liquidity by providing additional allowances or credits, especially as emissions caps tighten. Additionally, CDR integration could help lower the costs associated with carbon removal. However, this could also present risks, including the potential impacts on the prices of ETS allowances. Despite growing interest, real-world examples of CDR integration into ETSs remain limited. Among the frameworks reviewed, the ACCU Scheme and the NZ ETS stand out for their unique recognition of forestry-based CDR initiatives. In Australia, projects under the plantation forestry method can earn ACCUs by planting or maintaining forestry (Australian Clean Energy Regulator, 2024b). These credits can then be purchased by the Australian government or private entities, including Safeguard Facilities. However, the ACCU Scheme explicitly excludes direct air capture (DAC) technologies under the CCS method (Carbon Credits (Carbon Farming Initiative) Act 2011, 2020). Similarly, New Zealand recognizes forestry activities under the Climate Change Response Act 2002, enabling landowners to earn NZUs for emissions removals (Climate Change Response Act 2002, 2024). Under the NZ ETS, landowners are also required to surrender NZUs when they

clear forests to offset the resulting emissions. Building on this approach, the government is working on a future carbon removals strategy to build a more diverse portfolio of CDR activities beyond forestry and, as part of this initiative, will consider new legislation to enable additional removal activities to be recognized within the ETS (New Zealand Ministry for the Environment, 2023). The UK has also expressed its interest in integrating CDR into its ETS. In June 2023, as part of its review of the UK ETS, the UK ETS Authority indicated that it sees its compliance market as an appropriate long term market for GGRs while committing to further consultation on the matter (UK Government et al., 2023). Following this, in May 2024, the Authority launched a call for evidence to gather feedback on the potential integration of GGRs into its ETS, addressing issues such as market design and eligibility criteria (UK Government et al., 2024b). The proposed approach mirrors the NZ ETS's approach for forestry: GGR operators that meet specific requirements would be eligible to earn allowances for removing and storing CO₂. These allowances would be delivered ex-post, once the verification process has been completed. The operators of GGR facilities would then be allowed to sell their allowances on the UK ETS market, allowing other UK ETS participants to purchase them to meet their own compliance obligations. The Authority intends to maintain the gross cap of UK ETS allowance for the initial integration of GGRs. In contrast, the EU has taken a more cautious stance by excluding most CDR initiatives from its ETS, while also signaling a willingness to explore further integration. For biogenic CO₂ emissions, participants may or may not need to surrender EU ETS allowances based on the type of biomass used (zero-rated or non-sustainable) and the fuel mix (pure biomass or a blend with fossil fuels). Notably, installations that consume 100% zero-rated biomass are exempt from surrendering EU ETS allowances. However, the EU ETS currently does not permit the generation of new allowances (as seen in the NZ ETS case with forestry) or the accounting for negative emissions. Furthermore, DACCS facilities remain outside the EU ETS scope. BECCS and DACCS projects can instead generate credits for voluntary carbon markets in accordance with the recently-adopted EU Regulation regarding permanent carbon removals, carbon farming and carbon storage in products¹⁰. More recently, the European Commission initiated discussions on the potential integration of domestic CDR into the EU compliance carbon market as part of the future review of the EU ETS. This consultation, running from April to July 2025, seeks inputs on the following aspects (European Commission, 2025a) :-

- i. How the EU ETS could account for negative emissions resulting from GHGs that are removed from the atmosphere and permanently stored,
- ii. How negative emissions could be covered by 'emissions trading' or other policies,
- iii. What measures are necessary to ensure that CDRs do not merely offset required emissions reductions.

Following this consultation, the European Commission's expected to present a report to the European Parliament and the Council on the matter by 31 July 2026, as mandated by the revised EU ETS Directive. Finally, California's cap-and-trade program offers a different model for integrating certain CDR activities into an ETS. Rather than directly including CDR into the compliance market, CARB allows participants to use carbon offset credits to meet a portion of their ETS compliance obligations. From 2021 to 2025, entities may fulfill up to 4% of these requirements with offsets, increasing to 6% from 2026 to 2030 (Assembly Bill No. 398, 2017). Since 2021, at least half of these credits must come from projects that provide direct environmental benefits within the state of California. CARB issues offset credits only to qualifying projects that reduce or sequester GHGs under one of the six Board approved offset protocols – livestock management, mine methane capture, ozone depleting substance reduction, rice cultivation, US forest conservation and urban forestry – thereby incorporating some forms of nature-based CDR (CARB, 2025). Additionally, in early 2023, California State Senator Josh Becker introduced the Carbon Dioxide Removal Market Development Act, referred to as SB 30811, which sought to require emitters over 25,000 metric tons of GHGs annually to purchase carbon removal credits in addition to their cap-and-trade obligations (World Resources Institute, 2023). However, the bill stalled in the Assembly Appropriations Committee and died in August 2024, leaving the current recognition of CDR unchanged (California Legislative Information, 2024). Finally, DAC projects are eligible to receive credits under the LCFS. As their inclusion is currently limited to this program, further guidance is needed on whether they should be eligible under the broader cap-and-trade program.

