

ACCELERATING CARBON DIOXIDE REMOVAL

Unlocking the UK's potential
to support global net zero



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EXECUTIVE SUMMARY

Carbon dioxide removal (CDR) is attracting mounting interest from potential corporate purchasers in search of a solution for hard-to-abate residual greenhouse gas emissions, as well as investors and project developers looking to participate in a high-growth emerging industry. It reflects a growing recognition that carbon removal must scale substantially to limit global warming to tolerable levels.

As research for this report, we spoke with more than 30 companies operating in the carbon removal space to explore the state of the market today and the conditions necessary to foster the industry's expansion, globally and in the United Kingdom. We found promising signs of development across the ecosystem, but also major challenges that must be addressed if the market is to scale.

To date, we estimate that over \$30 billion in capital has been invested in CDR projects globally in anticipation of that growth. Yet CDR suppliers face considerable uncertainty over the scale of demand from corporates for the carbon credits their projects generate. Ambiguity over how carbon credits can be used in transition plans and mandatory disclosure frameworks, concerns over high price points for credits, and the lack of a clear link to carbon taxes and permit schemes are key barriers inhibiting corporates from purchasing at scale.

If these barriers are addressed, we estimate that the global market for CDR credits may reach \$100 billion a year between 2030 and 2035. On the current growth trajectory, we anticipate a market size one-tenth that amount.

The UK has the potential to play a leading role within this global market. The UK benefits from attractive geology and existing infrastructure to support carbon storage and is already a burgeoning centre for R&D in engineered solutions. With the woodland and peatland codes already in place, it is also well positioned to significantly scale nature-based solutions. As a major financial centre, it can bring together the financing, trading, insurance, legal, and standard-setting capabilities that will be needed to establish the level of integrity necessary to create a large-scale market.

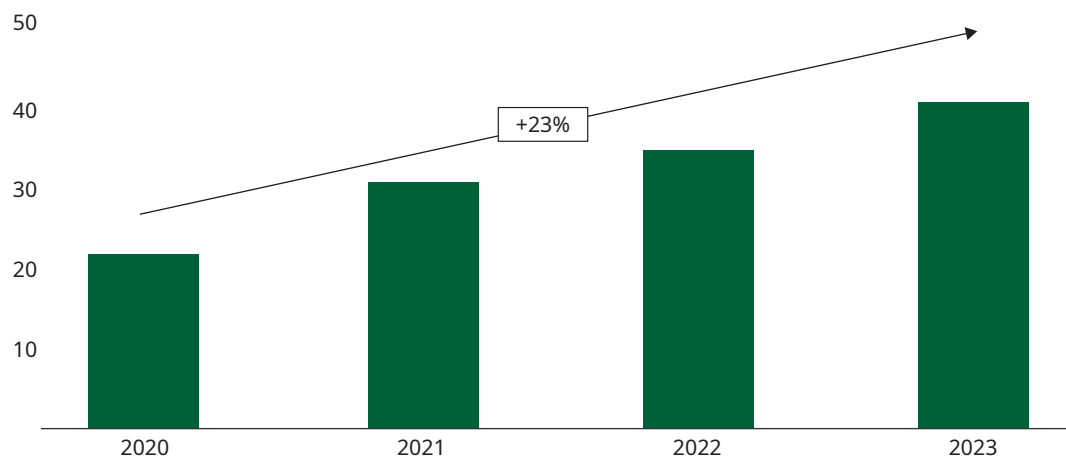
However, the UK must take action or risk losing ground to other markets that are also mobilising around the opportunity. We identify six actions that would help position the UK as a leading centre for CDR. They are:

- Articulate the role of carbon removal in the UK's net zero strategy
- Set out how removal credits should be recognised within corporate transition plans
- Put in place clear minimum standards for credits, with independent oversight
- Include carbon removal in the UK Emissions Trading System (ETS)
- Additional subsidies and financial support mechanisms for projects
- Support the development of the carbon market ecosystem

The research underpinning this report was led by Oliver Wyman in collaboration with the City of London Corporation and the UK Carbon Markets Forum.

Exhibit 1: Removal credit issuances are growing rapidly, up annually 23% on average

Carbon removal credits issued between 2020 and 2023

In megatonnes of carbon dioxide equivalent (Mt CO₂e)

Source: ClimateFocus.com, BeZero, CDR.fyi, Oliver Wyman analysis

DRIVERS OF CDR MARKET GROWTH

Global issuance of CDR-backed carbon credits has grown at an average annual rate of 23% since 2020. By contrast, avoidance and reduction credits have declined by 7% annually over the past three years, although they remain the bulk of the market today, accounting for 87% of voluntary carbon market (VCM) issuance in 2023. These credits are based on projects that seek to offset emissions by avoiding the destruction of ecological systems that sequester carbon dioxide (CO₂) or reduce emissions through the replacement of carbon-intensive activities with lower carbon alternatives. One example is the global effort to replace charcoal cooking with more efficient, low-carbon cookstoves.

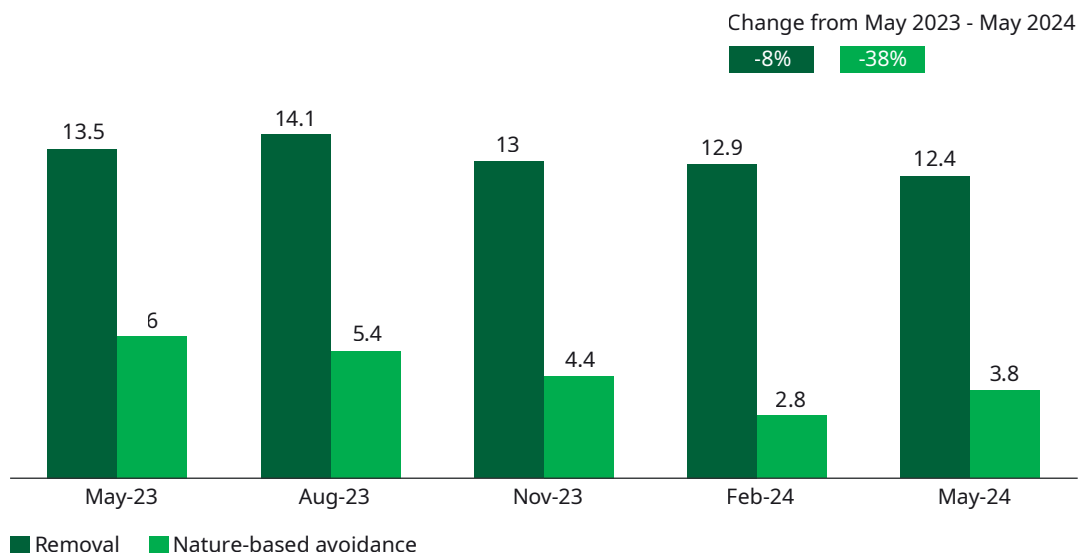
In recent years, environmental groups and others have raised questions about the validity of some of these credits, pointing to challenges in setting emission baselines and demonstrating the additionality of the projects. The primary question is whether avoidance projects lead to tangible cuts in carbon dioxide equivalent (CO₂e) emissions in the atmosphere that would not otherwise have occurred.

