Chapter 4

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A sapling plantation drive for agroforestry near Kanha National Park in Madhya Pradesh, India. By Aaran Patel

Chapter 4 | Voluntary demand for CDR

Voluntary demand for CDR helps to finance CDR projects. Despite the overall market share remaining small, both novel and conventional CDR have experienced strong growth, especially when compared to the reduction and avoidance parts of the VCM. Voluntary buyers are propelling most of the current demand for novel CDR, but compliance markets have the potential to become a source of demand over the long term.

Key insights

- Novel CDR issuances are growing much faster – over 100% year-over-year – than conventional CDR, though both still account for a relatively small share of credit issuances and retirements on the VCM.
- Novel CDR credits are structurally distinct from avoidance and conventional CDR credits and so do not tend to face the same types of additionality and permanence challenges. However, evidence of real-world performance remains nascent for many methods, and significant scientific uncertainties and MRV challenges persist.
- CDR deployment in the VCM is regionally concentrated. Latin America and the Caribbean host 47% of all CDR credit projects and 74% of conventional credit projects, while Europe leads in novel CDR credits, hosting 48% of all novel credit projects.
- Demand remains highly concentrated among a small number of voluntary buyers – a critical vulnerability for the ecosystem. Microsoft alone purchased over 80% of the novel CDR credits in 2024–2025.
- Emerging sources of voluntary demand, including Article 6 of the Paris Agreement and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), are unlikely to provide substantial new sources of offtake, given their lower average market prices relative to most CDR credits. This suggests the importance of additional, mandatory sources of demand coming online in future.

CDR has been part of the VCM since its inception, yet it has remained a relatively small component. The transaction volume of conventional CDR far exceeds that of novel methods. This largely is due to their longer development history, which stretches back to the Clean Development Mechanism (CDM) in the 2000s. More recently, growing concerns about the environmental integrity of offsetting based on credits with weaker additionality or permanence guarantees, alongside questions of net-zero alignment, have driven increased focus on CDR, particularly novel pathways.[1] This shift has spurred significant growth in voluntary market activity for CDR, accompanied by the emergence of specialist standards and registries to meet rising demand. This chapter unpacks the role of voluntary demand in scaling up CDR and examines trends in voluntary demand, including the size and composition of the market, drawing on multiple datasets to map trends in project types, volumes and buyers.

4.1 The role of voluntary demand in developing CDR

Demand for carbon removal has principally been facilitated via the VCM, which is present both internationally and in a range of domestic settings. The VCM can be conceived expansively as an ecosystem through which projects that avoid or reduce GHG emissions, or remove CO_2, are financed. As such, it includes traditional over-the-counter transactions of carbon credits, as well as various forms of bilateral offtakes. Markets facilitated by the United Nations could also support voluntary CDR demand. This includes markets under Article 6 of the Paris Agreement, which facilitates cross-border financing of mitigation, as well as CORSIA, which allows airlines to offset part of their emissions from international flights. While these examples are established under formal international agreements, participation by private entities to surrender credits under them remains voluntary. For example, airlines may choose to reduce emissions directly rather than purchase CORSIA Eligible Emissions Units. This serves as a contrast to compliance mechanisms where participation is mandatory within a given national or subnational context (see Chapter 5). Despite these forms of markets having distinct hallmarks, in practice they often constitute a blend of increasingly interrelated mechanisms (see Box 4.1).

Box 4.1 The evolution of carbon markets facilitating voluntary demand for CDR

While the carbon market landscape has evolved significantly over the past four decades, CDR has been present since its inception, and markets have proven an important conduit for voluntary investments into CDR credit projects.

Project-based trading of environmental attribute certificates emerged in 1982, when the US Environmental Protection Agency authorized refiners to engage in inter-refinery trading of lead credits, enabling them to meet mandated reductions in an economically efficient manner. The first VCM project was a removal-based agroforestry venture in Guatemala in 1989. From this foundation, the Kyoto Protocol catalysed the first generation of carbon markets under the United Nations through the CDM and Joint Implementation (JI), which became operational in the 2000s. The CDM marked the first large-scale attempt to channel finance towards project-based mitigation activities; this produced Certified Emission Reductions (CERs) each representing 1 tCO_2e in reduced or avoided emissions or removals. Importantly, the CDM only enabled conventional CDR to register temporary CERs rather than the permanent credits issued through other types of activities. The project-based CDM was later linked to some allowance-based compliance carbon markets, such as the EU ETS, becoming a further source of demand for credits. Integration between these markets was later suspended due to environmental integrity concerns, with close to one billion CER units having entered the EU ETS; this deflated prices and weakened the abatement signal.[2] In parallel with the CDM, the first generation of the VCM continued to take shape, borrowing methodologies and approaches from the CDM but primarily serving corporate social responsibility goals rather than regulatory objectives. The VCM did not adopt the temporary crediting format from UN markets, issuing carbon credits for conventional CDR projects of equivalence to ones from non-CDR activities.