Fig-2 CDR Integration Approaches within ETS Framework



¹⁰Regulation (EU) 2024/3012 of the European Parliament and of the Council of 27 November 2024 Establishing a Union Certification Framework for Permanent Carbon Removals, Carbon Farming and Carbon Storage in Products, 2024.

¹¹SB-308 Net zero greenhouse gas emissions goal: carbon dioxide removal: regulations, 2023.

Allocation of ETS revenues to support CCS or CDR projects - Emission trading schemes may generate revenue through the sale of allowances or credits, which governments can reinvest into clean industrial technologies, such as CCS and CDR, to further drive emissions reductions. This can represent an interesting source of revenue as the value of ETS allowances or credits is likely to rise in the coming years as jurisdictions tighten their emissions caps to align with long-term climate goals. However, fluctuations in ETS allowance for credit prices, driven by factors like market dynamics, economic shifts or regulatory changes, can also lead to unpredictable funding streams, potentially limiting the ability of governments to provide stable and long-term financial support for decarbonization projects.

The EU has adopted a direct reinvestment model, in which part of ETS auction revenues are channeled into dedicated funds; the Innovation Fund and the Modernization Fund. The Innovation Fund finances various low-carbon innovations by providing direct grants for successful projects, including the construction and operation of CCS and CDR facilities. The Innovation Fund has already backed numerous CCS projects capable of capturing approx. 10 million tons of CO₂ per annum, with operations starting as early as 2027 (European Commission, 2024a). The modernization fund primarily targets energy system improvements and efficiency measures. ETS review, initiated by the European Commission in April 2025, raised several questions regarding the use of ETS revenues, suggesting potential changes that could affect support for CCS and CDR projects like creation of an Industrial Decarbonization Bank. In California, revenues from the auction of allowances is used for creation of Greenhouse Gas Reduction Fund (GGRF), which finances various programs aimed at reducing GHG emissions at present there are no programs under the GGRF focusing exclusively on CCS projects. In Australia, although the ETS operates under a baseline-and-credit model, the ACCU Scheme generates revenue for the government. However, the funding streams opened under this initiative have not provided support for CCS. In contrast to the EU, California and Australia, the UK provides a different model, in which ETS revenues are not explicitly allocated to climate projects, such as CCS or CDR, but are instead absorbed into the general budget. Although the UK government has demonstrated strong public support for CCS, as evidenced by its recent announcement of up to £21.7 billion in funding over 25 years for CCUS and hydrogen development, this funding is not directly linked to revenues from the UK ETS (UK Government, 2024). Since 2024, New Zealand has adopted a similar

approach to the UK one, following the government's decision to scrap the Climate Emergency Response Fund (CERF) to help fund tax cuts. This marked a significant policy change, as the CERF was originally established in 2021 to reinvest revenues from the NZ ETS into climate-related initiatives. CERF did not allocate direct funding to CCS, although the fund backed forestry-based CDR initiatives in the forestry sector. Moving forward, revenues from the NZ ETS will no longer be dedicated to the CERF but will go toward the general government budget in the same way in the UK.

