Green Finance Institute

The Investment Readiness of Carbon Dioxide Removals in the UK - A Preliminary Assessment

With contributions from

ERM

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UNIVERSITY OF OXFORD

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Contents

Acronyms and abbreviations

Acronym	Description
BECCS	Bioenergy with carbon capture and storage
BSI	British Standards Institute
CCC	Climate Change Committee
CCfD	Carbon contract for difference
CC(U)S	Carbon capture (utilisation) and storage
CCP	Core Carbon Principles
CDR	Carbon dioxide removal
CRCF	Carbon Removal and Carbon Farming
CS	Cluster Sequencing
DACCS	Direct air carbon capture and storage
DESNZ	Department for Energy Security and Net Zero
EfW	Energy from waste
EPC	Engineering, procurement, and construction
ERW	Enhanced rock weathering
ETS	Emissions Trading Scheme
EU	European Union
GBE	Great British Energy
H2	Hydrogen
HMRC	His Majesty's Revenue and Customs
ICVCM	Integrity Council for the Voluntary Carbon Market
IP	Intellectual property
IPCC	Intergovernmental Panel on Climate Change
MOAE	Mineral ocean alkalinity enhancement
MRV	Measurement, reporting, and verification
NDC	Nationally Determined Contributions
NPT	Non-pipeline transport (of CO2)
NSTA	North Sea Transition Authority
NWF	National Wealth Fund
PAS	Publicly Available Specification
PPA	Power purchase agreement
RD&D	Research, development, and demonstration
T&S	Transport and storage
TRL	Technological readiness level
VAT	Value added tax
VCM	Voluntary carbon market
VCMI	Voluntary Carbon Markets Integrity Initiative
VCNM	Voluntary carbon and nature market

Introduction

Carbon dioxide removals (CDR) are a set of activities that capture and store CO_2 that is already in the atmosphere. CDR is essential for limiting the rise of global temperatures to well below 2 degrees C[1] as it enables corporates and countries to neutralise their hard to abate emissions. Nature based CDR, such as afforestation, plays a vital role in sequestering and removing carbon, and can offer valuable co-benefits for biodiversity and local communities. To reach the levels of carbon removal required, however, we also need to deploy engineered solutions such as direct air carbon capture and storage (DACCS), bioenergy with carbon capture and storage (BECCS), biochar, enhanced rock weathering (ERW), and mineral ocean alkalinity enhancement (MOAE) that can potentially reach mega tonne scale in the UK.

The largest barrier to deployment of engineered CDR across all pathways is low corporate demand, due to the high price point of carbon dioxide removal and the lack of a mandate to purchase CDR credits. Countries around the world are actively working on levers to boost corporate demand, and de-risk investment in these first of a kind technologies.

GFI and ERM interviewed 22 CDR developers in the UK across six technologies as part of a preliminary assessment of the investment readiness of engineered CDR. This paper summarises our findings and proposes a series of public and private sector levers that could meaningfully help to scale private sector capital for CDR.

1. A Primer on CDR Technologies

Carbon dioxide removals Carbon dioxide removals (CDR) are generally split into two categories:

- **Nature-based (sometimes referred to as conventional) CDR** include activities such as afforestation, soil carbon enhancement and ecosystem restoration. These CDR pathways are generally well practiced, lower cost and have co-benefits, but have higher reversal risks due to issues such as fires and changing land use.

- **Engineered (sometimes referred to as novel) CDR** include activities such as direct air carbon capture and storage (DACCS), bioenergy with carbon capture and storage (BECCS), biochar, and enhanced rock weathering (ERW). These CDR pathways are generally more expensive, less mature and more resource intensive, but they are able to store the CO_2 over much longer timescales.

Despite their early stage of development and higher costs, according to the IPCC[1],1.6-4.6 $GtCO_2$/year of engineered of engineered CDR is needed by 2050 in order to keep global warming well below 2^{oC}. Governments have begun to recognise the importance of these technologies in helping industries that will struggle to decarbonise entirely and have started to incorporate them into their national climate strategies. For example, the latest Carbon Budget produced by the UK Climate Change Committee (CCC) now includes around 36 $MtCO_2$/year of engineered CDR by 2050 in its balanced net zero scenario[2] (which represents the CCC's view of the best pathway for the UK to reach net zero by 2050). The role of CDR is clearly embedded within the UK's path to net zero and the UK Government has an ambition[3] to deploy 5 $MtCO_2$/year by 2030, although this is currently under review[4].

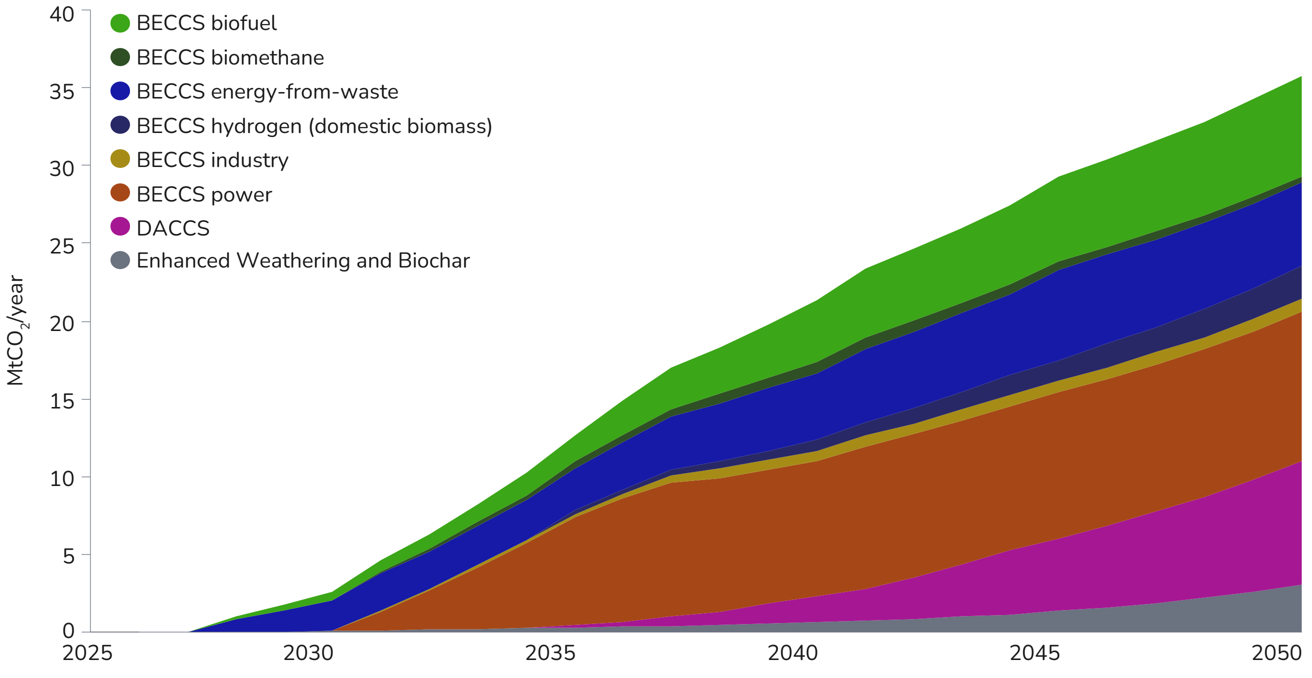
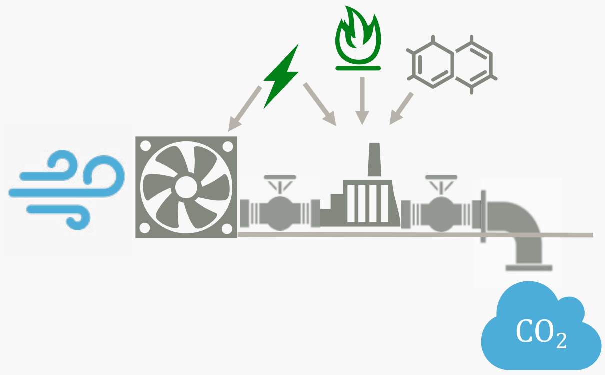


Figure 1: UK CDR deployment in CCC's 7th carbon budget[2]

GFI and ERM interviewed 22 project developers across six CDR pathways in the UK to learn more about the enabling conditions and incentives they face, as well as the barriers to achieving commercial scale. Although engineered CDR includes a wide range of solutions such as biomass burial and bio-oil injection that would benefit from further exploration our research was limited to DACCS, BECCS, biochar, ERW, concrete carbonation, and mineral ocean alkalinity enhancement (MOAE). **This paper puts forward practical recommendations to help unlock investment in these technologies.** Whilst we acknowledge that any negative environmental impacts associated with carbon dioxide removal technologies need to be addressed, that is out of the scope of this paper. These will, however, be factored in to our future work.