A second generation of carbon markets began in 2015 with the Paris Agreement and the introduction of carbon trading under Article 6 via cooperative approaches (Article 6.2) and the Paris Agreement Crediting Mechanism (PACM) (Article 6.4). These support the exchange of Internationally Transferred Mitigation Outcomes (ITMOs) as well as mitigation contribution units, both also measured in tonnes of CO_2e reduced or removed.[3,i] In this way, Article 6 has ushered in a new generation of UN carbon markets connected to international sectoral markets, such as CORSIA, as well as the broader second-generation VCM and its associated heightened focus on integrity of supply. These links signify a growing harmonization of standards and recognition of VCM credits within regulated and semi-regulated frameworks and have helped to facilitate the flurry of demand that came in the wake of net-zero commitments from 2018 onwards.

i While relevant UNFCCC decisions formally exclude "avoided emissions", they include forms of reducing emissions from deforestation and forest degradation in developing countries projects that are understood in the VCM as avoided emissions emission projects, including some forms of (REDD+). See Johnstone, I. Article 6 in focus: Bottlenecks and breakthroughs at Bonn 2024. https://www.smithschool.ox.ac.uk/news/article-6-focus-bottlenecks-and-breakthroughs-bonn-2024 (2024).

The current trajectory suggests a future where voluntary, UN and compliance markets are increasingly interoperable (see Chapter 5). In this sense, a third generation of carbon markets, which could facilitate seamless transactions across these three domains, could be emerging. Although these links remain speculative, the inclusion of cross-border CDR within future stages of ETS schemes could result in a project using a VCM methodology to produce ITMOs under Article 6.2 that are ultimately surrendered by a covered entity for compliance purposes. This evolving ecosystem reflects a gradual convergence of markets once seen as siloed. This is enabled by new standards, transparency requirements and governance frameworks that reflect lessons learned from earlier generations of market mechanisms.

Examples of carbon markets facilitating demand for CDR

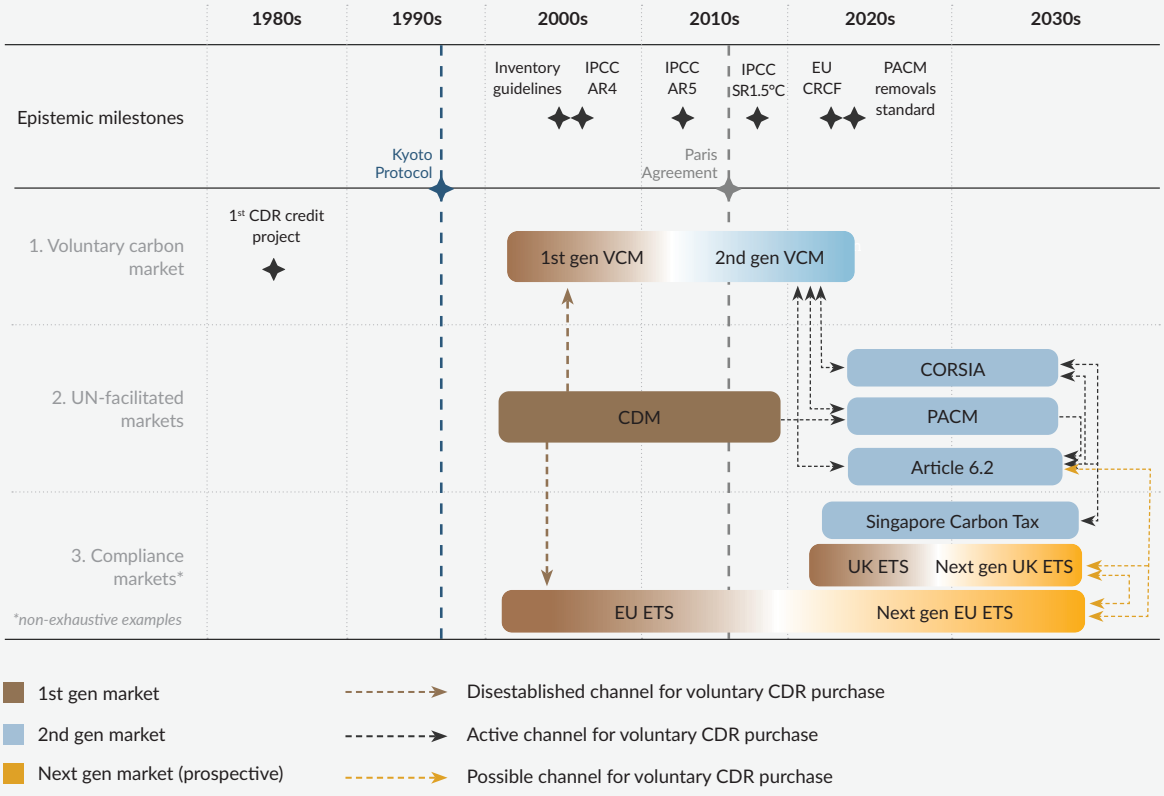


Figure 4.1 *Examples of carbon markets facilitating demand for CDR. Milestones indicate both epistemic and diplomatic milestones. Arrows indicate the connectivity between markets that is either one way (single arrow) or bi-directional (double-headed arrow). Note while over 80 compliance markets exist today, the ones profiled are chosen to show either integration between each other and of CDR specifically (EU and UK ETS) and/or existing compliance regimes that already integrate Article 6.*