At the same time, there is increasing focus amongst corporates on how they will address their residual emissions. Net zero frameworks, such as the one from the Science-Based Targets initiative (SBTi), state that CDR credits may be used to address hard-to-abate residual emissions. As a result, an increasing number of corporates are beginning to explore the CDR market, while approaching the remainder of the carbon credit space with caution.

This pivot toward removal credits is also reflected in the widening price spread between nature-based removal and avoidance credits. Data from Platts, part of S&P Global Commodity Insights, shows the decline in nature-based avoidance prices since early 2023 to be almost five times greater than the decline in nature-based removal prices.¹

Exhibit 2: The spread widens between removal and avoidance credit prices

S&P Platts assessment of credit price (In US dollars per tonne of CO₂e (\$/tCO₂e))



Source: Platts, part of S&P Global Commodity Insights

While demand for CDR credits is growing, it is not yet at a scale that would make current projects commercially sustainable and far below the level experts say is required to achieve net zero.

¹ Between the end of May 2023 vs 2024, the Platts CRC (removal credits) assessment shed 8% to be assessed at 12.4 \$/tCO₂e on 31 May 2024; by contrast, the Platts nature-based avoidance price assessment shed 38% of its value over the same period, ending 31st May 2024 at 3.8 \$/tCO₂e. Platts CRC reflects the daily, most competitive values of the most fungible removal credits.

Around 41 megatonnes of CDR credits were issued in 2023, with supplier revenues of \$2.7 billion.² We estimate sales would need to increase three to five times to provide a sustainable revenue base for the industry, based on current investment levels. According to the developers we interviewed, the lack of certainty around future demand for CDR credits is the biggest challenge they face.

There is also no clear consensus among climate standard setters on the right balance between carbon removal and reduction in emissions to reach net zero. But there's no doubt carbon removal needs to be part of the equation, with all major scenarios that set out a path to successfully limiting global temperatures require a massive scaling of the CDR market. For example, in a scenario where emissions are reduced by 90% by 2050, in line with SBTi guidelines, around one to 1.5 gigatonnes of removal per year is required by 2030-2035, growing to 4 gigatonnes by 2050. This implies a growth of 25 times relative to today's levels by 2030-2035, and 100 times by 2050. Scenarios that envision less success in reducing emissions and so require more aggressive growth in carbon removal technologies require even faster expansion of the CDR market. For example, the NGFS Delayed Transition scenario relies on 13 gigatonnes of removal by 2050³.

In the UK, the government has pledged to deliver five megatonnes per year of engineered removal by 2030, from no significant volume to date, and 75 to 80 megatonnes per year by 2050.

² Including forward offtake agreements

³ NGFS REMIND-MAGPIE

UNDERSTANDING CDR

A CDR credit certifies that a tonne of CO₂ equivalent has been permanently removed from the atmosphere. These credits can be delivered through various removal techniques, typically categorised into nature-based solutions, such as afforestation, and engineered solutions, such as direct air capture (DAC).

Exhibit 3: Removal credits certify CO₂ equivalent has been removed from the atmosphere

Avoidance Carbon Credits

Prevention of additional CO₂ emissions from entering the atmosphere by reducing harmful sources of emissions

Price point	~£5-20/tCO ₂ e
# issuances (2023)	~313 MtCO ₂ e
Growth (2020-2023)	12%



Avoided deforestation and forest degradation

REDD protects existing carbon stocks



Point-source capture and utilisation

Reuse of CO₂ for productive activities, e.g., carbon-neutral synthetic fuel



Cookstoves

Changes in cooking methods to reduce damage to communities health and the environment



Renewable energy

Alternative energy sources, e.g., wind, solar, and more.

Removal Carbon Credits

Removal of CO₂ emissions directly from the atmosphere, typically used for hard-to-abate carbon intensive processes

Price point	~£30-1,000/tCO ₂ e
# issuances (2023)	~41 MtCO ₂ e
Growth (2020-2023)	23%

Nature-based removals



Blue Carbon



Agri Land Management



Afforestation

Engineered removals



DAC



BECCS



Biochar/Bio-oil



Enhanced weathering



Ocean Alkalinity

Source: Oliver Wyman

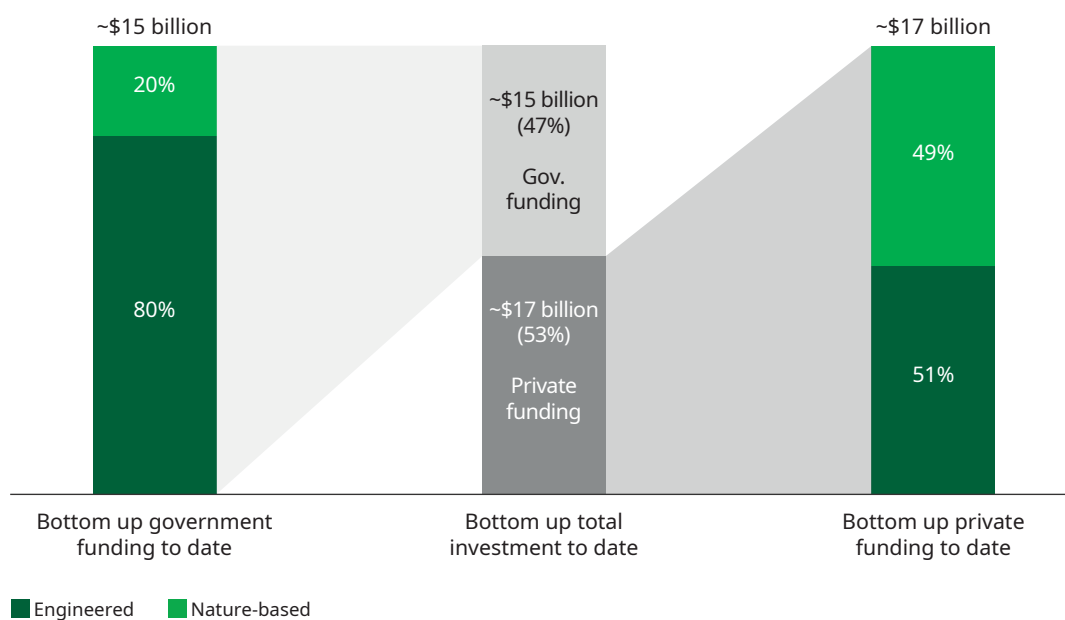
CARBON DIOXIDE REMOVAL INVESTMENT



The promise of significant growth in the CDR market has attracted a surge of capital into projects from investors, large corporates, and entrepreneurs. We estimate CDR projects have raised \$17 billion in private investment to date, split approximately evenly across nature-based and engineered solutions.⁴ Through a survey of about 40 public sector initiatives, we uncovered another \$15 billion of public money invested in CDR, heavily skewed towards engineered solutions (about \$12 billion). Market participants note that while this investment is encouraging, it falls well short of levels needed to grow the industry in line with global climate objectives.