1.1 Direct Air Carbon Capture and Storage (DACCS)



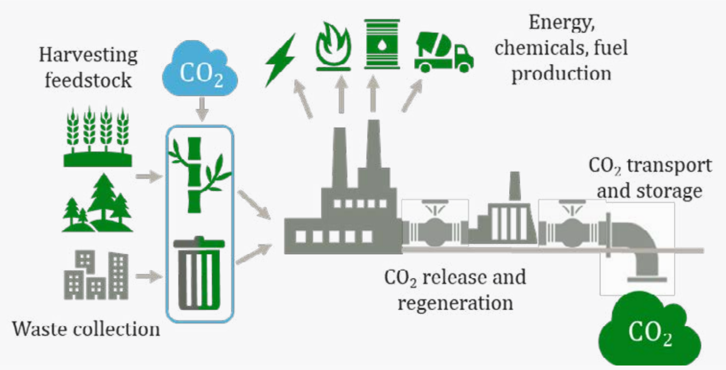
In typical DACCS systems, ambient air is moved through air contactors via fans. CO_2 from the air is bound to solid or liquid chemicals through adsorption. The chemicals are then regenerated using energy, which releases the CO_2 for further processing and permanent storage in geological formations. Technologies differ in their air contactor design, choice of capture chemicals, speed of process, and method of regeneration (e.g. temperature-swing, pressure-swing, electro-swing and moisture-swing etc.). In all cases, maximising the lifecycle efficiency of DACCS requires access to low carbon energy, which makes up a significant component of the total costs.

Tech Readiness Level (TRL)[5]	Avg. Credit Price[6]	Total Credits Sold[4]
Solids: 7, Liquids: 6	$470/tonne	2,267,714 tonnes

Scalability and investability in the UK:

- Good scaling potential in the UK with expected grid decarbonisation providing good access to low carbon electricity over the long-term, and the Government led development of an CO_2 transport network, coupled with a globally significant geological storage reservoir in the North Sea.
- To commercialise, projects require access to CO_2 transport and storage (T&S) infrastructure from 2028, access to low carbon power at lowest possible cost, access to subsidies from proposed revenue guarantee schemes, and further support on demand certainty.

1.2 Bioenergy with Carbon Capture and Storage (BECCS)



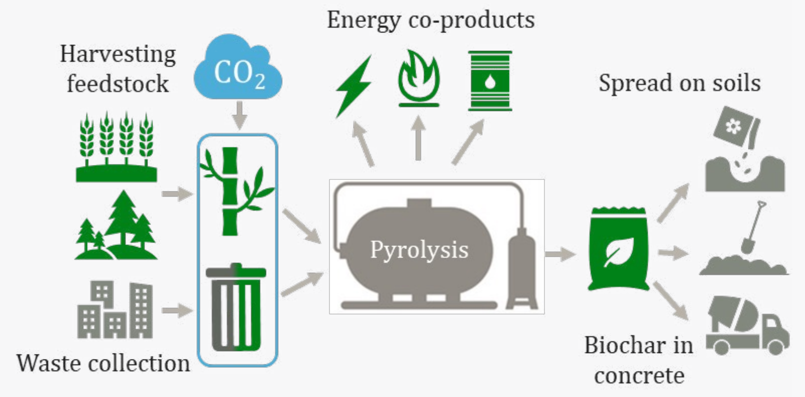
BECCS involves cultivation, processing and transport of biomass, generation of energy (such as electricity, heat, hydrogen, biomethane and biofuels), followed by capture, transport and permanent storage of the biogenic CO_2 in geologic formations. Sustainable sources of biomass could include forestry or agricultural residues, energy crops, municipal waste or waste wood. BECCS can be carried out at power plants, energy from waste (EfW) facilities, biorefineries, biofuel plants, biomethane upgrading facilities and other similar sites.

Tech Readiness Level (TRL)[5]	Avg. Credit Price[6]	Total Credits Sold[4]
Combustion: 6-7, Biomethane: 8, Gasification / Fermentation: 5	$170/tonne	7,618,980 tonnes

Scalability and investability in the UK:

- Scaling potential is significant in the medium-term but is limited by biomass availability in the long-term.
- To commercialise, UK projects require access to CO_2 T&S infrastructure from 2028 and access to subsidies from proposed revenue guarantee schemes. They also need support for non-pipeline CO_2 transport to enable BECCS at existing biomass and waste plants not located in clusters.

1.3 Biochar



Biochar is a charcoal-like solid predominantly made up of carbon. It is produced via pyrolysis, a process whereby biomass is heated in the absence of oxygen. Pyrolysis also produces co-products such as heat, bio-oil or syngas that may be used within the process or exported. Biochar is generally applied to agricultural land, so the carbon in the biochar is stored within the soil. Biochar slowly decays in soils, releasing some of its CO_2. Decay rates depend on the local soil conditions, climate, and the chemical makeup of biochar. Project developers must minimise decay by selecting optimal land for its application and by fine tuning their pyrolysis conditions to produce biochar that is resistant to decay. Biochar in soils can also have co-benefits such as enhanced nutrient retention, minimising the need for synthetic fertilisers. Biochar can also be durably buried at depth or embedded in building materials such as concrete and asphalt, but these applications are not yet widespread.

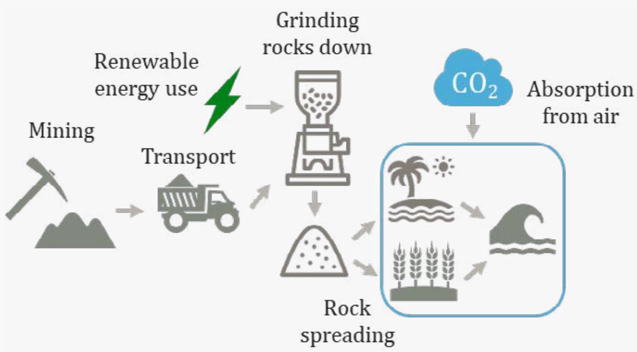
Tech Readiness Level (TRL)[5]	Avg. Credit Price[6]	Total Credits Sold[4]
9	$150/tonne	1,234,567 tonnes

Scalability and investability in the UK:

- Scalability could be limited by availability of appropriate feedstocks and land on which to spread the biochar. Current environmental regulations also limit the spreading of biochar (see below).
- Some biochar projects are already viable without subsidies, but face challenges due to permitting / planning limitations, difficulty of access to finance at required scales, lack of standardisation of biochar use in concrete, and low demand for physical biochar.

1.4 Enhanced Rock Weathering (ERW)

ERW accelerates the natural process of rock weathering using rocks rich in minerals such as calcium and magnesium, for example basalt or olivine. These rocks can be obtained as waste products from quarries or purposefully mined for ERW. Silicate-rich industrial wastes (e.g. mine tailings or fly ash) may also be used. Finer particles yield higher efficiencies, so rocks may be ground down before being spread over large surfaces such as farms, forests or beaches. When the minerals react with CO_2 in water, carbon is durably locked away in solid form. ERW can also improve soil health by reducing acidity and adding essential nutrients, but further research is required to fully understand these impacts.

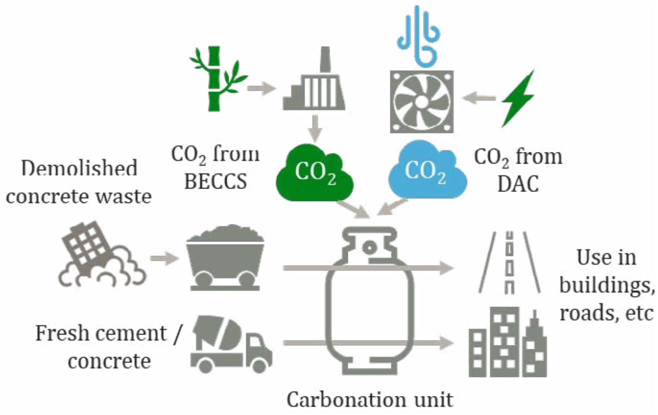


Tech Readiness Level (TRL)[5]	Avg. Credit Price[6]	Total Credits Sold[4]
6	$340/tonne	636,166 tonnes

Scalability and investability in the UK:

- Scalability is limited by the availability of feedstock and land to deploy the rock, distance from the feedstock to application sites, and soil saturation levels
- Key challenges for commercialisation include immaturity of measurement, reporting and monitoring (MRV) standards, a relatively small pool of scientific experts specialised in ERW to drive improvements in technology and MRV, exclusion from government revenue support to date, and a lack of access to consistent, high-quality feedstocks due to underinvestment in central quarries.

1.5 Concrete Carbonation



Carbonation is a process whereby atmospheric CO_2 binds with minerals to form solid carbonates. Natural carbonation of concrete and certain industrial wastes such as bottom ash occurs over long periods, but this can be accelerated if particles are exposed to concentrated CO_2 streams. Demolished concrete or other wastes can be carbonated before being used as aggregates, for example in road construction. CO_2 may also be injected directly into fresh concrete, reducing the overall demand for cement, as well as achieving removals. Carbonation is irreversible under normal use conditions (without exposure to strong acids or very high temperatures) so removals are achieved if biogenic or atmospheric CO_2 is used.