Markets that trade in CDR also enable trade in other project types. A key distinction – crucial for evaluating the durability and integrity of credits – is between projects that reduce or avoid emissions and projects that actively remove carbon from the atmosphere.[4] Projects that reduce or avoid emissions include forest conservation and clean cookstoves. Removal projects may be novel, such as DACCS, where carbon is sequestered for millennia, or conventional, such as afforestation, where stored carbon may be rereleased over time due to fire or land-use changes. Some methodologies, however, involve both removal and avoidance. Following the approach of *The State of CDR 2nd Edition*, this chapter classifies carbon projects according to the methodology they employ to generate credits (see Table 4.1).

Classification of projects by methodology

Project type	Methodological description	Examples
Emissions reductions	Activities that reduce emissions relative to an observed baseline	Renewable energy, cookstoves
Avoided emissions	Activities that avoid emissions that would occur under a counterfactual scenario	Avoided grassland conversion, avoided deforestation (REDD+)
Mixed (mainly avoided)	Activities that both avoid emissions and remove carbon, but primarily avoid emissions	Most forms of improved forest management, sustainable agriculture
Mixed (mainly CDR)	Activities that both avoid emissions and remove carbon, but primarily remove carbon	Sustainable grassland management, peatland restoration, some forms of improved forest management
Conventional CDR	Activities that remove carbon through land-based management of carbon stocks	Afforestation and reforestation, some forms of improved forest management
Novel CDR	Activities at lower readiness levels that remove carbon and durably store it, usually in geological formations, the ocean or products	Biochar, DACCS, BECCS

Table 4.1 *Note: Section 4.2.1 of the Technical Annex provides a detailed list of how projects are mapped to the project classes.*

To assess the state of carbon market financing for CDR, we combine several sources to provide an overview of the current structure and dynamics of voluntary demand for CDR, including:

- OffsetsDB, which covers credit issuance and retirements across five main registries, including emission reductions, avoidance and conventional CDR;
- CDR.fyi, which tracks forward contracts, prices and deliveries of novel CDR; and
- nbs.CDR.fyi, which tracks forward contracts of conventional CDR.

While these sources provide broad coverage of voluntary market activity, they are limited to the tracked registries and do not capture all existing crediting systems, including emerging national or domestic standards.

4.2 Voluntary demand for CDR across carbon markets

Market composition

Emissions reduction projects continue to dominate the market, both in terms of credit volumes (see Figure 4.2a) and numbers of projects (see Figure 4.2b). From 2024 to 2025, they accounted for 72.1% of issued credits and 63.4% of retired credits, while representing 79.3% of all active projects. Active projects are those that either issued or retired credits in at least one of those years; projects with forward contracts but no issued or retired credits are excluded. Avoided emissions (including purely avoided and mainly avoided) is the second-largest project class by credit volumes and number of active projects. Avoided emissions projects account for 10.9% of issued credits and 25.0% of retired credits, while mixed (mainly avoided) projects also account for 10.9% of issued credits but only 4.2% of retired credits. Together, these categories represent 8.2% of all active projects, but they account for a disproportionately large share of credit volumes – suggesting larger average project sizes. CDR-based projects make up a significantly smaller share of the market. Conventional CDR projects (2.9% of projects) and mixed (mainly CDR) projects (4.7%) together represent 7.6% of active projects. Conventional CDR projects account for 2.8% of issued credits and 4.3% of retired credits, while mixed (mainly CDR) projects account for 3.0% of issued credits and 2.8% of retired credits. Finally, novel CDR projects account for 4.9% of all active projects on the VCM, but only 0.3% of issued credits and 0.3% of retired credits, reflecting the early-stage nature of many novel CDR approaches.

VCM market activity by project class, 2024–2025

a) Volume of credits issued and retired (millions)

Project Class	Year	Issued credits	Share of issuances (%)	Retired credits	Share of retirements (%)
Emissions reductions	2024	216		105	
	2025	191	72.1%	102	63.4%
Avoided emissions	2024	21		46	
	2025	41	10.9%	35	25.0%
Mixed (mainly avoided)	2024	26		5	
	2025	36	10.9%	9	4.2%
Mixed (mainly CDR)	2024	9		4	
	2025	8	3.0%	5	2.8%
Conventional CDR	2024	7		8	
	2025	8	2.8%	5	4.3%
Novel CDR	2024	0.6		0.3	
	2025	1	0.3%	0.6	0.3%