Exhibit 4: Engineered removals have received the bulk of capital

High level private and government investment in carbon removal solutions to date
\$ billion, based on publicly available data



Source: Trove Research, CDR.fyi, Oliver Wyman analysis

NATURE-BASED SOLUTIONS

To date, around \$8.5 billion has been invested in nature-based solutions, with the bulk going to afforestation and land management projects. So far, a mix of funding has come from venture capitalists (VCs), large corporates, specialist funds, and banks. Nature-based approaches appeal to market participants looking to have additional impact beyond emissions reduction in such areas as biodiversity, flood risk mitigation, and societal and economic development. For example, Apple Inc. launched the \$200 million Restore Fund in 2021 to invest in forestry-based removals in Brazil and Paraguay. The fund has since grown to \$280 million, thanks to additional commitments from other corporations.

⁴ Bottom-up assessment of investment by carbon removal pathway, verified with top-down estimates for engineered CDR investment to date from CDR.fyi and nature-based CDR investment to date from Trove Research

Governments and public bodies have also offered support, such as the US government's \$1.13 billion for tree-planting and management, and the European Union's \$1.3 billion for a similar forestry programme. The price of nature-based carbon credits varies by project type, ranging from \$20 to \$50 per tonne for land management and afforestation to over \$100 per tonne for blue carbon projects that safeguard and restore marine and coastal habitats.

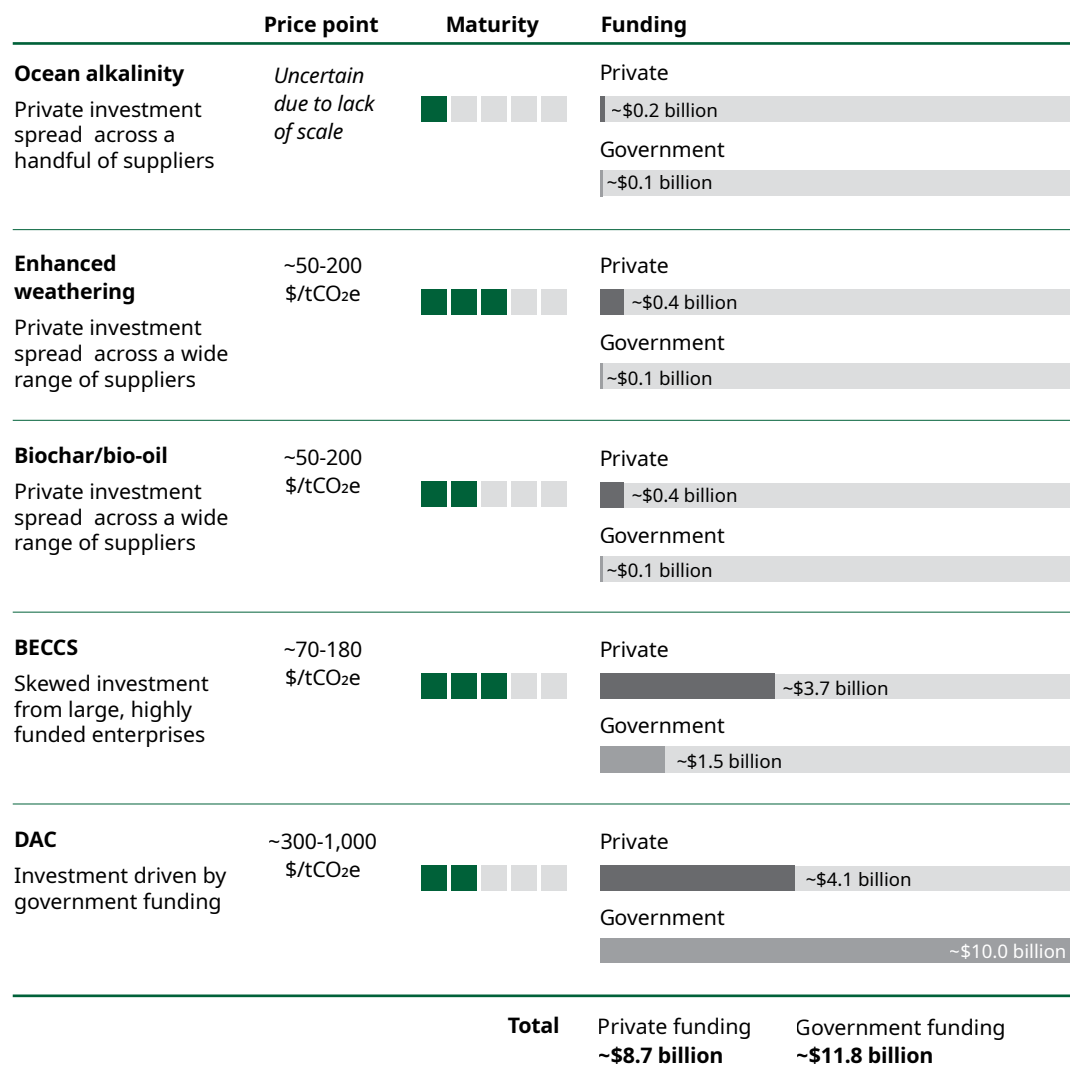
Exhibit 5: Afforestation projects have received the bulk of capital for nature-based removals

	Price point	Maturity	Funding
Blue Carbon Limited investment to date, primarily from incubator funds and government funding	~130-500 \$/tCO ₂ e		Private funding ~\$0.4 billion Government funding ~\$0.5 billion
Land Management Significant investment from large corporates as part of their wider environmental strategy. Significant government funding provided to date rarely carbon removal specific	~10-60 \$/tCO ₂ e		Private funding ~\$4.6 billion Government funding (not included in total) >\$10 billion
Afforestation Significant investment from large corporates as part of their wider environmental strategy	~5-20 \$/tCO ₂ e		Private funding ~\$3.5 billion ~\$2.5 billion
Total			Private funding ~\$8.5 billion Government funding ~\$3.0 billion

Note: Rounding error from solution segments, 2. c. 55% of investment in agricultural land management, c. 40% in afforestation, c. 5% in blue carbon

Source: Company websites, Crunchbase, PitchBook, Tracxn, CDR.fyi, Oliver Wyman analysis

But nature-based projects face some uncertainty around how permanent the carbon removal they achieve is, given the potential for future deforestation or changes in land use. Engineered removals may present less risk of reversal, given that the carbon is generally sequestered in geological storage sites over a kilometre underground, as is the case with DAC and bioenergy with carbon capture storage (BECCS). Other engineered pathways involve storage in highly stable materials, such as weathered rock or biochar. The uncertainty over the permanence of nature-based options has driven an increased focus on delivering engineered removals at scale and a more attractive price.