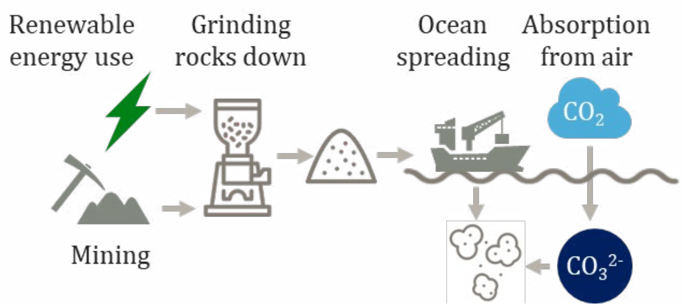
Tech Readiness Level (TRL)[5]	Avg. Credit Price[6]	Total Credits Sold[4]
9	$560/tonne	202,879 tonnes

Scalability and investability in the UK:

- Scalability is limited by the low availability of feedstock, low volumes of CO_2 captured per unit of feedstock, as well as the requirement for co-located biogenic / atmospheric CO_2. Biogas plants provide a high purity CO_2 source but competing demand from other sectors such as the food and beverage industry can lead to unstable prices. Densely populated areas are most likely to provide co-location of available CO_2 and aggregate feedstocks.
- Projects are commercially viable today as they do not require large infrastructure build, and can secure revenue streams from the sale of aggregates.

1.6 Mineral Ocean Alkalinity Enhancement (MOAE)

MOAE involves adding alkalinity through mineral particles into natural bodies of water (e.g. oceans, seas, rivers) or marine outfalls (e.g. wastewater treatment plant effluents). MOAE is very similar to ERW, the primary difference being that particles are **directly** deposited into oceans, seas and rivers. Silicates, carbonates or other mineral derivatives can be used as feedstock and be ground down to achieve higher efficiencies. Once in the water, these minerals react with carbonate to create compounds that durably store carbon. Depleted carbonates are replaced by absorption of CO_2 from the air to the water. In addition to carbon removal, MOAE also reduces water acidity and is already used for this purpose in rivers following acid rains.



Tech Readiness Level (TRL)[4]	Avg. Credit Price[5]	Total Credits Sold[5]
5-6	$480/tonne	62,638 tonnes

Scalability and investability in the UK:

- Scalability is high as oceans can absorb an almost unlimited amount of alkaline product.
- Commercialisation is challenging today as the MRV is very immature, largely due to complications with directly and accurately measuring impacts in open water. There are also some scientific and public concerns around potential negative impacts of altering ocean chemistry, leading to permitting challenges and exclusion from government policy thus far.

2. Where are the UK's Project Developers?

Although most CDR technologies are not at commercial stage, as of 2025 the UK is home to at least 80 CDR companies, based on analysis by CO2RE (UK GGR Hub), Oxford Net Zero, University of Oxford and ERM[7].

The technology range of UK companies is broad, but there is a higher prevalence of DACCS, BECCS and biochar developers, most likely due to their maturity, scalability, and policy support. Geographically, the companies are relatively widespread with a greater concentration in the south of England but given the Government's current focus on industrial clusters and corresponding support with access to CO_2 T&S, we expect to see future large-scale BECCS and DACCS projects deployed in Hynet, Teesside, and other clusters. EfW facilities are prime candidates for BECCS retrofits in the UK and are well distributed around the country, generally alongside population centres[8].

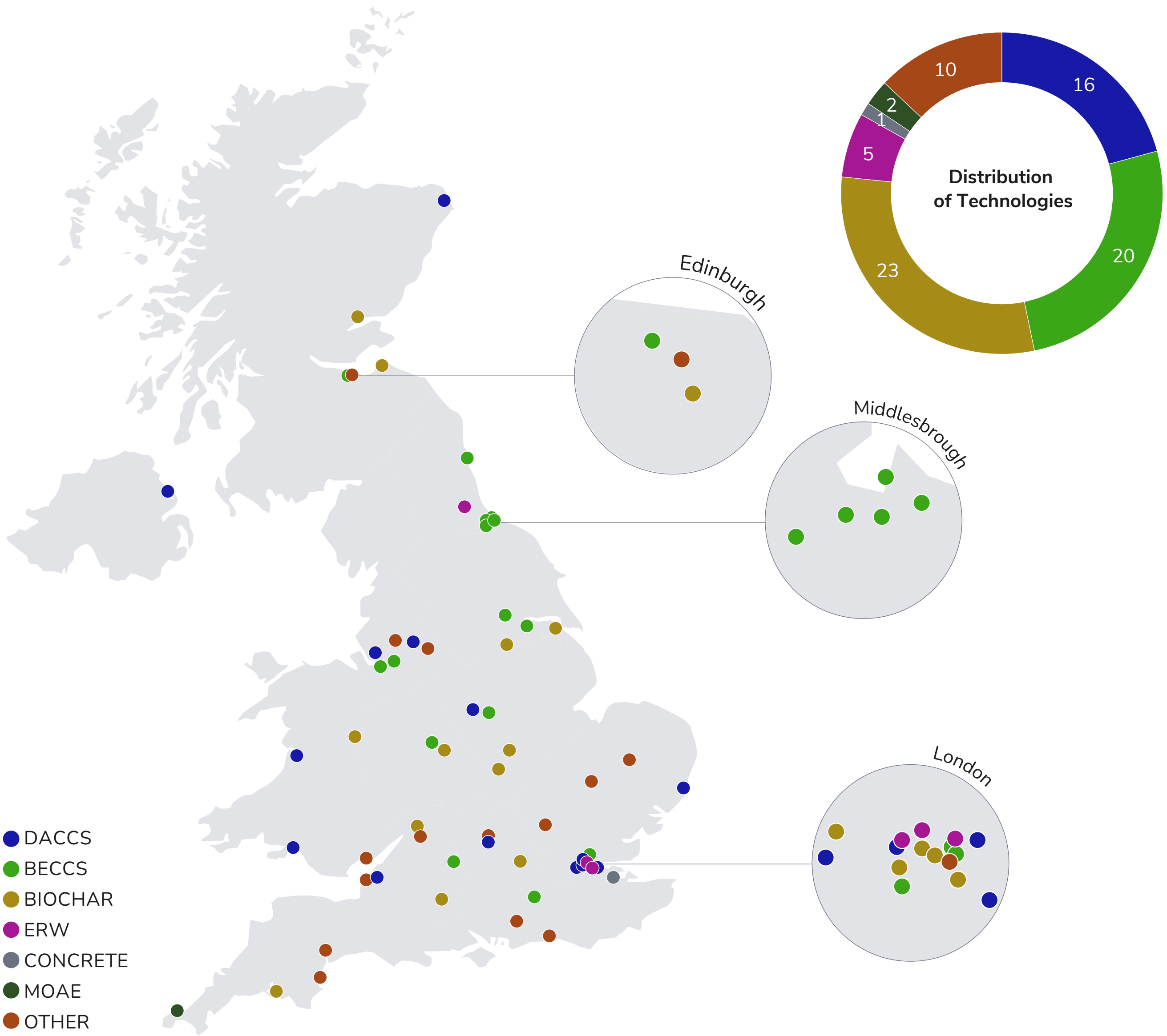


Figure 2: Map of engineered CDR companies operating in the UK[7]

3. Measurement, Reporting, and Verification (MRV)

MRV refers to a set of activities for quantifying, tracking and verifying climate impacts of projects. MRV is generally used for certification, credit issuance or compliance purposes. In the voluntary markets, MRV is governed by activity specific methodologies developed by standard setters such as Verra, Gold Standard, Puro Earth, and Isometric. These methodologies ensure that projects are additional, quantified accurately, use appropriate baselines, cause no unintended harm or carbon leakage, and result in durable carbon reduction or removal.

Effective MRV is paramount for ensuring trust in carbon markets. In recent years, significant criticisms of MRV methodologies for some activities (e.g. afforestation and clean cookstoves) have undermined confidence in the voluntary carbon market and reduced credit prices and demand. Prices of engineered CDR credits, however, have remained high due to their permanence rates and the ease of MRV for technologies such as DACCS and BECCS.

The first methodologies for engineered CDRs were launched[9] in April 2019. The CDR MRV market was initially driven by new standards developers solely focusing on CDR (not emission reduction) and CDR project developers themselves who were looking for practical solutions to deliver credits to their initial customers. Over the last few years, however, CDR methodologies have proliferated rapidly with more traditional standard developers expanding into removals. As of early March 2025, a total of 57 methodologies existed for engineered CDR,[10] but many are yet to be applied in practice and challenges for emerging CDR remain. These could be partially or entirely mitigated by applying specific market products to protect against uncertainty around MRV, such as buffer pools and insurance products.