b) Proportion of active projects in the VCM

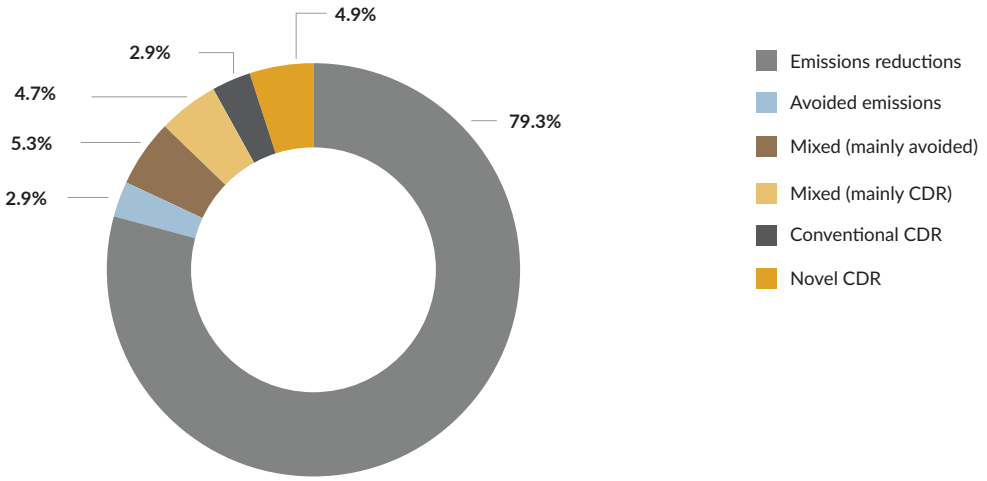


Figure 4.2 *Composition of the VCM across the six project types described in Table 4.1 by (a) the volume of credits issued and retired and (b) the proportion of projects active within the VCM in 2024–2025, by project type (see Technical Annex 4.2.1).*

While nascent, a distinctive pipeline of projects is emerging under the Article 6 framework of the Paris Agreement that could provide a further source of voluntary demand as countries and corporates use it to meet their climate targets. Determining the volume of CDR developed via the emergent Article 6 regime is a more complex picture given its role connecting compliance markets and the VCM to international sources of demand such as CORSIA. Article 6.2 could lead to the development of CDR-focused transactions but does not yet have a formal, CDR-based cooperative approach registered – despite a joint pilot between Norway and Switzerland to test the Article 6.2 infrastructure with a novel CDR transaction.[5,6]

The Article 6.4 PACM project pipeline has a higher number of CDR projects in play. These come from both a transfer of activities from the CDM as well as new projects that have submitted initial notifications under the PACM. As of January 2026, the UN Environment Programme-Copenhagen Climate Change Centre pipeline showed that 2,462 projects and programmes of activities had applied for transition from the CDM into the PACM, 12 of which were conventional CDR.[6] None of those 12 have been approved by the host country to transition.[6] Under the list of activities that have expressed prior consideration to be issued under the PACM standard, 72 out of 1,112 projects are CDR projects. The majority (68 total) are conventional CDR projects, and the minority (4 total) are novel CDR, respectively representing up to 7.7% and 0.0065% of potential future annual Article 6.4 Emission Reductions issuance via this route.[6]

The monetary size of the market

Looking at the market value of the different carbon credit types provides a very different picture from the volume data. Reliable whole-market estimates are difficult to produce: prices vary widely across methods, and most novel CDR transactions remain undisclosed. But even on conservative price assumptions, the dollar value of contracted novel CDR substantially exceeds that of conventional CDR, and the gap widened sharply in 2025 alongside the surge in novel contracted volumes.

Retired volumes tell a different story. Conventional CDR dominates in dollar terms, because much of the novel CDR market remains forward-committed rather than delivered. For context, the total reported value of the voluntary carbon market was US$535 million in 2024[7]; the forward-contracted value of novel CDR very likely exceeds this several times over.

Table 4.2 summarizes the estimated volume of CDR credits transacted on the VCM in 2024 and 2025, separating conventional and novel approaches. It shows that the VCM still facilitates much more conventional CDR than novel CDR at present. However, there is significant growth in both purchase and issuance volumes of novel CDR credits, as large purchases by big enterprises continue to contribute to forward demand and as more novel CDR credit projects move from the pilot to the commercial phase or expand operational capacity to fulfil that demand.

Estimation of CDR volumes in the VCM, 2024–2025

Project Type	Year	Contracted credits	Issued credits	Retired credits
All conventional CDR	2024	21,120,308	16,064,733	12,737,438
	2025	12,968,007	16,492,317	10,372,711
Afforestation, reforestation, forest management	2024	21,120,308	14,409,515	10,072,834
	2025	12,968,007	15,374,683	7,985,205
Soil carbon sequestration in croplands and grasslands	2024	0	0	1,332,381
	2025	0	1,039,245	1,125,358
Peatland and coastal wetland restoration	2024	0	1,655,218	1,332,223
	2025	0	78,389	1,262,148
All novel CDR	2024	8,173,080	620,752	320,841
	2025	30,215,409	1,249,194	628,104
BECCS	2024	5,092,871	157,592	54,276
	2025	20,819,157	363,142	243,921
Biochar soil amendment	2024	1,123,648	388,821	242,339
	2025	2,964,559	793,796	339,431
Bio-oil storage	2024	290,995	10,728	3,650
	2025	5,215,296	37,031	12,090
DACCS	2024	842,707	953	856
	2025	238,453	848	500
Enhanced weathering	2024	365,248	1,370	1,135
	2025	197,957	19,804	12,956
Mineral products	2024	102,023	55,978	13,972
	2025	353,499	14,149	13,677
Biomass sinking	2024	201,223	1,044	1,044
	2025	200,001	526	0
Alkalinity enhancement of water bodies	2024	139,787	0	0
	2025	117,641	3,323	1,649
Biomass burial	2024	11,948	4,266	3,569
	2025	71,100	16,575	3,880
DOCCS	2024	2,630	0	0
	2025	37,746	0	0