Exhibit 6: DAC and BECCs have received the majority of capital for engineered solutions

Note: Includes BiCRS, 2. Rounding error from solution segments

Source: Company websites, Crunchbase, PitchBook, Tracxn, CDR.fyi, Oliver Wyman analysis

ENGINEERED SOLUTIONS

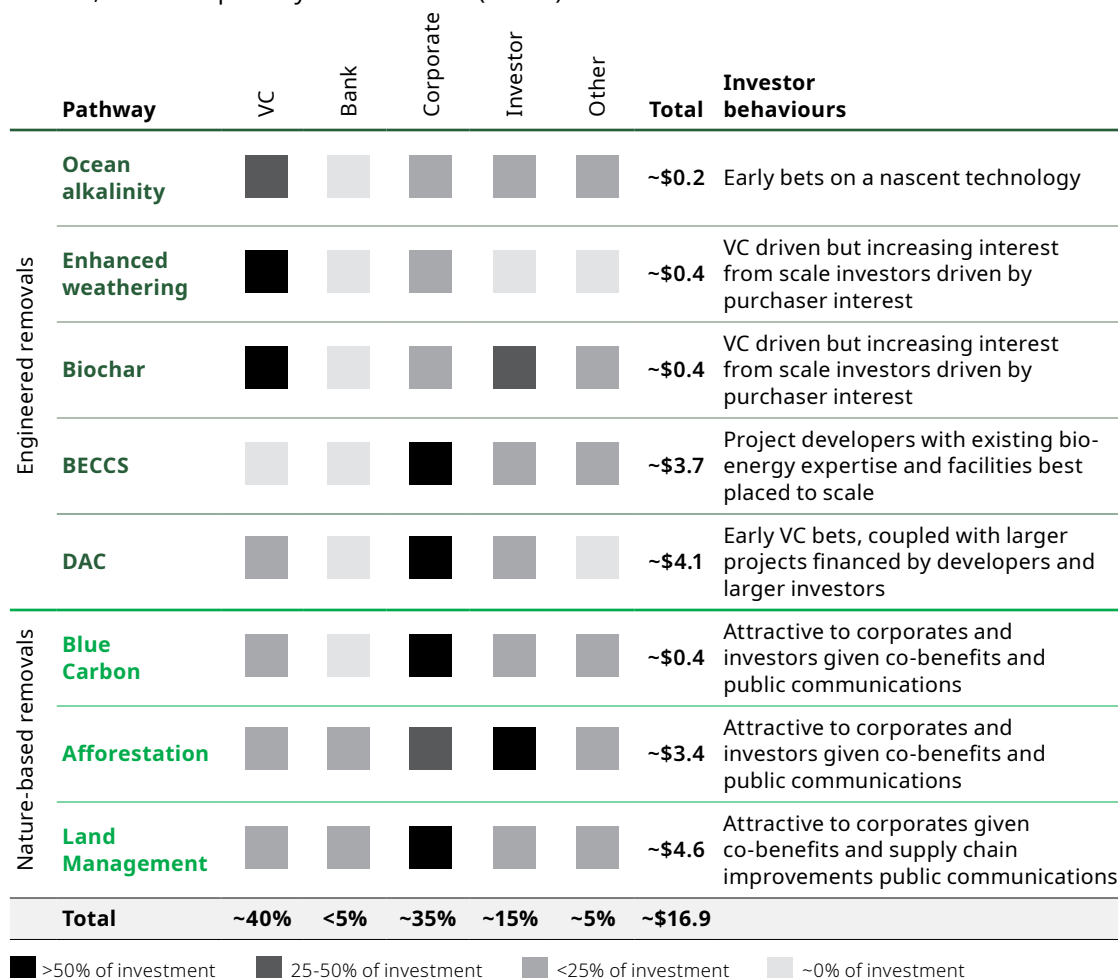
Engineered removals have received about \$8.7 billion in investment to date, predominantly for DAC, which received \$4.1 billion, and BECCS, which saw \$3.7 billion in investment. Both have received over half of their support from corporate project developers, such as Drax Group's investment in the first at-scale BECCS facility in the United States.

Biochar and enhanced weathering have also gained traction, with investment of about \$400 million, predominantly from VCs, who believe the projects have significant scale potential to generate high-quality removals at relatively low price-points. Biochar solutions run between \$50 and \$200 per tonne versus \$150 to \$500-plus per tonne for other engineered removals, making it more accessible to a broader set of purchasers. Other, more nascent pathways such as ocean alkalinity have received early-stage support from VCs and a small cohort of investors.

Exhibit 7: Incubator funds and corporates provided 75% of private investment to date

Source of private investment segmented by carbon removal pathway

To date, based on publicly available data (billion)



Source: CDR.fyi, Oliver Wyman analysis

INVESTMENT IN THE UK

In the UK, by our estimates, projects have received over £600 million in private investment, primarily for DAC (£400 million), BECCS (£160 million), and nature-based projects (£80 million). Investments in DAC and BECCS are supported through wider investments in UK energy transition infrastructure, such as industrial clustering and offshore transport and storage.



It will take years for some of these investments to pay off and there are a few companies that are happy to take this risk. There needs to be a long-term demand signal to grow investment

UK Energy Company

Market participants indicated that the UK could accelerate activity by providing further detail on overarching CDR strategy, including the role of nature-based solutions. They also expected capital investment to remain constrained until applications for access to industrial cluster infrastructure are approved.

The clear message from UK-based investors is that they cannot support the required scale until there is better elaboration of the UK strategy and support mechanisms for CDR. Investors are also looking for more convincing signals that a higher volume of purchasing from a broader set of participants will be realised in coming years.



Some investors are hesitant to invest, with concerns surrounding the uncertainty in long-term cost curves for CDR solutions and subsequent high price points for credits

Because the market is pay on delivery, carbon removal projects currently do not have significant cash flow. Banks therefore have concerns around project delivery risks

Global Bank

THE DEMAND CHALLENGE



Removal purchases to date have been predominantly comprised of direct bilateral offtake agreements between a small group of highly motivated corporates and suppliers of CDR credits. Two major issues are currently preventing the demand base from broadening.

First, many of the market participants we spoke with felt that guidance on the use of carbon credits is still not sufficiently clear, despite recent progress on this topic. To justify the expenditure of voluntarily purchasing carbon credits, corporates need to see a clear benefit — in terms of reducing reported emissions or contributing to net zero commitments, for example.

They also need to be confident that the purchase of credits will not introduce new reputational risks. Thus they look for clear links into the most widely used net zero frameworks such as SBTi's, or mandatory disclosure regimes, such as the one proposed by the UK Transition Plan Taskforce. There is a sense that too many corporates today feel perceived risks outweigh the potential benefits.

Notably, market participants also emphasised that this guidance needs to cover the whole voluntary carbon credit space. For instance, the Oxford Offsetting Principles suggest that companies begin offsetting by purchasing lower cost avoidance or reduction credits and then increase the proportion of removal credits in their portfolio over time. The guidance notes that companies should look to increase the volume of carbon removal purchasing over time so that 100% of offsetting requirements are met through carbon removal by 2050.