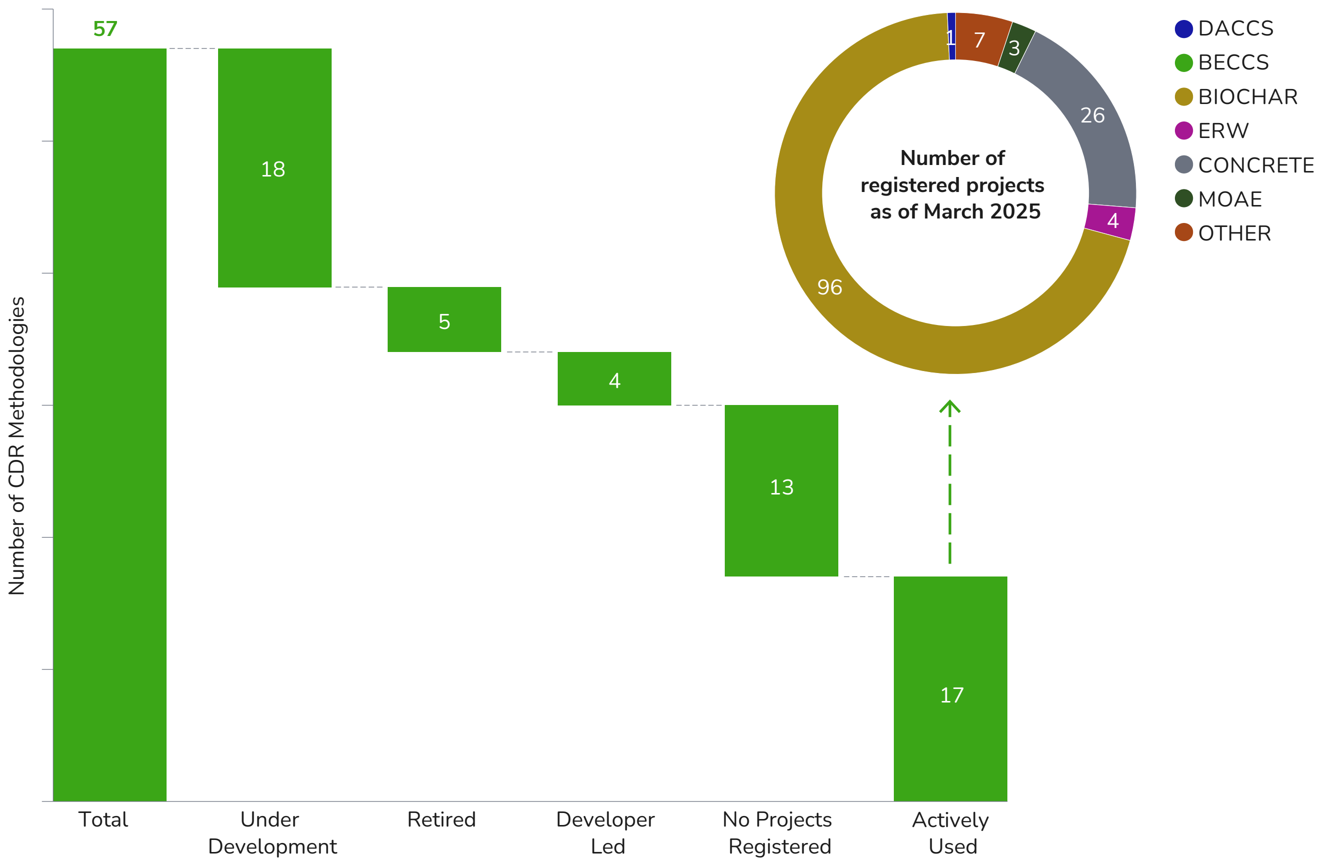


Figure 3: Breakdown of the existing MRV methodologies of CDRs (left) and the distribution of officially registered CDR projects (right)[6,11]

3.1 Key Issues with MRV for CDR

Different Carbon Dioxide Removal (CDR) methods face distinct challenges related to measurement, reporting, and verification (MRV). For DACCS, debates centre on how precisely power purchase agreements should match electricity demand, with hourly matching offering better emissions accounting but at higher costs. BECCS struggles with accounting for indirect land use changes and biomass competition. Biochar faces extensive uncertainties, including around biomass supply, degradation rates influenced by local conditions, and lack of consensus on durability timelines. ERW's CO_2 uptake is hard to measure directly, relying on complex modelling and site-specific data, with added concerns around soil toxicity. Concrete carbonation raises questions about baseline natural carbonation and long-term CO_2 stability in future use cases. Meanwhile, MOAE shares ERW's measurement difficulties, with the added complexity of tracking CO_2 dissolution in ocean environments, although controlled settings such as wastewater plants may offer more reliable MRV.

Some governments are implementing their own MRV standards against which to assess technologies in receipt of subsidies, such as a carbon contract for difference in the UK[12]. In October 2024, the UK Government appointed **the British Standards Institute (BSI) to develop national minimum quality thresholds, followed by full methodologies, for DACCS and BECCS**[13].

In the European Union, the Carbon Removal and Carbon Farming (CRCF) Framework[14] is establishing standards to provide confidence to corporate buyers of both engineered and nature-based carbon removal credits, while other countries such as Canada[15] and Japan[16] are incorporating some engineered CDR technologies into their compliance carbon pricing schemes. Under the UNFCCC Article 6.4, the Supervisory Body is also developing protocols for different engineered and nature-based CDR methodologies.

Recommendations:

- The Government and BSI should continue to develop robust UK CDR standards, including covering technologies that have near-term deployment potential such as biochar (even if at smaller scales).
- The Government should provide R&D support to improve scientific understanding and MRV methods for novel CDR pathways. This support could explore innovations to improve the accuracy of MRV and reduce costs, especially for ERW, biochar and MOAE.
- CDR developers and standard developers should support training of project validation and verification experts, especially for scientifically complex CDR such as ERW and MOAE.
- Where MRV uncertainties persist, prospective buyers of CDR credits should look at market innovations for derisking investment, such as:
    - » **Discounting:** Discounting is when buyers make fewer contribution or compensation claims than credits retired to account for uncertainties in measurement, durability, or effectiveness.
    - » **Buffer Pooling:** Buffer pooling is when a portion of credits are reserved in a shared pool to cover potential carbon reversals or project failures across multiple projects.
    - » **Insurance:** A third party provides financial coverage or replacement carbon credits to compensate for underperformance or carbon re-release, shifting the risk away from project developers.

4. Policy, Regulatory and Funding Support

The main value provided by CDR technologies is the climate benefit of carbon removals, which currently can only be monetised through voluntary purchasing, through government support, or by the sale of co-products from the carbon removal process, e.g. waste heat. Over the last five years, the UK Government has been at the forefront of establishing a favourable investment environment for CDR. The UK's most prominent policies directly supporting CDR are:

- **CDR Targets**: In its Net Zero Strategy (2021)[3] the Government committed to deploy at least 5 $MtCO_2$/year of engineered removals by 2030, potentially rising to 23 $MtCO_2$/year by 2035 and 76-81 $MtCO_2$/year by 2050. In March 2025, the Government announced a review of these targets[4], but nonetheless engineered CDR targets are likely to remain ambitious, and act as an important signal to industry.

- **Research, Development and Demonstration Funding**: In 2020, the government announced a £100 million DAC and Greenhouse Gas Innovation Programme in partnership with UK Research and Innovation (UKRI). This included an investment of £31.5 million for a central CDR coordination hub (CO2RE), as well as regional demonstrators for DACCS, ERW, BECCS, biochar, and afforestation. The remaining funds were used to support 15 innovative pilot engineered CDR projects with a target to achieve 100 or 1000 tonnes of annual removal capacity by 2025.

- **National CDR Standards**: In October 2024, the Government instructed[8] BSI to develop Greenhouse Gas Removal Standards, which will be used to quantify and certify CDR activities. BSI will prioritise DACCS and BECCS methodologies, first developing a set of Minimum Quality Thresholds followed by a series of more detailed protocols known as Publicly Available Specifications (PASs).

- **Long-term Demand Creation**: In the summer of 2024, the government ran a consultation[17] on the integration of engineered CDRs and afforestation / reforestation credits into the UK Emissions Trading Scheme (ETS), working to a 2028-2030 timeframe. Although the response to the consultation is yet to be published, this could generate bankable long-term demand for CDR if the ETS price is sufficiently high, or if it is combined with a carbon contract for difference (CCfD) mechanism. Equally the Government could look to other design principles to boost demand, such as a sub mandate requiring purchase of a certain percentage of CDR credits.

- **Price Support:** The government is committed to supporting most types of CCS activities through a CCfD business model. CCfDs are private law contracts between project developers and an appointed counterparty, which tops up market revenues (e.g. from carbon credit or ETS sales) to pre-agreed levels to enable financial viability for up to 15 years. Currently, there are separate CCfDs models being rolled out for EfW BECCS, power BECCS, industrial BECCS, and DACCS. Combined with the overall Cluster Sequencing Programme (see below), CCfDs will help enable deployment of large-scale commercial CDR within early CCS clusters.

In addition to the direct policy and governance support discussed above, other policies, regulations, and funds could indirectly benefit engineered CDRs in the UK:

- **CO_2 Transport and Storage (T&S)**: As part of the Cluster Sequencing Programme, the Government is providing financial support for CO2 T&S networks through a regulated asset base (RAB) model, where operators will be able to recover pre-agreed fees from subsidised industrial carbon capture projects. Over time, these networks will be required to allow access to third parties, including future DACCS and BECCS projects.
- **National Wealth Fund (NWF)**: The NWF was created in October 2024 with a mandate to be a public financial institution and support the wider industrial strategy, particularly where private investment is lacking. It has an initial budget of £27.8 billion and is required to spend £5.8 billion of this on five focus areas, including CCS. NWF's financial products (equity, debt, and guarantees) could be directed towards CDR or indirectly support CDR via wider CCS network support.
- **Endorsement of Carbon Markets**: In November 2024, the UK Government published its principles for voluntary carbon and nature market (VCNM) integrity, followed by a consultation on the implementation of these principles in April 2025. The principles strongly encourage private sector actors to purchase high quality carbon credits by following international best practice, such as purchasing those accredited with the Integrity Council for Voluntary Carbon Markets' Core Carbon Principles (CCP) label and making claims using the Voluntary Carbon Markets Integrity Initiative's (VCMI) Claims Code of Practice. Although the Government is not proposing any measures to directly encourage CDR demand, explicit endorsement of the voluntary carbon market (VCM) - including support for eligible frameworks for communicating and accounting for the use of high integrity carbon credits - could unlock additional demand for CDR, which heavily rely on these markets to scale.
- **Expansion of ETS to EfW**: Fossil-based CO_2 emissions of EfW facilities (~50% of total emissions) are expected to be subject to UK ETS costs from 2028 which serves as an additional incentive to retrofit CCS units and sell CDR produced by the biogenic components of the incinerated waste.
- **CCS Regulations**: Storage of CO_2 in offshore geologic formations is permitted and regulated by the North Sea Transition Authority (NSTA) based on the Energy Act 2008 and The Carbon Dioxide (Licensing) Regulations 2010. Point source capture and pipeline transport of the CO_2, as well as its MRV, is regulated through the UK ETS Authority.[18] Together, these create a favourable regulatory environment for DACCS and BECCS, although non-pipeline transport (NPT) is currently not regulated.
- **CCS Readiness Requirements**: In England, fossil power plants above 300 MW capacity have been required since 2009 to be CCS-ready in order to receive planning permission. From 28 February 2026, demonstration of decarbonisation readiness through either CCS retrofitting or H2 transition will be required. This will also apply to all new or substantially refurbished combustion-based electricity generation plants (including bioenergy and EfW installations) and will be required for environmental permit applications through the Environment Agency. As a result, future biomass electricity projects will be designed to be BECCS-ready.