Table 4.2 *Notes: Volume of CDR credits on the VCM by method. "Contracted" refers to pre-market activity, where credits are contracted before the underlying carbon removal occurs. "Issued" corresponds to on-market activity, where verified credits are issued and traded. "Retired" refers to off-market activity, when credits are permanently taken out of circulation and used for climate claims. The CDR volumes (in tonnes) include transactions tracked by OffsetsDB and CDR.fyi from projects classified as conventional CDR, novel CDR, as well as mixed (mainly CDR), based on their respective project activities.*

Afforestation, reforestation and forest management dominate conventional CDR activity across all transaction types. These projects accounted for the bulk of issued credits in both 2024 (14.4 $MtCO_2e$) and 2025 (15.4 $MtCO_2e$) and a majority of retirements (10.1 $MtCO_2e$ in 2024 and 8.0 $MtCO_2e$ in 2025). Peatland and coastal wetland restoration – along with soil carbon sequestration in croplands and grasslands – contributed comparatively modest volumes, generally in the low millions or below one $MtCO_2e$ per year. Total contracted volumes for conventional CDR reached 21.1 $MtCO_2e$ in 2024 and 13.0 $MtCO_2e$ in 2025.

Novel CDR shows a different pattern. In 2025, contracted volumes of novel CDR amount to 30.2 M tCO_2e, an almost four-fold increase from 2024, for the first time overtaking contracted volumes of conventional CDR. Contracted volumes are dominated by BECCS, with more than 5.1 $MtCO_2e$ contracted in 2024 and a sharp increase to 20.8 $MtCO_2e$ in 2025. BECCS is followed by bio-oil storage and biochar projects in terms of contracted credit volumes. Delivered and retired volumes, however, are led by biochar. Biochar issuances reached 388,821 tCO_2e in 2024 and 793,796 tCO_2e in 2025, with retirements of 242,339 tCO_2e in 2024 and 339,441 tCO_2e in 2025. Other novel pathways – mineral products, bio-oil storage, enhanced weathering, DACCS, alkalinity enhancement and biomass sinking – contributed much smaller volumes overall, typically in the tens of thousands of tonnes or less. Importantly, most novel CDR credits remain ex ante, meaning the underlying removal activity will occur in the future, while conventional issuances and retirements reflect ex post, verified removals.

Geographic distribution of voluntary CDR credit projects

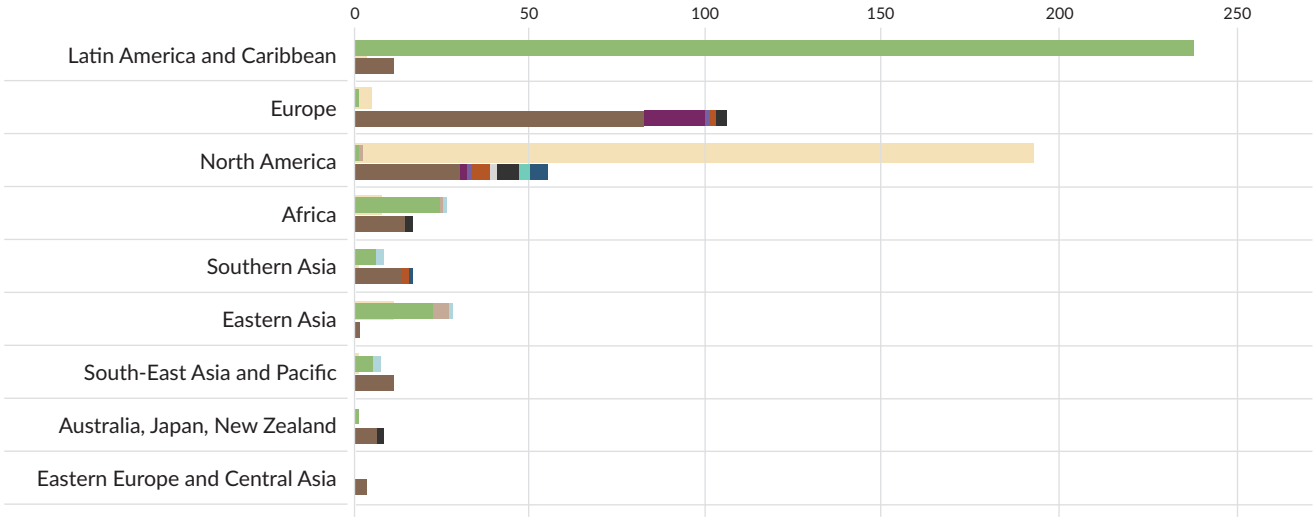
Figure 4.3 shows how active CDR credit projects were distributed across regions and countries from 2024 to 2025, covering both novel and conventional approaches.