Second, the high price point of CDR credits is a significant barrier, and this is particularly acute for engineered solutions. While engineered solutions accounted for only about 10% of issuance volume in 2023, their higher price point resulted in them accounting for about 65% of revenue from sales. The demand base for engineered removals remains narrow, with over 90% of purchases to date from just 10 companies.⁵ The top purchaser, Microsoft Corp., accounts for over half of all engineered removal purchases.

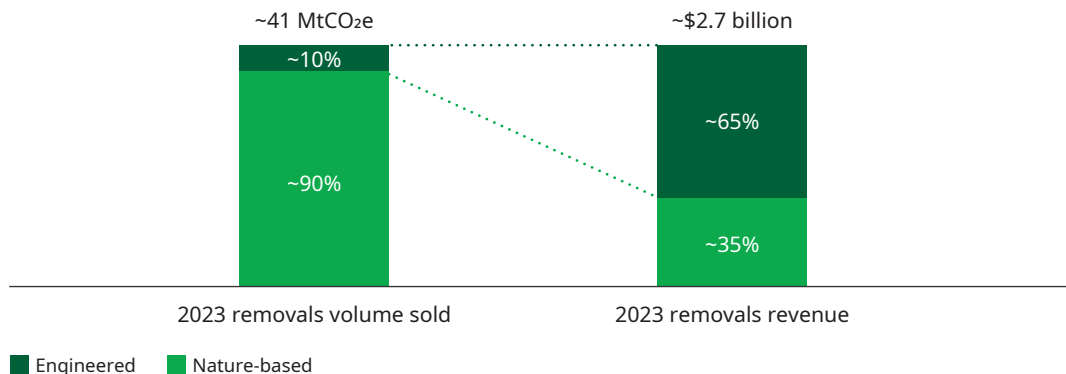
Carbon removal developers are reliant on cash flow from long-term offtake agreements, but there are only so many Amazons and Microsofts in the world. We need to find a way to bring the broader demand base into the market, or investment will fall behind

US CDR Technology Developer

⁵ As per CDR.fyi as of May 2024

Exhibit 8: Engineered removals account for 10% of carbon removed, 65% of sales in 2023

Nature-based and engineered carbon removal solutions issuances and sales

Mt CO₂e, \$ billion, 2023

Source: Climatefocus.com, Trove Research, CDR.fyi, Oliver Wyman analysis

The high price point is particularly challenging for more emissions-intensive sectors. For example, if the airline industry was required to buy carbon removal credits equivalent to 10% of their baseline emissions, at \$50 per tonne, our analysis indicates it would cost the sector about 10% of its profits. Achieving the same outcome with more expensive engineered credits could mean wiping out around half of industry-wide earnings. This equation is even more challenging for such hard-to-abate sectors as cement and steel. By contrast, technology and other low emissions-intensity sectors could cover 10% of emissions for less than 1% of industry profits.

Exhibit 9: Buying behaviours reflect fundamental differences across industries

Indicative sector spend on removals as a % of profit margins following SBTi 90% reduction guidance

	Energy and power		Hard-to-abate			Fuel-switching			High margin, low intensity		
	Power	O&G	Cement	Steel	Agri.	Auto.	Air	Shipping	Tech	FIs*	PS**
Emissions (Scope 1 and 2) (Gt/yr)	15.8	5.1	2	2	4	3.5	0.9	0.7	0.5	~0.1	~0.1
Removal cost at \$50/tn (\$billion)	79	25.5	10	9.5	20	17.5	4.5	3.5	2.5	0.5	0.5
~% of 2023 industry profits	~40%	~5%	~20%	~15%	~25%	~10%	~10%	<5%	<1%	<1%	<1%

*Financial Institutions

**Professional Services

Source: IEA, Statista, S&P Capital IQ, Oliver Wyman analysis

These structural characteristics are reflected in different buyer behaviours emerging in the nascent marketplace:

1. Nature-focused purchasers take the position that nature pathways deliver more carbon drawdown per dollar spent as well as other benefits beyond emissions reduction. Several energy companies fall into this group.

2. Buyers wanting to experiment with CDR often see carbon removal as a part of their wider portfolio of decarbonisation efforts. For instance, in the aviation sector, a few companies are trying to understand the relative cost of carbon removal technologies versus incorporating alternative fuels such as sustainable aviation fuel (SAF) into their operations.

3. Early adopters are purchasing the full suite of removal pathways at significantly higher volumes than most of the demand base, with a view of securing supply early and taking a position of leadership in the market.

The government should be standing behind some high-quality guidance and provide a clear route for corporates to follow

US CDR Trading Platform Provider

Many of the participants we interviewed noted the potential role of compliance schemes in driving demand. They argue that allowing a regulated set of carbon removal credits to be used with these permit schemes would give emissions-intensive sectors a clear commercial incentive to purchase removal credits and drive volume into approved contract types. Some international markets are beginning to allow this, such as Singapore where a nationwide carbon tax was recently established. Removal credits are not currently included within the EU or UK ETS. While market participants are clear on the potential compliance markets offer, questions remain around the design of these schemes and the potential impact on existing emission trading schemes.

Price points are currently too high for some organisations to engage with the market. Very few want to pay more than £250 per tonne

UK Bank

Exhibit 10: Sector archetypes removal positioning and potential purchasing strategy

Sectors	Current buying behaviour		Potential triggers for growth	Potential annual spend on removals (2030-2035)
Energy and Power Power, Oil and Gas	Low	<ul style="list-style-type: none"> Limited purchases, given many are already paying a regulated carbon price (e.g. through the EU ETS) Some engagement in nature-based solutions Some direct investments to generate removal credits (e.g. BECCS) 	<ul style="list-style-type: none"> Inclusion of CDR in emissions compliance schemes Subsidy support for engineered solutions Clarity over use of CDR in disclosure frameworks 	~\$1-50 billion
Hard-to-abate Cement, Steel, and Agriculture	Low	<ul style="list-style-type: none"> Limited demand to date Some already falling within permit schemes / regulation Opportunities for within value-chain reduction at lower cost per tonne than engineered CDR (e.g. CCUS) Some opportunities to generate credits (e.g. agriculture) 	<ul style="list-style-type: none"> Extension of compliance schemes and inclusion of CDR Clarity over use of CDR in disclosure frameworks 	~\$1-20 billion
Fuel-switching Automotive, Airlines, Shipping	Mid	<ul style="list-style-type: none"> Early experimental engagement with engineered solutions, in anticipation that abatement costs will remain high, leaving significant residual emissions 	<ul style="list-style-type: none"> Relative cost of CDR vs. alternative fuels (e.g. SAF) Involvement in compliance schemes or industry-wide commitments (e.g. CORSIA) Clarity over use of CDR in disclosure frameworks 	~\$1-10 billion
High-margin, low intensity Technology, Financial Services and Professional Services	Very high	<ul style="list-style-type: none"> Major source of demand today, with a number of companies playing a pioneering role to seed the market Low emissions intensity and relatively profitable industries contributing to willingness and ability to pay largest purchasers of engineered removals at high price points; also active in Nature-based solutions 	<ul style="list-style-type: none"> Clarity over use of CDR in disclosure and net zero frameworks 	~\$1-30 billion

Source: Analysis developed using the Oliver Wyman Carbon Demand model- global model of supply, pricing and purchasing behaviour

Inclusion of removals in the compliance market would give a clear signal to purchasers on the role of CDR

Global Exchange Group

A MATURING MARKET ECOSYSTEM



A range of new propositions are emerging to support the growth of the market, encompassing data, analytics, market access, insurance and financing. These are being driven by large financial institutions as well as small innovative companies backed by growth capital. The space is likely to evolve rapidly, with some commercial models falling away and others taking off. At the same time, work continues to strengthen the standards that underpin the market.