Fig-3- Comparative Regulatory Considerations for CDR & CCS projects

REGULATORY CONSIDERATIONS	EU ETS	UK ETS	CALIFORNIA CAP-AND-TRADE PROGRAM	AUSTRALIAN CARBON CREDIT UNIT SCHEME	NEW ZEALAND ETS
ETS interaction with CCS applications	✓ Subtraction from ETS liability	✓ Subtraction from ETS liability	? Subtraction from ETS liability in the transport sector, CCS yet to be included for other sectors	✓ Credit generation (under the ACCU Scheme)	? Flexible approach under government consideration and likely expansion beyond geothermal sector
ETS interaction with CDR applications	? Ongoing discussion; report by July 2026	? Positive but subject to future legislation	? Some nature-based CDR considered; DAC included only under CCS Protocol developed for LCFS	? Limited to forestry, clear exclusion for DACCs	? Limited to forestry up to now, expansion under consideration
Consideration of all means of CO ₂ transport	✓ Following recent changes effective as of January 2025	? Under consultation, pending future legislation	? Unclear, but covered under CCS Protocol developed for LCFS	✓ ACCU Scheme adopts a technology-neutral definition and methodology	? Regulatory provisions still to be developed
Storage in jurisdictions outside the ETS	? Currently not allowed, but interest from the European Commission	? Currently not allowed, but interest from the UK government	? Unclear, but covered under CCS Protocol developed for LCFS	✗ Not allowed under the ACCU Scheme	? Likely not to be allowed
Revenues from ETS supporting CCS or CDR technologies	✓ Example of EU Innovation Fund supporting both CCS and CDR initiatives	✗ ETS revenues reallocated to government general budget	✓ Example of CRISP supporting CDR initiatives, but not CCS	? Revenues reallocated to Powering the Regions Fund, with no possibility of support for CCS or CDR so far	✗ ETS revenues reallocated to government general budget

Summary of ETS Approaches - The Emissions Trading System (ETS) is a market-based mechanism to reduce greenhouse gas (GHG) emissions by putting a price on carbon. Governments set an overall emissions cap and issue emission allowances. Companies that emit less than their allocated allowances can sell the surplus, while companies exceeding their limits must purchase additional allowances or pay penalties. There are subtle differences in ETS approaches around the European Union (EU), Australia, New Zealand (NZ), and the United Kingdom (UK) which we have considered the four jurisdictions in this paper. The EU ETS operates on the principle of "cap and trade." A limit is set on the total amount of greenhouse gases that covered sectors may emit. Companies must surrender one emissions allowance for each tonne of carbon dioxide equivalent they emit, while allowances can be bought and sold on the market. As the overall cap decreases over time, the supply of allowances tightens, creating an economic incentive to reduce emissions. It regulates thousands of installations across EU member states as well as certain participating non-EU countries, accounting for a substantial share of the region's greenhouse gas emissions. It encourages investment in renewable energy, energy efficiency, and low-carbon industrial technologies. It contributed to significant emissions reductions in covered sectors. Australia initially introduced a Carbon Pricing Mechanism (2012), often referred to as a carbon tax transitioning toward emissions trading. Baseline-and-Credit.NZ follows similar ETS approach as in EU known as Cap-and-Trade, and it covers 50% of NZ's

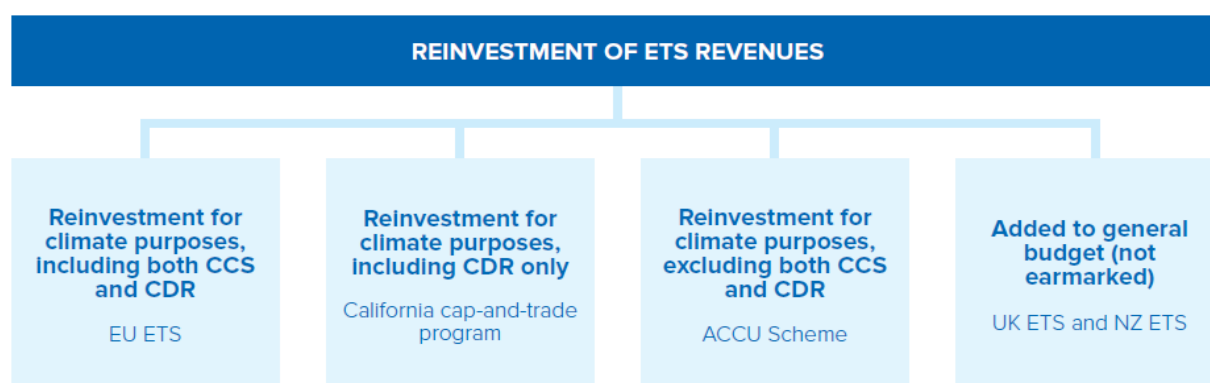
emissions. UK Emissions Trading Scheme works independently post Brexit, as UK left the EU and it established its own ETS in 2021.

For CCS deployment, ETS systems provide an economic incentive by assigning a cost to CO₂ emissions. Industries that install CCS can reduce their emissions, lowering the number of allowances they need to purchase or enabling them to sell surplus allowances.