The regional distribution (panel a) shows a strong concentration of CDR projects in certain regions. Latin America and the Caribbean stand out with the highest levels of activity, with 74% of contracted conventional CDR and 47% of all active CDR credit projects on the VCM. Europe leads in novel CDR deployment, hosting 48% of all novel projects. Europe is almost entirely focused on novel CDR, with a notable deployment of biochar (86 projects). Africa ranks third with 9.2% of all active VCM projects and a relatively balanced share between conventional and novel CDR, especially driven by afforestation, reforestation and forest management (25 projects) and biochar (18 projects). North America has 8.2% of active CDR projects with a relevant share of biochar (18 projects), and the highest deployment of enhanced weathering (5[ii]) and bio-oil storage (6 projects). Southern Asia and South-East Asia and Pacific also host a notable share of biochar projects (16 and 11 projects, respectively), while Eastern Asia shows relevant deployment in conventional CDR, particularly afforestation, reforestation and forest management (23 projects). In

ii North America would count the highest number of active CDR projects on the VCM in 2024–2025 if we were to include projects with mixed methodologies without a clear removal focus, which applies to all improved forest management projects in North America.

Number of active CDR projects in the VCM, 2024–2025

a) Number of active CDR projects by region



Conventional CDR

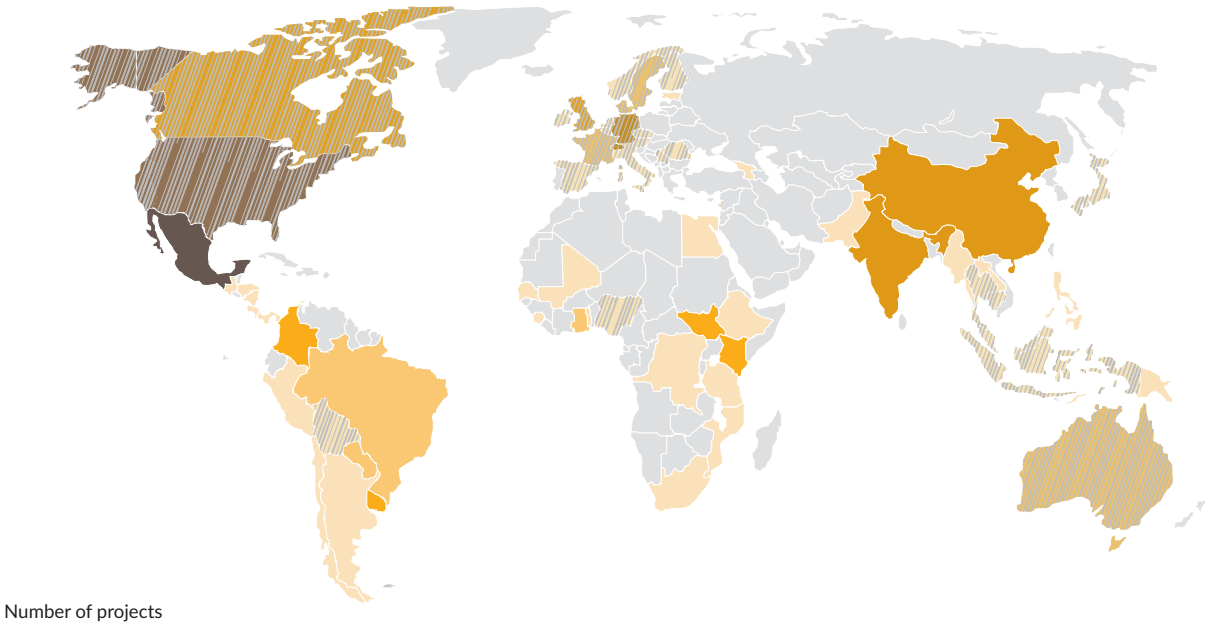
Afforestation, reforestation, forest management
Soil carbon sequestration in croplands and grasslands
Peatland and coastal wetland restoration

Novel CDR

Biochar soil amendment
Mineral products
DACCS
Enhanced weathering
Alkalinity enhancement of water bodies
Biomass burial
Biomass sinking
Bio-oil storage

Mixed (mainly avoided) projects

b) Number of active CDR projects by country



Number of projects

1–5
6–10
11–20
21–50
51–150
150+

Hatched lines indicate locations where novel CDR projects outnumber conventional ones

Figure 4.3 *Number of active CDR credit projects in the VCM (a) by region and (b) by country, 2024–2025. Active projects are those that issued or retired credits in at least one of the two years covered (2024–2025); projects with forward contracts but no issued or retired credits are excluded. Section 4.2.1 of the Technical Annex provides a detailed list of how each project class and type is mapped to the corresponding SoCDR method. (Note that regional classifications have been updated since The State of CDR 2nd Edition: Mexico is now categorized within Latin America and the Caribbean rather than North America.)*

other regions, such as Australia, Japan and New Zealand, as well as Eastern Europe and Central Asia, CDR activity remains comparatively limited.