As an example, the Voluntary Carbon Market Integrity Initiative (VCMI) is developing guidance on carbon credit use, creating a claims code whereby corporates can achieve silver, gold, or platinum status. Yet VCMI does not set out a specific role for carbon removal within a net zero framework. The SBTi, the leading standard setter for emissions reduction targets, has indicated an approach, stating that companies should target 90% emission reduction by 2050, with the remaining residual emissions addressed through permanent removals. However, this guidance outlines neither principles for the purchasing of removals nor the appropriate scaling of removal portfolios prior to 2050.

The Integrity Council for the Voluntary Carbon Market (IC-VCM) sets a global standard for the quality of the credits themselves. They published the Core Carbon Principles (CCPs), an assessment framework which sets a threshold for quality in the VCM. Programs and carbon credit methodologies are now being assessed for alignment against this standard. To date, five programs have been approved (ACR, Verra, ART, CAR, Gold Standard), representing 98% of credits in the market. Approved programs can only label credits as IC-VCM approved if the credit methodology is also CCP-approved. A global standard also ensures alignment across regions, driving confidence for purchasers and enabling credit fungibility. The IC-VCM's principles build on the cross-border standards agreed to under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and align with developments under Article 6.

Carbon removal insurance is a big enabler for project financing. A lack of insurance is a substantial deterrent for scale

UK CDR Insurer

As this work on standards progresses, a host of new service providers have emerged offering data, analytics, risk management, and market access that could help provide an infrastructure for a more mature market. Several data providers are now offering services that analyse pricing and volumes, while others provide quality assessments and ratings for removal projects. Some offer a curated selection of credits, often together with data, analysis, and data management services aiming to help corporates and developers access the market more easily and confidently.

Other marketplaces have defined a particular set of standards for a certain type of credit and seek to create a safe environment for corporates to find high quality credits of a certain type. An example is the London Stock Exchange, that has developed a listing of approved publicly traded funds that invest in removal projects and issue credits to investors. As standards mature and accreditation becomes more commonplace, we are likely to see further innovation, as well as consolidation around winning models.

Insurance solutions are also emerging to address some of the risks inherent in VCM projects, with policies designed for both investors and credit purchasers that cover when projects fail to be delivered. In addition, insurers are looking to develop policies around the risk of reversal, although some fundamental challenges persist given potentially long time horizons for real permanence, extending to millennia in the case of geological storage. Despite this, market participants believe that well-designed insurance offerings would be a significant enabler of increased investment and purchasing.

Dedicated sustainable investment funds have also started to emerge and focus on this space. Most have focused on nature-based investments, often combining income from sustainable forestry with income from carbon credits. Other investment strategies offer clients access to investments in nature-based carbon projects, in return for high impact carbon credits. These funds have generally seen significant growth in assets under management in recent years.

The market is currently driven by bi-lateral, long-term offtake agreements, however, intermediaries are emerging, and it is expected a sophisticated market will evolve in time

UK Investor

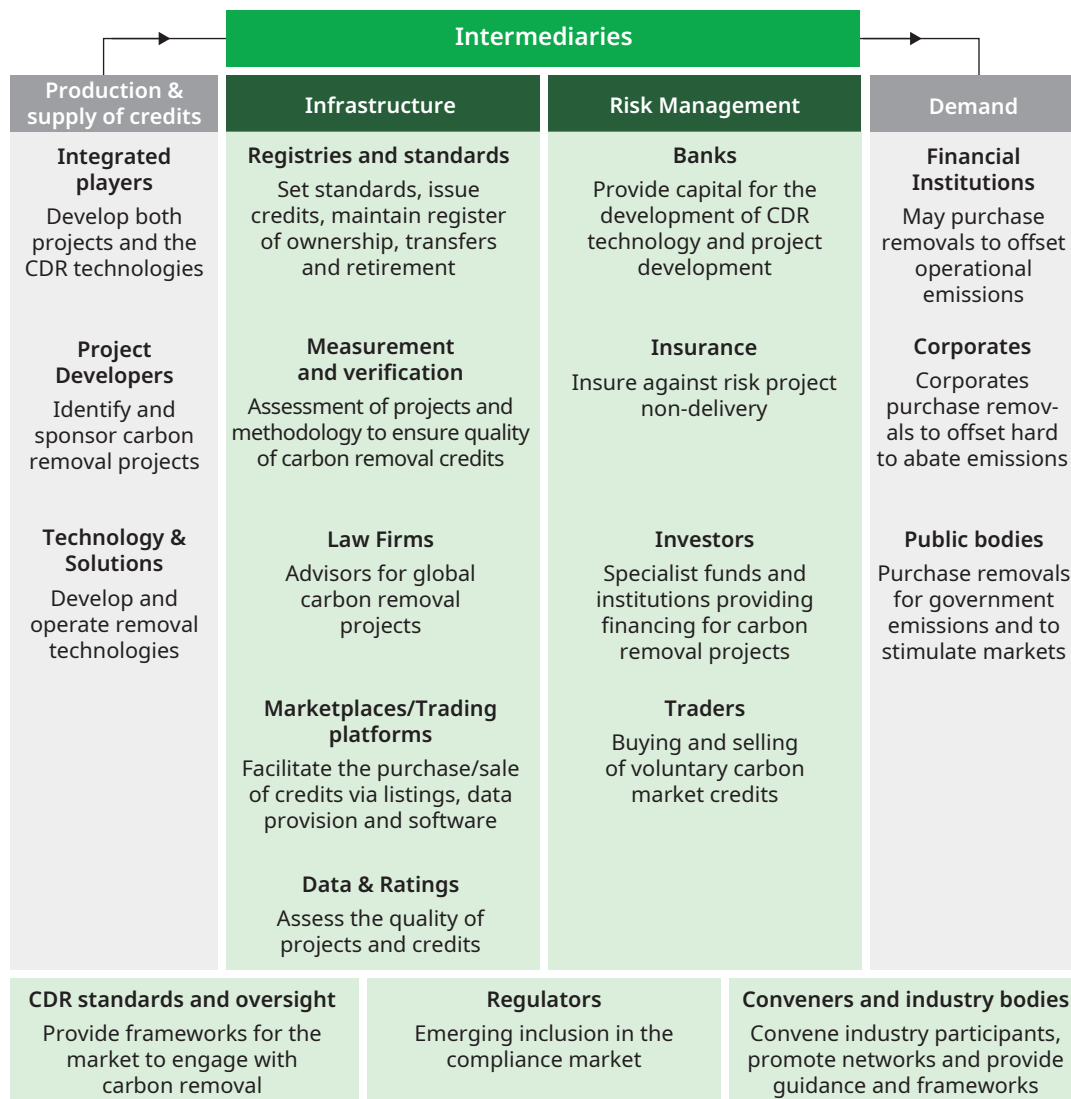
Banks and trading firms are also gearing up. Most of the largest global wholesale banks and a growing number of regional banks now have a presence in carbon markets, alongside many of the specialist commodity traders and the trading arms of the major energy producers. To enable financing of carbon removal projects at scale, financiers and investors are looking for long-term offtake agreements and clear signals of demand at price points that support project economics.