Focus Box: Alternative Non-Targeted Financial Opportunities

In addition to the CDR specific support mechanisms above, there are opportunities for early-stage CDR companies to benefit from non-specific national or local programmes providing early-stage finance, grants, tax reductions, etc. These opportunities may be overlooked by many start-ups and could make a large impact. Below are examples that have been used by at least one CDR company in the UK:

- Patent Box scheme allowing companies exploiting their exclusive UK-based patents to pay a reduced corporation tax of 10%.
- The Natural Environment Investment Readiness Fund which offers competitive grants to projects that improve and safeguard the natural environment (the last round of funding closed in 2024).
- The UK Shared Prosperity Fund, which allows local authorities to invest in local businesses, alongside communities, people, and skills.
- Innovate UK innovations loans for small companies with late-stage R&D projects.
- Business grants, advisory, and other support from Scottish Enterprise.

Table 1: Summary scoring of UK CDR policy and funding support

National Context		Tech-specific Support		
UK CDR Targets		DACCS	BECCS	Primary target of all CDR policies and benefit from wider CCS networks, but funding not committed yet.
CDR Certification Standards		Biochar	ERW	Not prioritised for certification, not eligible for business model support, some R&D support, possibility for future ETS integration.
R&D and Demo Support		Concrete	MOAE	

Recommendations:

- Expand CCfD business model support to other CDR technologies such as biochar and ERW.
- Harmonise the policy development of the business model and ETS integration to ensure the combined outcome provides both price and demand certainty to CDR developers.
- Establish a new CDR accelerator to replace the previous DAC and GGR Innovation Programme that finished in March 2025 and continue the excellent coordination, research and innovation work carried out by CO2RE.
- Recognise non pipeline transport of CO_2 within the ETS and allow non pipeline transport projects to apply for support under the CCS business model.
- Include engineered CDR as a priority funding area for the National Wealth Fund.
- Re-evaluate the Environment Agency's list of types of biochar that are allowed to be spread on farmland with a view to expanding the eligibility of feedstocks.
- Clarify, simplify, and expedite the planning and permitting processes for engineered CDR, starting with DACCS and biochar.
- Establish incentives for land managers to deploy biochar or ERW on their land, such as direct payments included within R&D funding, or inclusion within the next iteration of the Sustainable Farming Incentive (for more mature applications).
- Develop building regulations to place greater value on sustainable materials such as CO_2-enriched recycled aggregates to incentivise recycling plants to invest in concrete carbonation.

5. UK's Market Infrastructure

Private sector involvement in the UK carbon credits market

The UK has a fully developed VCM ecosystem which is home to the headquarters of multiple standard setters, verification bodies, carbon credit rating agencies, insurance providers, financiers, legal advisors and portfolio advisers, some of whom specialise in CDR.

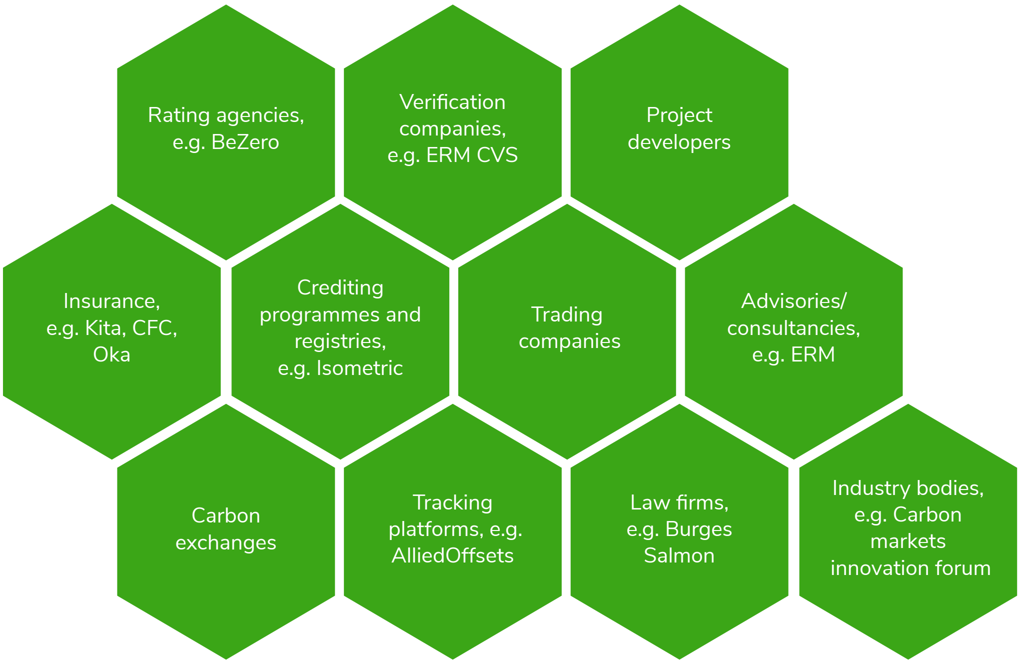


Figure 4: Players in the voluntary carbon market

There are a growing variety of players in the carbon finance space in the UK, with some examples illustrated below where the UK is leading the way:

- **London Stock Exchange Group's (LSEG) Voluntary Carbon Market designation**: The LSEG has introduced a designation for funds or operating companies that invest in climate change mitigation projects that are expected to yield carbon credits. Once an entity has received the designation, it can issue carbon credits as a dividend, retire the credits on behalf of shareholders and/or provide cash dividends. This is designed to support the financing of projects at scale through private investment.
- **UK national carbon standards:** Although the UK's national CDR standards are still under development by the BSI, the Woodland[19] and the Peatland Carbon Codes[20] are examples where the Government has already successfully supported market-based projects in the past. The Woodland Carbon Code aims to set best practice for high-integrity carbon accounting and ensure high standards of sustainable forest management. The Peatland Code is a voluntary standard that provides assurance and clarity for businesses and other investors in peatland restoration projects through independent validation and verification.
- **Insurance**: This is a nascent and growing area of interest for carbon credits. New companies or divisions are creating insurance products to address the gap in the market in the UK to protect carbon credit investments, assets and loans from all risks including political, fraud and natural disasters. Examples include: CFC, Kita (a Lloyd's coverholder) and Oka (a Lloyd's syndicate) which has an insurance product for voluntary carbon credits sold with Article 6 authorization[21].

The UK Government's position on the voluntary carbon markets (VCM)

- **UK Government stance on the VCM:** The UK Government released its principles for high integrity voluntary carbon and nature markets in November 2024, followed up by a detailed consultation in April 2025 on how to implement them[22]. The Government is minded to encourage development of VCNMs through a multi-faceted approach, involving endorsing international disclosure and credit quality standards; market regulations; clarified legal definitions of credits and accounting principles; guidance on key terminology (e.g. carbon neutrality); and compelling FTSE100 and regulated financial companies to follow mandated disclosure requirements. These initiatives demonstrate the UK Government's awareness that high integrity voluntary carbon markets can play a major role in scaling private sector finance for carbon reduction and carbon removal projects.

- **VAT status of carbon credits:** UK HMRC defines a carbon credit as "*a tradable instrument issued by an independently verified carbon-crediting programme. … Voluntary carbon credits are any carbon credits that are not compliance market credits.*" The UK carbon credit market, and the secondary trading market, are sufficiently developed that in September 2024, HMRC updated the VAT status of carbon credits. While previously the sale of carbon credits was VAT-exempt, the sale of carbon credits must now be treated as taxable for VAT where the place of supply is in the UK[23].

UK's Cluster Approach to Supporting CO_2 Infrastructure[24]

Rather than supporting stand-alone full chain CCS projects, the UK Government has adopted a **cluster approach to deploying CO_2 infrastructure**, where multiple capture sites in proximity are linked through a common pipeline connecting to a shared storage space. This is managed through the **Cluster Sequencing (CS) Programme** where clusters are assigned priorities (Track 1, Track 2, etc.) and are allocated funding sequentially. HyNet (Northwest and North Wales) and East Coast Cluster (Teesside and Humber) have been selected as the first two clusters to be developed by 2030. The main funding support will then be in the form of **CCfD business model support** for the capture sites representing best value for money and for the common CO_2 T&S networks (please see Section 4 above).