At a country level, Mexico (37%) hosts the largest shares of active CDR credit projects for 2024 to 2025, followed by much smaller project shares in the United States (6.6%), India (6.0%), Germany (5.4%), China (5.4%) and Colombia (4.6%). The country map (Figure 4.3b) further highlights which project class – novel or conventional CDR – is dominant. Novel CDR deployment is most concentrated in the United States (16%) and Germany (14%), while conventional CDR is most dominant in Mexico (59%), followed by China (8.8%) and India (4.1%)

Under Article 6, the distribution of CDR credit projects shifts towards developing countries, with India representing approximately half of conventional and novel CDR credit projects that have undergone prior notification under the PACM.

Pricing

There is considerable variation in CDR credit prices in the VCM, both between and within project classes. While conventional CDR credits tend to trade at relatively low and narrow price ranges, prices for credits from novel CDR methods are generally higher and vary more widely (see Table 4.3).

Average market price (US$) of contracted credits by project type, 2024–2025

Project type	2024	2025
Novel CDR		
Mineral products	700	1,301
DOCCS	1,381	1.100
DACCS	315	593
Alkalinity enhancement of water bodies	451	279
Enhanced weathering	303	407
Bio-oil storage	337	362
BECCS	245	364
Biomass sinking	250	250
Biomass burial	101	127
Biochar soil amendment	132	136
Conventional CDR		
Peatland and coastal wetland restoration	28	29
Afforestation, reforestation, forest management	15	17

Table 4.3 *Note: The price per tonne is not necessarily the same as cost per tonne. Costs may be lower, allowing for a profit margin, or higher, if subsidizing the sales price with external funding. A price premium is already evident for VCM credits that obtain corresponding adjustments via Article 6, but data on this is not yet available for CDR credit projects. Note that the novel CDR price data is based on a small number of public data points.*

CDR purchasers

Based on insights from CDR.fyi and nbs.CDR.fyi, purchasers for both novel and conventional CDR are highly concentrated in the software sector. In novel CDR, 15% of unique purchasers came from the software sector and accounted for 87% of the total tonnes contracted from 2024 to 2025. In conventional CDR, 46% of purchasers came from the software sector and accounted for 80% of total tonnes contracted. Microsoft Corporation is the clear leader in both markets, having contracted 82% of total novel CDR tonnes and 76% of total forward conventional CDR tonnes from 2024 to 2025. An assessment based on the number of unique purchasers reveals that around half of both novel CDR purchasers (49%) and conventional CDR purchasers (55%) have a background in one of three sectors: software, financial or service. Purchasers from the United States dominate both novel (26%) and conventional (37%) CDR. The increase in voluntary advanced market commitments, such as Frontier (a consortium of buyers, who have committed to buying over US$1 billion of novel CDR) the Symbiosis Coalition (who have committed to buying 20 Mt of conventional CDR) have also provided a key conduit for such investments. As a result, there are now more purchasers of forward CDR contracts in novel CDR than in conventional CDR.

4.3 Quality considerations

Several characteristics are considered key to assessing the quality of carbon credits, including additionality, conservative quantification, permanence and the avoidance of double counting. Next to these basic criteria, safeguards against social and environmental harms, appropriate distribution of benefits, and robust governance of the underlying carbon crediting programmes also remain essential. A sizeable literature has documented systemic quality problems across these domains in the most common forms of carbon credits on today's market.[11-14] This triggered a wave of methodological and institutional reforms, extending across the broader carbon crediting landscape. The ecosystem is evolving rapidly, with new standards, methodologies and project types emerging alongside entirely new categories of actors, including carbon credit rating agencies such as BeZero, Sylvera and CalyxGlobal, insurers like Kita and Oka, and buying consortia such as Frontier. Whether or not these developments will fundamentally address the persistent quality issues the market faces remains unclear, including for CDR.

Quality CDR depends not only on the underlying technology but also on the strength of the broader supply chain, methodologies, audits and systems of finance and governance. Conventional CDR credits tend to suffer many of the same challenges that avoidance credits do, but particularly face challenges with the durability of their mitigation outcome. Novel CDR approaches are often structurally designed to address several of the quality challenges carbon credits generally face, for instance by offering greater permanence and

more direct MRV protocols. However, independent scientific assessments of their real-world performance remain limited. For novel CDR in particular, challenges include: the provenance of biomass for BECCS and biochar, which must be sourced sustainably to avoid negative impacts on food security and ecosystems; the additionality of projects, since some processes, such as biomass gasification that yields biochar as a by-product, offer limited net benefit; and the permanence of storage, where long-term security and reliable MRV systems are nascent. In addition, significant uncertainties persist around the measurement of geochemical processes such as enhanced weathering and ocean alkalinity enhancement, as well as the lifecycle emissions of energy-intensive approaches such as DACCS.