1. EU ETS: Strongest driver for CCS due to high carbon prices and expanding sector coverage.
2. UK ETS: Closely aligned with UK net-zero strategy and industrial decarbonisation.
3. NZ ETS: Particularly valuable when combining CCS with bioenergy or forestry-based carbon removal.
4. Australia: The strengthened Safeguard Mechanism encourages emissions reductions at large industrial facilities, where CCS can play a role in meeting declining emissions baselines.

Fig-4 Various Approaches of ETS Revenue Generation within ETS framework

Figure 4 - Various approaches in the use of ETS revenues in selected ETS frameworks



CONCLUSION

The integration of industrial carbon management technologies such as CCS and technological CDR within an ETS offers a promising avenue for achieving net emission reductions and lowering atmospheric concentrations. This paper explores how various jurisdictions have approached this relationship across five key regulatory considerations: the treatment of CCS and CDR activities within ETS frameworks, the recognition of different CO₂ transport methods, the possibility of CO₂ storage in jurisdictions outside the ETS and the allocation of ETS revenues to support CCS or CDR deployment. By analyzing these factors, the paper highlights various policy design options, which can serve as a reference for policymakers considering similar integrations. Furthermore, it shows how some ETS frameworks are evolving to enhance the deployment of industrial carbon management techniques. However, ETS frameworks alone remain insufficient to drive widespread adoption of CCS and CDR. Globally, only a limited number of facilities currently reduce ETS compliance obligations or generate credits through these technologies. In particular, successful projects have often relied on a combination of policy support mechanisms to improve economic viability and mitigate financial risks (International Energy Agency, 2023; Global CCS Institute, 2024). Combining ETS incentives with additional regulatory and financial support may offer a better avenue to scale up CCS and CDR deployment to meet climate targets.

REFERENCES

1. Assembly Bill No. 398 (2017). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398
2. Australian Clean Energy Regulator. (2024a). Carbon capture and storage method 2021 - simple method guide: User guide for carbon capture and storage projects. www.cleanenergyregulator.gov.au

1. Australian Clean Energy Regulator. (2024b). Understanding your plantation forestry project: Australian Carbon Credit Unit Scheme simple method guide for plantation forestry projects registered under the Carbon Credits (Carbon Farming Initiative-Plantation Forestry) Methodology Determination 2022. https://cer.gov.au/document_page/understanding-your-plantation-forestry-project-simple-method-guide.
2. Australian Department of Climate Change, E. the E. and W. (2021). Carbon Credits (Carbon Farming Initiative-Carbon Capture and Storage) Methodology Determination 2021. <https://www.legislation.gov.au/F2021L01379/latest/text>
3. Australian Department of Climate Change, E. the E. and W. (2024a). Safeguard Mechanism: About the Safeguard Mechanism and the reforms. <https://www.dcceew.gov.au/sites/default/files/documents/safeguard-mechanism-reforms-factsheet.pdf>
4. Australian Department of Climate Change, E. the E. and W. (2024b). Safeguard Mechanism: About the Safeguard Mechanism and the reforms.
5. Australian Department of Industry, S. E. and R. (2020). Technology Investment Roadmap: First Low Emissions Technology Statement. <https://www.dcceew.gov.au/sites/default/files/documents/first-low-emissions-technology-statement-2020.pdf>
6. Australian National Audit Office. (2024). Issuing, compliance and contracting of Australian carbon credit units: Clean Energy Regulator.
7. California Air Resources Board. (2024a). About the cap-and-trade program. <https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program>.
8. California Air Resources Board. (2024b). State of California Regulation for the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms 2024 Amendments Standardized Regulatory Impact Assessment (SRIA). https://ww2.arb.ca.gov/sites/default/files/2024-04/nc-Cap-and-Trade_SRIA2024.pdf
9. California Energy Commission. (2024). Carbon Removal Innovation Support Program - CRISP. https://www.energy.ca.gov/programs_and_topics/programs/carbon-removal-innovation-support-program-crisp
10. California Legislative Information. (2024, August 4). SB-308 Net zero greenhouse gas emissions goal: carbon dioxide removal: regulations. (2023-2024). https://leginfo.legislature.ca.gov/faces/billStatusClient.xhtml?bill_id=202320240SB308
11. CARB. (2025). Compliance Offset Program. <https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program>
12. Carbon Credits (Carbon Farming Initiative) Act 2011 (2020). <https://www.legislation.gov.au/C2011A00101/2020-09-06/>
13. CCSA. (2024). Accelerating a Europe-wide CO₂ storage market. [https://www.ccsassociation.org/all-news/ccsa-news/a-europe-wide-CO₂ market-can-reduce-storage-costs-by-20-2/](https://www.ccsassociation.org/all-news/ccsa-news/a-europe-wide-CO2-market-can-reduce-storage-costs-by-20-2/)
14. Climate Change Response Act 2002 (2024). <https://www.legislation.govt.nz/act/public/2002/0040/latest/DLM158590.html>
15. Commission Implementing Regulation (EU) 2024/2493 of 23 September 2024 Amending Implementing Regulation (EU) 2018/2066 as Regards Updating the Monitoring and Reporting of Greenhouse Gas Emissions Pursuant to Directive 2003/87/EC of the European Parliament and of the Council (2024). http://data.europa.eu/eli/reg_impl/2024/2493/oj
16. Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 Amending Directive 2003/87/EC Establishing a System for Greenhouse Gas Emission Allowance Trading within the Union and Decision (EU) 2015/1814 Concerning the Establishment and Operation of a Market Stability Reserve for the Union Greenhouse Gas Emission Trading System (Text with EEA Relevance) (2023). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L0959>
17. European Commission. (2019). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions “The European GreenDeal.”