Co-location of projects in a cluster enables scaling of CCS due to **cost efficiencies of sharing common infrastructure**, potential access to waste heat sources, and delegation of the T&S operations to specialists within the cluster. CS also reduces operational cross-chain risk so the T&S network is still feasible if one capture site fails. **The CS Programme has advantages over other standalone financial incentives around the world** as it reduces project cost risk by developing capture and T&S operations in parallel.

Once initial clusters are operational, **DACCS and BECCS projects will have an opportunity to deploy in these areas** by gaining access to T&S services at reasonable prices and will increase the resilience of the network by diversifying CO_2 sources.

Recommendations:

- Align UK standards, such as the Flex Standards under development by BSI, with the ICVCM Core Carbon Principles, EU CRCF, and UNFCCC Article 6 criteria being developed by the Supervisory Body for the Paris Agreement Crediting Mechanism. This is to ensure that UK CDR projects are not perceived to be inferior to those meeting international standards, so that project developers can easily adapt to the UK's requirements, and so potential buyers of credits are not confused or overwhelmed by the number of different international standards.

- The UK Government's VCMN consultation should ensure all corporates are encouraged to use high integrity carbon credits in addition to decarbonising their operations.

- To ensure that the UK delivers on its CDR targets, the Cluster Sequencing process could be leveraged fully by requiring CCS clusters to host a minimum number of diverse CDR technologies.

6. Financing CDR

CDR developers, like most companies advancing nascent technologies, are expected to go through a common financing cycle, depicted in Figure 5 below. **The type of finance required is expected to transition from grants and equity funding to project finance** as technologies and business models mature, the sector scales, and risks are reduced.

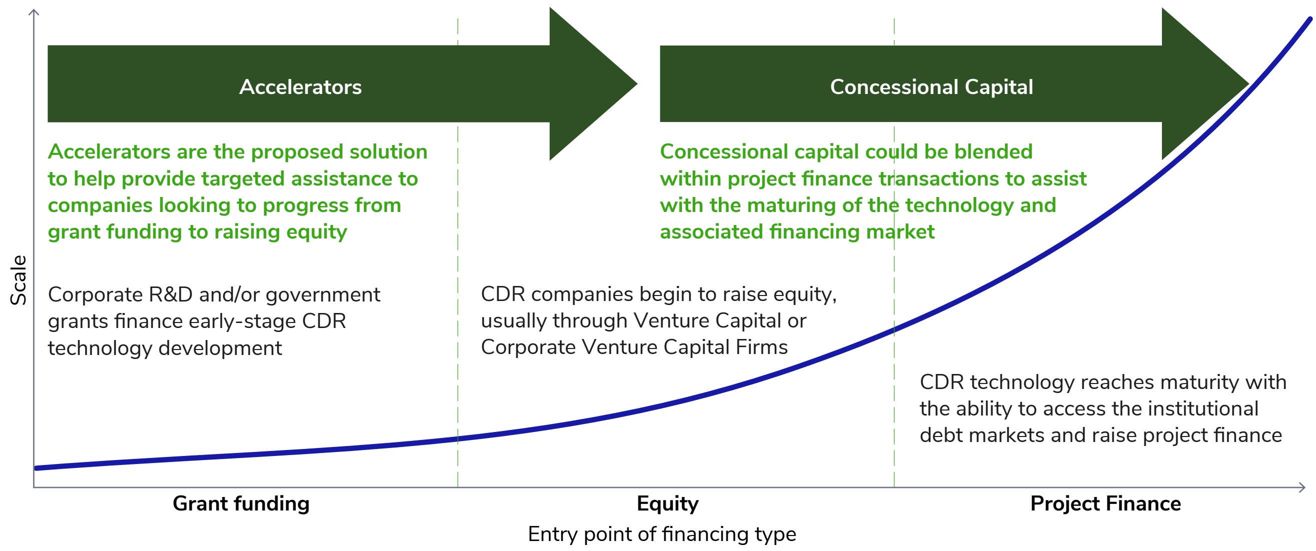


Figure 5: General Financing Cycle of innovative CDR Technologies

Accelerators and concessional capital provided by private or public organisations are likely to be the most effective finance solutions in helping companies attract initial investment.

As CDR developers progress their projects towards commercial enterprises, project finance will be necessary to provide the significant capital investment required to construct the facilities. To raise project finance it is critical to first secure long-term contracted revenues through offtake agreements. These contracts help de-risk the project by providing predictable cash flows. Investors and lenders are more willing to commit when strong counterparties guarantee future income streams.

However, certain engineered CDR technologies have a high cost of production (see A Primer on CDR Technologies section above), particularly when compared to nature-based removals. Consequently there is insufficient demand in the market for long-term offtake agreements at the volumes required to scale the sector. The proposed UK Government GGR Business Model (see Policy, Regulatory, and Funding Support section) will be a critical enabler to reduce the price premium of engineered CDR, but more still needs to be done to support demand.

6.1 Boosting Demand for CDR across all Pathways

Demand from the VCM alone will be insufficient to scale the sector and meet UK Government removals targets. Further action is required, with several potential measures listed below that would increase CDR demand in the UK. Critically, any demand side drivers need to work seamlessly with the GGR Business Model. GFI and ERM will explore demand side drivers in greater detail in a complementary paper.

Table 2: Potential cross-cutting solutions to increase CDR demand

White Rows:	Financial Factors	Grey Rows:	Non-Financial Factors

	Barriers	Solutions
High Impact	Lack of corporate demand for engineered CDR.	A **UK-focused CDR fund that combines demand for CDR and appetite to invest in CDR technologies.** The fund should support investors and corporate buyers of carbon credits to finance CDR projects according to their risk appetite. Backing from one or more larger companies may encourage participation of smaller or first-time entrants.
		A government-backed **voluntary corporate net zero framework for the eligible use of carbon removal credits**, or mandating carbon removal milestone targets for corporates (with some exclusions) such as introduced in Switzerland in early 2025.
		A public **procurement programme** to drive demand, knowledge and expertise in the sector, and to test the introduction of CDR into the UK ETS.
		Government **mandates for companies to purchase CDR credits**, which could be set through the UK ETS by requiring obligated parties to source a minimum level of CDR allowances or through novel mechanisms such as a Carbon Takeback Obligation, requiring companies in certain sectors or of certain sizes to procure CDR in proportion to their emissions.
		Create a Government backed CDR purchasing vehicle that aggregates ETS demand to facilitate long-term bankable offtake agreements for CDR developers.

The subsections below provide an initial assessment of the average position of DACCS, BECCS, biochar and ERW companies on the finance journey. We have not included concrete carbonation and MOAE due to insufficient data but will be researching these pathways in greater detail in future work.

We have also suggested solutions to overcome the financing barriers faced by each technology. Some of these would need to be delivered by policymakers, while others are targeted towards investors or the CDR community.

6.2 DACCS

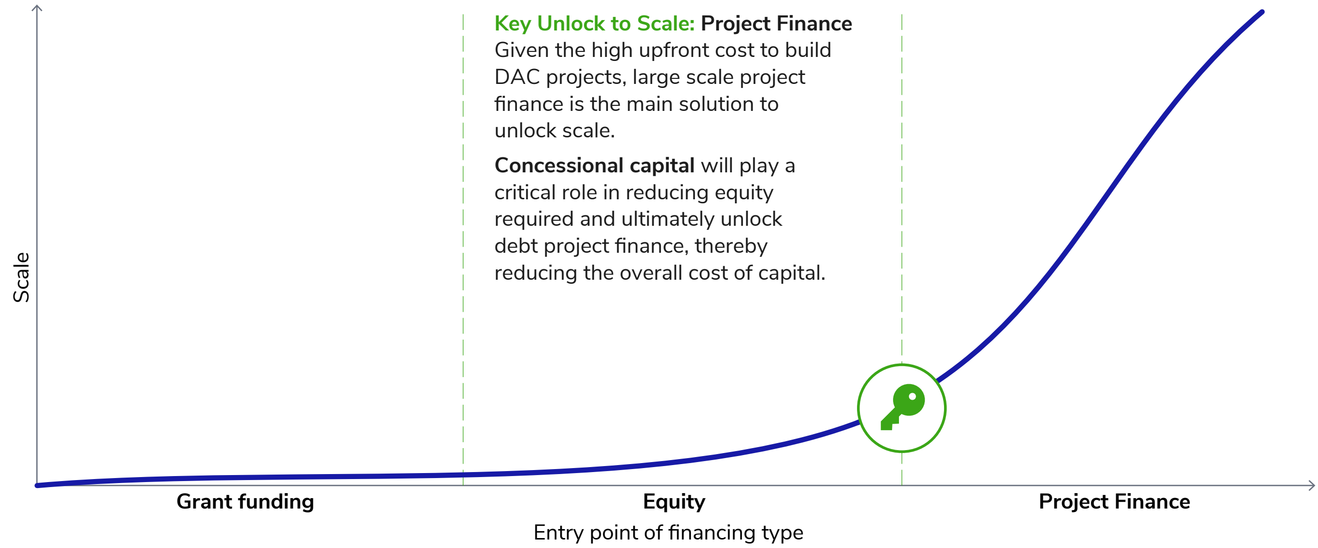


Table 3: Key barriers and potential solutions for DACCS deployment in the UK.