Looking ahead, several important developments are shaping the landscape on CDR quality. New standards are emerging, with the PACM under Article 6.4 having articulated an ambitious vision for high-integrity carbon removal. However, realizing that vision depends critically on the development of CDR-specific methodologies by the Article 6.4 Supervisory Body and their use in Article 6.2 cooperative approaches which do not have such safeguards.[15] The EU CRCF Regulation also holds potential, though early assessments highlight troubling flaws, even as revisions and updates are underway.[16]

Box 4.2 Limitations and knowledge gaps

- Pricing data on the VCM at large remains opaque, meaning that information is limited on the various factors affecting price formation – including the shares that go to intermediaries.
- As a shift begins from a spot-market focused VCM to an increasing blend of financial mechanisms to cover the growing range of CDR technologies, questions related to assessing financial additionality and the avoidance of double counting between country and corporate ledgers for particular projects will become more vital.
- Manual collection remains necessary for tracking contracted volumes of conventional CDR.
- The exact volume of transitions of CERs from the CDM into new Article 6.4 Emission Reductions under the PACM remains unclear, as does the extent to which Article 6 overall will provide a source of demand for CDR projects.

4.4 Outlook

As we approach the 2030s, the outlook for the voluntary market for CDR is characterized by both challenges and opportunities. In the increasingly interconnected carbon market that has emerged since the Paris Agreement, a key area for attention will be the development and adoption of common standards with wide geographic acceptance. Frameworks such as the Core Carbon Principles under the Integrity Council for the Voluntary Carbon Market (ICVCM) have been viewed as a potential part of this convergence, as has the EU CRCF. The standard set under the PACM of Article 6.4 is also being looked to as one that can guide the development of CDR credit projects and further catalyse voluntary demand. Setting such a framework could drive fungibility of units, promote interlinkages and enable the more rapid scaling of mitigation projects – all of which are needed. However, without careful attention to ensuring the consistent quality of the credits traded across linked platforms, market dynamics could very quickly create a "race to the bottom" where high-quality credits are priced out. The risk of lower-quality credits flooding carbon markets is generally higher for non-CDR forms of mitigation outcomes but remains a general concern across all activity types.[17, 18]

Robust demand in carbon markets is critical for the scaling of CDR. At present, most demand stems from voluntary net-zero commitments. However, the vast majority of novel CDR was contracted by one company (Microsoft), with only a small increase in volume from other buyers, indicating that demand is likely insufficient to meaningfully scale solutions. This is particularly the case as reports in April 2026 indicate that Microsoft could be pausing their purchasing programme.[19] The important role of scaling CDR on the path to net zero was underlined during the revision of the Corporate Net Zero Standard 2.0 of the Science Based Targets initiative (SBTi). To offset the significant volumes of residual emissions that are projected, planning for increased CDR capacity needs to begin now.[1] Some emerging literature argues GHGs emitted should be removed in a like-for-like manner, requiring the durability of the removal to match the permanence of the emission in the atmosphere.[20,21] The increasing integration of more durable forms of CDR into the ETS (see Chapter 5) is a notable but insufficient step in this direction.

There are various challenges for voluntary demand for CDR, which further underscore the importance of fostering robust standards and frameworks. For example, there is the perception that scaling CDR could delay emissions reductions.[22] Additionally, even when investing in durable CDR, the delivery risk is significant. One key industry where these challenges are apparent is aviation. The compliance phase of the CORSIA scheme, which begins in 2027, will prompt airlines to either directly mitigate their emissions below the established 85% of 2019 baseline or offset their ongoing emissions. Given the relative costs involved, many airlines likely will opt to offset their emissions with CORSIA-eligible units. Herein lies a central tension, as the CORSIA criteria – developed prior to the commercial emergence of many forms of durable CDR – have also led to difficulties

as a pathway for CDR development, for example, by relying on access to corresponding adjustment via Article 6.2 of the Paris Agreement; this can be a challenge if that CDR unit is not already being counted towards a nation's inventory.[23] As a result, airlines voluntarily purchasing some novel CDR credits remain unable to surrender them for CORSIA compliance. This challenge highlights the frictions that persist in driving a more fungible and higher quality carbon market.

Currently, the VCM plays a critical role in financing CDR. CDR remains a small share of overall market activity by volume but dominates market value and innovation (see Chapter 2). Conventional CDR leads issued and retired volumes, while novel CDR is characterized by high prices, extensive forward contracting and limited near-term delivery. Demand is concentrated among a small number of buyers and sectors, and quality varies across CDR methods and project types. This shows a market that is still forming, one that is capable of early deployment and experimentation but not structured to deliver CDR at the scale required for broader climate goals. Thus, additional measures clearly will be necessary, including policy support (see Chapter 5).

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