<https://eurlex.europa.eu/legalcontent/EN/TXT/?uri=COM%3A2019%3A640%3AFIN>

18. European Commission. (2021). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions “Fit for 55”: Delivering the EU’s 2030 Climate Target on the way to climate neutrality.
https://ec.europa.eu/clima/citizens/support_en.
19. European Commission. (2024a). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions “Towards an ambitious Industrial Carbon Management for the EU.”
20. European Commission. (2024b). Report from the Commission to the European Parliament and the Council on the functioning of the European carbon market in 2023.
https://climate.ec.europa.eu/document/download/92ec0ab3-24cf-4814-ad59-81c15e310bea_en?filename=2024_carbon_market_report_en.pdf
21. European Commission. (2025a). Call for evidence for an evaluation and impact assessment run in parallel - Review of the EU ETS for maritime, aviation and stationary installations, and of the Market Stability Reserve. https://climate.ec.europa.eu/eu-action/eu-emissionstrading_system-eu-ets_en
22. European Commission. (2025b). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Region on the Clean Industrial Deal: A joint roadmap for competitiveness and decarbonisation.
https://commission.europa.eu/topics/eu-competitiveness/clean-industrial-deal_en
23. European Commission. (2025c, February). EU enlargement. https://commission.europa.eu/strategy-and-policy/policies/eu-enlargement_en
24. European Commission. (2025d, April). EU emissions trading system for maritime, aviation and stationary installations, and market stability reserve – review.
https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14549-EU-emissions-trading-system-formaritimeaviation-and-stationary-installations-and-market-stability-reserve-review_en
25. European Commission. (2025e, May 19). A renewed agenda for European Union – United Kingdom Cooperation Common Understanding.
https://ec.europa.eu/commission/presscorner/detail/en/statement_25_1267
26. Global CCS Institute. (2024a). CCS Policy, Legal and Regulatory Review.
https://www.globalccsinstitute.com/wp-content/uploads/2024/11/PLR-Review-Report_15-November.pdf
27. Global CCS Institute. (2024b). Global Status of CCS 2024: Collaborating for a Net-Zero Future.
<https://www.globalccsinstitute.com/wpcontent/uploads/2024/10/Global-Status-Report-2024-Interactive.pdf>
28. International Energy Agency. (2023). CCUS Policies and Business Models: Building a commercial market.
<https://iea.blob.core.windows.net/assets/d0cb5c89-3bd4-4efd-8ef5-57dc327a02d6/CCUSPoliciesandBusinessModels.pdf>
29. La Hoz Theuer, S., Olarte, A., La Hoz Theuer, S., & Olarte, A. (2023). Emissions Trading Systems and Carbon Capture and Storage: Mapping possible interactions, technical considerations, and existing provisions.
30. Low Carbon Fuel Standard (2020). https://ww2.arb.ca.gov/sites/default/files/2020-07/2020_lcfs_fro_oal-approved_unofficial_06302020.pdf
31. New Zealand Environmental Protection Authority. (2025, January 13). Participants in the ETS.
<https://www.epa.govt.nz/industry-areas/emissions-trading-scheme/ets-reports/participants/>
32. New Zealand Government. (2025, February 21). Carbon capture one step closer.
<https://www.beehive.govt.nz/release/carbon-captureonestep>.
33. New Zealand Ministry for the Environment. (2022, June 17). Coverage of the New Zealand Emissions Trading Scheme. <https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/coverage-of-the-nz-ets/>
34. New Zealand Ministry for the Environment. (2023, August 21). Carbon removals strategy.