White Rows:	Financial Factors	Grey Rows:	Non-Financial Factors

	Barriers	Solutions
High Impact	Limited access to affordable low carbon power.	Preferential tariffs and low carbon power purchase agreements (PPAs)- perhaps supported by GB Energy - could reduce price volatility risk. DACCS plants may also be exempted from electricity taxes or decarbonisation policy levies. Co-location of projects to take advantage of waste heat.
High Impact	Accessibility and high cost of finance for FOAK projects.	Availability of grants and concessional capital to create investable projects, coupled with access to government provided revenue support (e.g. CCfD).
High Impact	Complex transport and storage (T&S) infrastructure requirements.	Cluster approach: Inclusion of DACCS projects within existing and future T&S clusters. This could be extended to a government requirement to include a DACCS project within each cluster.

6.3 BECCS

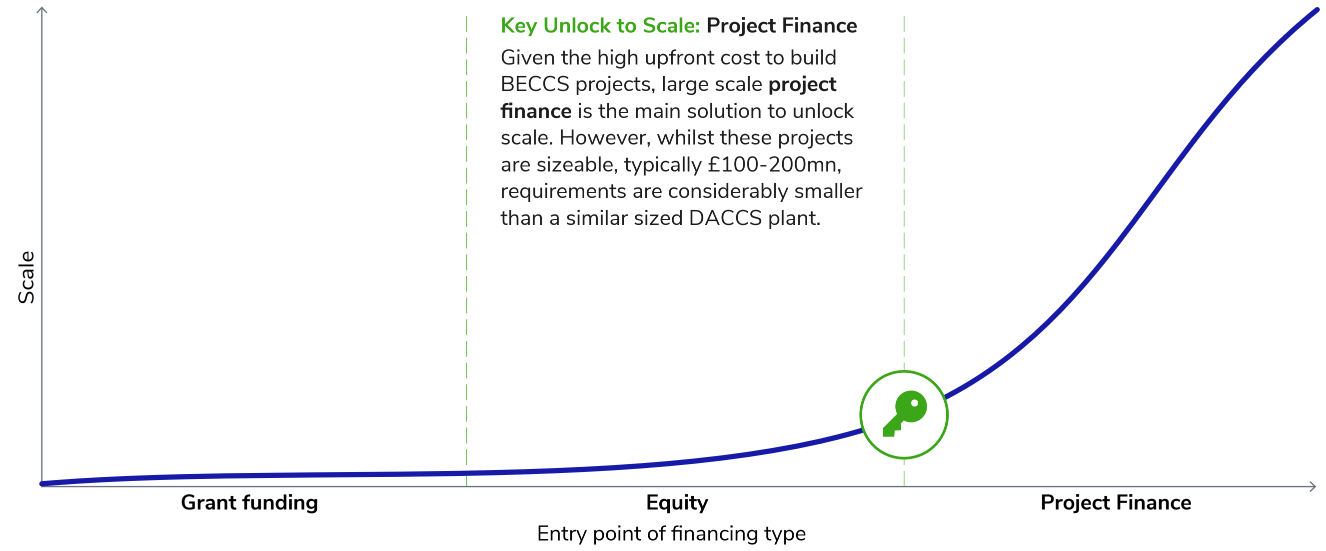


Table 4: Key barriers and potential solutions for BECCS deployment in the UK.

White Rows:	Financial Factors	Grey Rows:	Non-Financial Factors

	Barriers	Solutions
High Impact	Accessibility and high cost of finance for FOAK projects.	Access to government provided revenue support (e.g. CCfD).
High Impact	Complex transport and storage (T&S) infrastructure requirements.	Cluster approach: Inclusion of BECCS projects within existing and future T&S clusters. This could be extended to a government requirement to include a BECCS project within each cluster.
Medium Impact	Limited availability of sustainable, domestic biomass feedstocks and public acceptability concerns, which does not exist for EfW plants or projects using waste wood feedstock.	Setting robust biomass sustainability criteria as with the Low Carbon Hydrogen Standard. Requiring CDR projects to meet these for 100% of feedstock supply.

6.4 Biochar

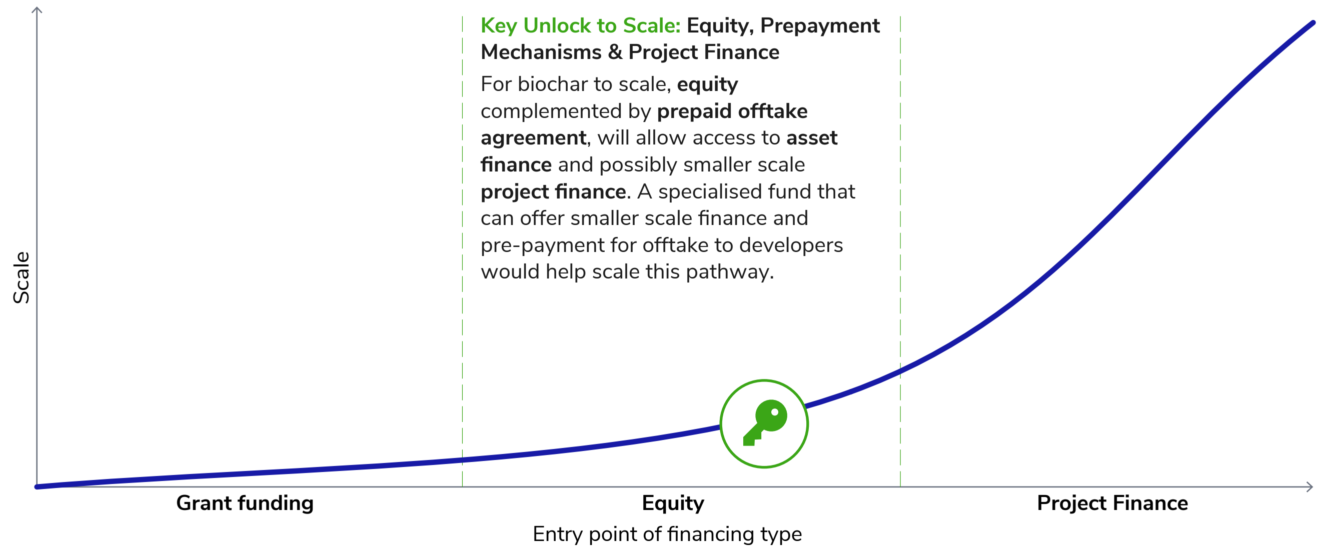


Table 5: Key barriers and potential solutions for Biochar deployment in the UK.

White Rows:	Financial Factors	Grey Rows:	Non-Financial Factors

	Barriers	Solutions
High Impact	Difficulty of accessing small scale financing options (<£20m).	Diversified CDR investment fund offering smaller scale finance and prepayment of offtake agreements.
High Impact	Lack of incentives for landowners to spread the biochar	Incentives for land managers to deploy biochar on their land, for example inclusion of biochar application within the next iteration of the Sustainable Farming Incentive.
High Impact	Biochar being excluded from early CCfD business model support schemes	Allow biochar projects to apply for CCfD business model support for removals. If desired, biochar projects could compete in a separate funding pot to ensure that multiple technology pathways are eligible for support.
High Impact	Current Environment Agency regulations only allow spreading biochar from the cleanest wood and agricultural waste to farms and limit the volumes that can be spread per year. This excludes using residues such as compost, manure, and other animal waste that have been demonstrated to be safe.	Review restrictions around biochar land application and develop a Publicly Available Specification (PAS) on biochar, expanding the types of feedstocks allowed in producing biochar for land applications. To strike a balance between simplicity and environmental protection, the PAS could have a list of eligible feedstocks, coupled with a process to test the environmental safety of the feedstock.
Medium Impact	Long lead times for pyrolysis equipment.	Investment opportunity: Investing in pyrolysis manufacturing and technology developers
Medium Impact	Most VCM standards and product standards do not recognise / allow biochar stored in concrete, asphalt, other products or used for water filtration.	Expand biochar methodologies to consider alternative storage methods if durability can be robustly demonstrated. Consider moving to performance-based concrete / asphalt standards, rather than composition-based standards.
Low Impact	Complex permitting and planning requirements increasing project costs and timelines by classifying certain projects that use waste as a feedstock as waste management activities.	Simplification of the permitting process by central and local government, plus guidelines to help developers in different regions navigate the process.
Low Impact	Lack of a clear authority on biochar related matters, with both Defra and DESNZ having responsibilities.	Identify a single department or office to be the primary point of contact for biochar related permitting, standards, and funding.