A key concern from some market participants is the current market structure. Today, most purchases are conducted bilaterally between providers and purchasers and do not provide the transparency needed to establish clear reference points on price and quality. Participants pointed to the need for clear reporting and standards, as well as wider carbon credit markets, that might include reduction credits, to help develop liquidity and reference prices in the near term.

In the last 15 months we have a significant increase in appetite for carbon credits driving financial institutions to develop financing solutions for their clients

Global Insurer

Exhibit 11: The role of intermediaries in scaling the carbon removal market



Source: Oliver Wyman analysis

There is a need for more capital in the market if carbon removals are to meet the required scaling for net zero targets. Government intervention is needed to provide incentives to drive demand

SCENARIOS FOR CDR GROWTH






We believe the market may expand to between \$40 billion and \$100 billion a year in the 2030-2035 timeframe if scale constraints can be addressed globally. But “business as usual” will not get us there.

We have developed three alternative scenarios for what the future market might look like by 2030-2035:

Exhibit 12: A fast-growth scenario for removals puts market at \$100 Billion plus by 2030

Scenarios for CDR market evolution (2030-2035)

Scenario dimensions	Current trajectory	Reductions-driven net zero	Pivot to engineered solutions
Context	<ul style="list-style-type: none"> Mixed progress in reducing emissions, but continued debate over the role of removals 	<ul style="list-style-type: none"> Strong progress in reducing emissions across the economy, with a clear but limited role for removals in the transition 	<ul style="list-style-type: none"> Concern over lack of progress in reducing emissions leads to bold steps to support the growth of removals
Key changes	<ul style="list-style-type: none"> Standards continue to improve, but remain voluntary 	<ul style="list-style-type: none"> Clear guidance for corporates, linked to mandatory emissions reporting Targeted subsidy support 	<ul style="list-style-type: none"> Clear guidance for corporates, linked to mandatory emissions reporting Subsidy and inclusion of CDRs in compliance schemes
Demand base	<ul style="list-style-type: none"> Grows at current rate Demand driven by a small group of highly motivated organisations 	<ul style="list-style-type: none"> Growth at ~35% per annum Demand broadens in hard to-abate and fuel-switching sectors Limited participation from energy sector 	<ul style="list-style-type: none"> Growth of ~50% per annum Majority of demand from sectors in-scope of compliance schemes (e.g. energy, hard-to-abate sectors)
Supply dynamics	<ul style="list-style-type: none"> 90% of volumes are nature-based Limited scaling of engineered solutions 	<ul style="list-style-type: none"> 90% of volumes are nature-based Greater up-tick of demand for engineered solutions, with some technologies scaling 	<ul style="list-style-type: none"> 70% of volumes are nature-based Engineered developments significantly de-risked through subsidy and broadened demand base
CDR volumes and implied market size	 ~0.2-0.5 Gt/year	 ~1-1.5 Gt/year	 ~2-3 Gt/year
	Av. Price per tonne ~\$50	Av. Price per tonne ~\$50	Av. Price per tonne ~\$60-80
	Market Size (billion) ~10	Market Size (billion) ~40	Market Size (billion) 100+

Source: Analysis developed using the Oliver Wyman Carbon Demand model-global model of supply, pricing and purchasing behaviour

A “current trajectory” scenario envisions a world where corporate guidance remains ambiguous, and subsidies do little to close the gap between price points and willingness to pay. The demand for removals continues to grow but remains confined to a small set of highly motivated corporates. In this scenario, the market will be challenging for project developers, and carbon removal capacity would fall short of levels required to meet net zero pathways.

A “reductions-driven net zero” scenario sketches a world in which corporates make strong progress in reducing emissions and receive clear guidance on the use of removals. Corporates can count their removal purchases against their reported carbon emissions and/or net zero targets, triggering a broadening of demand across sectors. Under this scenario, both nature-based and engineered solutions would see a significant uptick in demand.

A “pivot to engineered solutions” scenario assumes a step-change in political will to accelerate the removals market, driven by concerns that reduction efforts are falling short. As well as the clear guidance on the use of removals, there are also major subsidies, and links are established to the major compliance markets. As a result, demand from major primary emitters grows substantially, as well as across the broader economy. Progress in scaling carbon removal compensate for the shortcoming in emission reduction efforts.

These scenarios are, of course, only sketches of possible futures, but it is clear that significant intervention is required if the market is to reach its potential, and play the role required in the energy transition.

HOW THE UK CAN ACCELERATE CARBON MARKET GROWTH

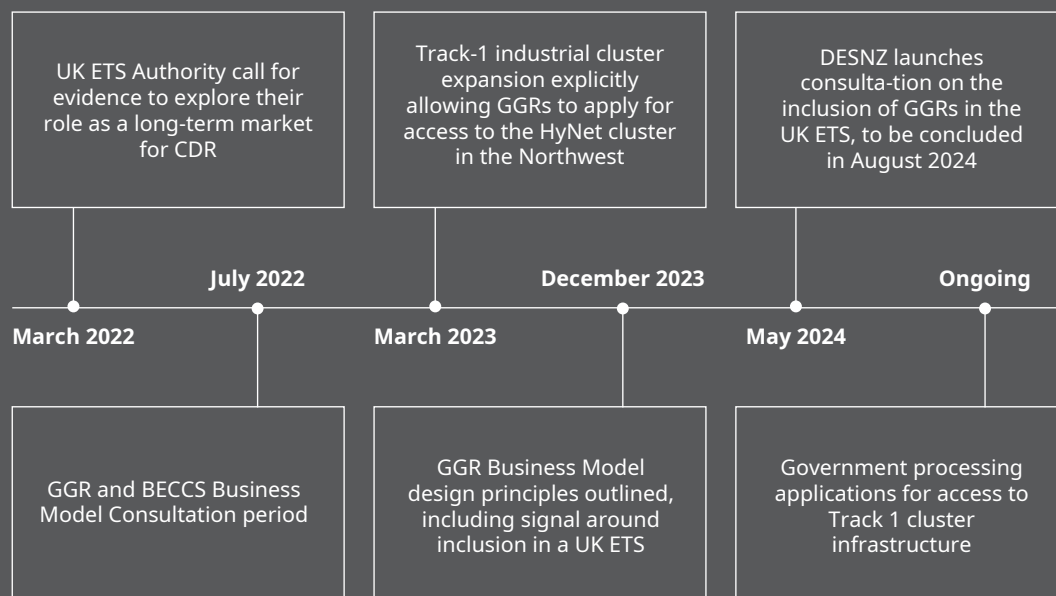


As a world leader in research and development, finance, and insurance, the UK is well placed to be a leading centre of activity in this space. The UK also benefits from exceptionally well characterised geological storage sites in the North Sea, as well as advanced plans for supporting carbon capture and storage infrastructure. Existing frameworks, such as the woodland and peatland codes, provide a foundation for scaling nature-based solutions.