- <https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/carbon-removals-strategy/#:~:text=The%20strategy%20aims%20to%20build,or%20in%20long%20lived%20products.>
35. New Zealand Ministry of Business, I. and E. (2024). Regulatory Impact Statement: Policies for Carbon Capture, Utilisation and Storage.
 36. New Zealand Treasury. (2024, November 6). The Climate Emergency Response Fund. <https://www.treasury.govt.nz/information-and-services/nz-economy/climate-change/climate-emergency-response-fund>
 37. Parliament of Australia. (2024). Reforming Australia's safeguard mechanism: an update. https://parlinfo.aph.gov.au/parlInfo/download/library/prspub/10022673/upload_binary/10022673.pdf
 38. Regulation (EU) 2024/3012 of the European Parliament and of the Council of 27 November 2024 Establishing a Union Certification Framework for Permanent Carbon Removals, Carbon Farming and Carbon Storage in Products (2024). <http://data.europa.eu/eli/reg/2024/3012/oj>
 39. Romanian Ministry of Investments and European Projects. (2024). The modernization fund. https://oportunitati-ue.gov.ro/en/program/fondul-pentru-modernizare/?sf_paged=2
 40. SB-308 Net zero greenhouse gas emissions goal: carbon dioxide removal: regulations. (2023). SB-308 Net zero greenhouse gas emissions goal: carbon dioxide removal: regulations. https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB308
 41. Senate Bill No. 905 (2022). https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB905
 42. UK Department for Energy Security & Net Zero. (2023a, December 18). The long-term pathway for the UK Emissions Trading Scheme. <https://www.gov.uk/government/publications/uk-emissions-trading-scheme-long-term-pathway/the-long-term-pathway-for-the-uk-emissions-trading-scheme>
 43. UK Department for Energy Security & Net Zero. (2023b, December 20). Carbon Capture, Usage and Storage: a vision to establish a competitive market. <https://www.gov.uk/government/publications/carbon-capture-usage-and-storage-a-vision-to-establish-a-competitive-market/carbon-capture-usage-and-storage-a-vision-to-establish-a-competitive-market#fn:1>
 44. UK Department for Energy Security & Net Zero. (2024, May 7). CCUS: non-pipeline transport and cross-border CO₂ networks - call for evidence. [https://www.gov.uk/government/calls-for-evidence/carbon-capture-usage-and-storage-ccus-non-pipeline-transport-and-cross-border-CO₂-networks/ccus-non-pipeline-transport-and-cross-border-CO₂-networks-call-for-evidence](https://www.gov.uk/government/calls-for-evidence/carbon-capture-usage-and-storage-ccus-non-pipeline-transport-and-cross-border-CO2-networks/ccus-non-pipeline-transport-and-cross-border-CO2-networks-call-for-evidence)
 45. UK Department for Energy Security and Net Zero. (2024). Integrating greenhouse gas removals in the UK Emissions Trading Scheme. <https://www.gov.uk/government/consultations/integrating-greenhouse-gas-removals-in-the-uk-emissions-trading-scheme>
 46. UK ETS Authority. (2023). Evaluation of the UK Emissions Trading Scheme: Phase 1 report. <https://assets.publishing.service.gov.uk/media/657c4d9595bf65001071908c/evaluation-of-uk-ets-phase-1-report.pdf>
 47. UK Government. (2024, October 4). Government reignites industrial heartlands 10 days out from the International Investment Summit. <https://www.gov.uk/government/news/government-reignites-industrial-heartlands-10-days-out-from-the-international-investment-summit>
 48. UK Government, Scottish Government, Welsh Government, & Department of Agriculture, E. and R. A. for N. I. (2023). Developing the UK Emissions Trading Scheme: Main Response. <https://assets.publishing.service.gov.uk/media/649eb7aa06179b000c3f7608/uk-emissions-trading-scheme-consultation-government-response.pdf>
 49. UK Government, Scottish Government, Welsh Government, & Department of Agriculture, E. and R. A. for N. I. (2024a). Analytical annex to the UK Emissions Trading Scheme (ETS) scope expansion: maritime. <https://assets.publishing.service.gov.uk/media/67476284cf0d45234dd8d0f3/uk-ets-scope-expansion-maritime-consultation-analytical-annex.pdf>