6.5 ERW

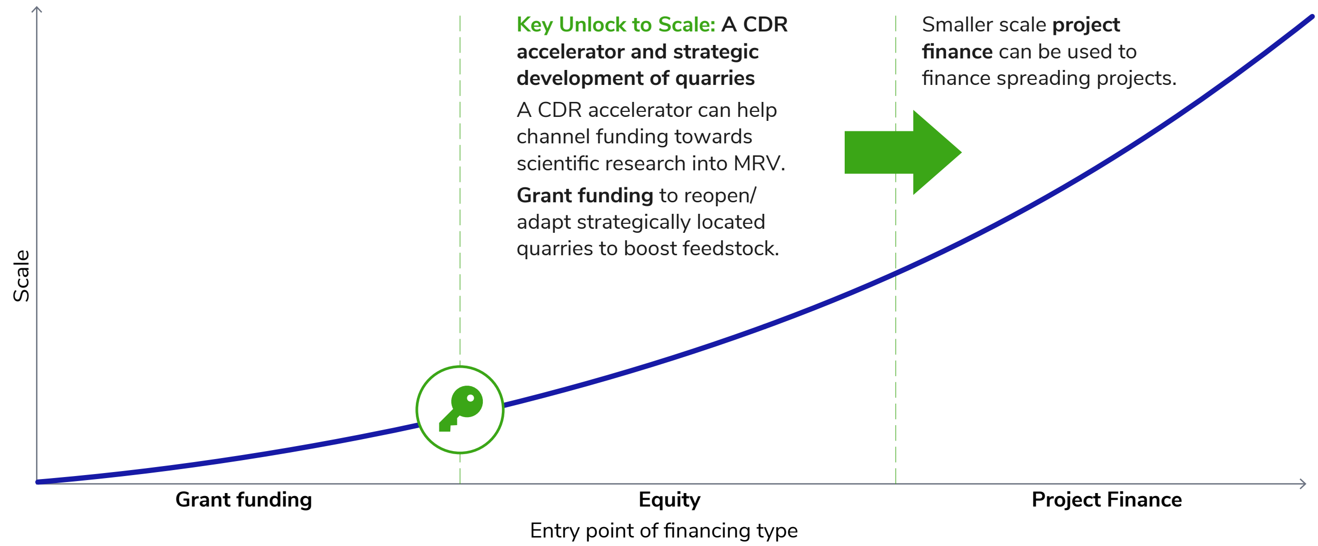


Table 6: Key barriers and potential solutions for ERW deployment in the UK.

White Rows:	Financial Factors	Grey Rows:	Non-Financial Factors

	Barriers	Solutions
High Impact	Remaining key methodological uncertainties on MRV, amplified by limitations in knowledge sharing.	Establish a CDR accelerator that can channel public and private funding to scientific research in MRV, e.g. UKRI grants may be used to support innovation in monitoring and sensor technologies. Encourage knowledge sharing as part of grant funding.
High Impact	Lack of incentives for landowners to spread the rock.	Incentives for land managers to deploy rock on their land, for example offering payments to land managers as part of R&D grant funding.
High Impact	ERW being excluded from early CCfD business model support schemes	Allow ERW projects to apply for CCfD business model support for removals.
Medium Impact	Lack of high quality and consistent feedstock supply due to small quarries in the UK that have different rock compositions requiring complex tests and trials.	Public and private financial support to establish a central feedstock supply point, e.g. a currently mothballed mine with high quality and consistent rocks. This site could serve multiple ERW projects and companies, achieving economies of scale.
Medium Impact	Shortage of scientific experts in ERW who can support innovation in MRV, project development and due diligence.	Increased cooperation between academics and private companies – facilitated by a CDR accelerator. CDR sector skills funding, with support for PhD programmes and laboratory upgrades.

7. Conclusion

The UK is on the way to becoming an attractive location for investing in CDR, not least because of the UK Government's 'carrot and stick' approach to supporting the sector. In an effort to stimulate deployment of CDR technologies, the Department for Energy Security and Net Zero is actively working on the roll out of bespoke carbon contract for difference models (the GGR business model) to provide revenue support, as well as potential access to further upfront grant funding to de-risk first of a kind technologies. Furthermore the country's industrial CCS clusters present a commercial opportunity for large scale plants such as DACCS and BECCS through co-location with, and guaranteed access to, CO_2 storage sites, as well as support with transport and storage costs. As regards a 'stick' to drive investment into CDR, the Government is currently consulting on the integration of CDR into the UK ETS. In parallel, the Government hopes to boost demand for removals credits in the voluntary carbon market through its Principles for High Integrity Voluntary Carbon and Nature Markets.

Underpinned by a world leading academic knowledge base, the UK is a hub for technology and project innovation. With its specialist insurance providers and financial and legal expertise, its carbon registries and carbon credit traders, the UK is also well positioned to be a global centre of delivery services for high integrity and innovative carbon markets.

In order to maximise the potential of the sector as an attractive prospect for investors, however, we need to combine **specific policy support** with **voluntary corporate demand** and **innovative financial solutions**. Policymakers are urged to accelerate key support programmes and consider the policy solutions explored above. We believe this is the best route to underpin private sector investment and significantly scale engineered CDR in the UK.

The GFI recommends the following four public - private levers that could be effective in the short term to drive CDR commercialisation and investment:

1. **Public: Harmonise integration of CDR into the UK ETS with the design of the GGR business model.** In order to make these high risk technologies attractive to private capital, the GGR business model needs to address the fundamental needs of the finance sector to ensure it meaningfully de-risks early stage investment. The interlinkage of the GGR Business Model with the UK ETS will be critical to de-risking the sector over the long-term.

2. **Public: Prioritise several large-scale engineered CDR plants (e.g. DACCS and BECCS) in planned and future clusters,** getting several projects to commercialisation and building investor confidence in the UK. Unleash the full potential of CDR by inclusion of non-pipeline CO_2 transport in business models.

3. **Public- private: Establish a CDR accelerator to support multiple technology pathways as they progress from pilot stage to early commercialisation, to early growth stage,** creating a portfolio of solutions that would ideally feed into a UK CDR fund. Depending upon the technology pathway, support could range from access to urgently needed R&D funding for improvements in measurement and verification, through to access to investors and strategic growth partners. The accelerator should build on work carried out by CO2RE and work in close collaboration with the academic and scientific research community in the UK.

4. **Private: Establish a UK focused diversified fund ideally combining investment in CDR offtake agreements and CDR projects or companies,** with an independent fund manager, thereby harnessing the expert carbon market services available in the UK. By investing in a portfolio of projects, support can be channelled to all technology pathways, including smaller, distributed technologies such as biochar, ERW, and concrete carbonation, as well as larger projects.

8. References

1 Smith, S., et al. The State of Carbon Dioxide Removal, 2nd Edition (June 2024) [Link]

2 CCC, The Seventh Carbon Budget (February 2025) [Link]

3 HM Government, Net Zero Strategy: Build Back Greener (October 2021) [Link]

4 DESNZ Independent Review of GGRs: Terms of Reference (March 2025) [Link]

5 TRLs are based on a combination of ERM's opinions and the definitions and assessments made by IEA's Energy Technology Perspectives (October 2024) study [Link]

6 CDR.fyi average credits prices by technology and credits sold per supplier (accessed 04.03.2025) [Link].

7 UK CDR company data is based on data provided in kind by CO2RE, which was updated by ERM based on an online search of the companies and addition of more companies with publicly stated intensions to become BECCS developers. Location is based on company headquarters and was sourced from company websites, LinkedIn profiles, and official business registers via Gov.uk. In cases where companies are based outside of the UK but have active projects in the UK, project locations were used as the basis for inclusion in the map.

8 ERM, EfW with CCS: a key pillar for net zero in the UK (November 2024) [Link]

9 Puro Earth's "About us" webpage (accessed 12.03.2025) [Link]

10 Based on ERM's review of the voluntary carbon markets as of early March 2025, which builds on the public list of methodologies identified by CDR.fyi [Link]. ERM cannot guarantee comprehensiveness of this data because CDR M R V is a highly dynamic field with rapid emergence and retirement of methodologies almost every month.

11 Registered projects are based on projects officially appearing on registries of all the identified standards, including projects in the process of registering. Note that these are not likely to be the actual number of all CDR projects in the world, since some projects may not register with standards.

12 DESNZ Update on the Design of the Greenhouse Gas Removals Business Model and Power BECCS Business Model (December 2023) [Link].

13 DESNZ Contract Award Notice: Greenhouse Gas Removals (GGR) Standards and Methodologies (October 2024) [Link]

14 DESNZ Contract Award Notice: Greenhouse Gas Removals (GGR) Standards and Methodologies (October 2024) [Link]

15 EU CRCF Regulation official website (accessed 05.03.2025 [Link]

16 Preliminary Draft Federal Offset Protocol for DACCS under Canada's Greenhouse Gas (GHG) Offset Credit System (January 2025) [Link]

17 DESNZ consultation on integrating greenhouse gas removals in the UK Emissions Trading Scheme (May 2024) [Link]

18 The main UK ETS regulation is the Greenhouse Gas Emissions Trading Scheme Order 2020, which is broadly based on the EU ETS regulations, including the associated monitoring, reporting, and verification regulations. [Link]

19 The UK Woodland Carbon Code, version 2.2, April 2022 [Link]

20 The Peatland Code, version 2.1, October 2024 [Link]

21 Oka's Corresponding Adjustment Protect insurance product [Link]

22 DESNZ Policy Paper on voluntary carbon and nature market integrity: UK Government principles (November 2024) [Link] and DESNZ consultation on raising VCNM integrity (April 2025) [Link]

23 UK HMRC, Revenue and Customs Brief: VAT treatment of voluntary carbon credits (May 2024) [Link]

24 UK Government press release funding UK's first carbon capture sites (October 2024) [Link]

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