But the UK faces stiff international competition. The EU and US are also emerging as prominent markets in the growing uptake of carbon removal, while Singapore has taken steps to position itself as a centre for carbon trading. Where the EU is pushing standards, the US is offering subsidies through the Inflation Reduction Act to make the exercise more economically viable.

The UK's Department for Energy Security and Net Zero (DESNZ) are in the process of developing policy support for the uptake of greenhouse gas removals (GGRs). Their current program of work looks to define business model support for the emerging industry, as well as enabling access to industrial clusters and the inclusions of GGRs in compliance schemes.

Exhibit 13: Possible policy implementation that would support UK carbon removal market



Source: Oliver Wyman analysis

The UK's 2021 Net Zero Strategy states an ambition to deliver five megatonnes per year of engineered removals through 2030. If realised, this would deliver a market size of over \$500 million, assuming an average engineered credit price of over \$100 per tonne and support the creation of thousands of jobs around the whole country. This will not happen without government and industry support beyond what has already been offered.

To catalyse growth and position the UK as a leading centre for carbon removal, we highlight six priority actions:

Exhibit 14: Six actions to accelerate CDR activity in the UK

Triggers to drive growth	Potential actions	Rationale	Suggested driver(s)
1 Articulate the role of carbon removal in the UK's net zero strategy	<ul style="list-style-type: none"> A clear statement over the role of CDRs in meeting the UK's Net Zero goal Within this, a clear indication of the role for nature-based and engineered removals Within this a clear link to the industrial cluster strategy, and how CDR technologies will access relevant infrastructure (e.g. storage) 	<ul style="list-style-type: none"> A strategic framework to guide activity 	<ul style="list-style-type: none"> • DESNZ
2 Endorse the use of removals credits within corporate net zero strategies and transition plans	<ul style="list-style-type: none"> Clarity on the specific role of removal credits, and carbon credits more broadly, in corporate net zero plans and claims Recognising removals based carbon credits as offsets within mandatory emission and Transition Plan disclosures Signalling by government on the use of credits, for instance through direct procurement of a material volume of removals credits by UK Government, in contribution to UK NDCs 	<ul style="list-style-type: none"> Increased demand from corporates 	<ul style="list-style-type: none"> • VCMi • SBTi • UK Government (Treasury)
3 Set or endorse clear standards for project integrity	<ul style="list-style-type: none"> Set minimum MRV standards with independent oversight of project developers and standards, eg through endorsing ICVCM Use these to determine which credits can be used within corporate transition plan disclosures 	<ul style="list-style-type: none"> Strengthen trust in credits 	<ul style="list-style-type: none"> • ICVCM • DESNZ
4 Include carbon removal in the UK Emissions Trading Scheme	<ul style="list-style-type: none"> Define the terms on which carbon removal credits can be used within the new UK ETS Consider a pilot or gradual phase in to manage impacts on the market 	<ul style="list-style-type: none"> Drive volume into defined contract types 	<ul style="list-style-type: none"> • UK ETS Authority • DESNZ
5 Set out a framework for financial support for the market	<ul style="list-style-type: none"> Finalise market based financial support mechanisms (e.g., GGR business models) Mobilise development and catalytic capital (e.g. loans, guarantees, equity) Consult with market participants on appropriate support mechanisms per removal pathway 	<ul style="list-style-type: none"> Help emerging technologies scale in the UK 	<ul style="list-style-type: none"> • DESNZ • UK IB
6 Support the development of the supporting market ecosystem	<ul style="list-style-type: none"> Drive collaboration between market participants on shared learnings, approaches and commitments on removal activity Support the development of trading, insurance, analytics and financing to help mobilise capital and accelerate growth 	<ul style="list-style-type: none"> Secure the UK as a trading and financing centre 	<ul style="list-style-type: none"> • UK Carbon Markets Forum

APPENDIX

GLOSSARY OF CDR PATHWAYS

Blue carbon refers to the carbon stored in coastal and marine ecosystems, such as mangroves, seagrasses, and salt marshes, which can help mitigate climate change

Agricultural land management involves implementing practices that optimize soil health and carbon sequestration in agricultural systems, such as cover cropping and reduced tillage

Afforestation is the process of establishing forests in areas where there were no forests before, with the aim of increasing carbon sequestration and biodiversity

Biochar is a type of stable carbon produced through burning of biomass in low oxygen environments that may be also used as a soil amendment to enhance soil fertility

Enhanced weathering involves accelerating the natural process of rock weathering to capture and store carbon dioxide from the atmosphere

Bio-energy carbon capture and storage (BECCS) is a technology that combines bioenergy production with carbon capture and storage, allowing for the removal of carbon dioxide from the atmosphere

Direct air capture (DAC) is a technology that captures carbon dioxide directly from the air and stores it, helping to reduce greenhouse gas emissions

Ocean alkalinity enhancement involves adding alkaline substances to the ocean to increase its capacity to absorb and store carbon dioxide from the atmosphere

ABOUT THE GLOBAL CITY CAMPAIGN

The Global City campaign is the City of London Corporation's overarching initiative to promote the UK as a world-leading international financial centre. It showcases the UK as a great place for financial and professional services firms to invest, locate and grow. theglobalcity.uk

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The UK Carbon Markets Forum was established in April 2021 to support the growth of a high-integrity scaled carbon market in the UK and to support and amplify common international frameworks. The Forum is chaired by Dame Clara Furse, with City of London Corporation providing secretariat support.

The City of London Corporation (CoLC) is the governing body of the Square Mile dedicated to a vibrant and thriving City, supporting a diverse and sustainable London within a globally successful UK. We provide the secretariat to the UK Carbon Markets Forum, and we are also a founding sponsor of the Integrity Council for the Voluntary Carbon Market (IC-VCM). Beyond this policy work, we operate a Carbon Removals and Land Management Project as part of our Climate Action Strategy to protect the existing carbon stored by our open spaces and to increase their carbon sequestration capacity. Our open spaces currently remove over 16,000 tonnes of carbon from the atmosphere every year.

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