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PRI Principles for Responsible Investment

UN-convened NZAOA

How to Get to the Net?

A discussion paper on carbon dioxide removal

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All examples in this paper should be considered as illustrative only and not member guidance. Asset owners are expected to reduce their investment portfolio emissions in line with the Target Setting Protocol, to engage with investees on their emissions reductions and residual emissions carbon removals, and are asked to consider supporting the scaling up and increasing the credibility of the CDR market by investing in carbon removal investment projects.

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Acronyms & abbreviations

CDR	Carbon Dioxide Removal
GHG	Greenhouse gas
PPM	Parts per million
IPCC	Intergovernmental Panel on Climate Change
CCS	Carbon capture and storage
CCU	Carbon capture and utilization
MRV	Monitoring, reporting, and verification
DACCS	Direct air carbon capture and storage
BECCS	Bioenergy carbon capture and storage
NDC	Nationally Determined Contributions
ETS	Emissions Trading Schemes
JCM	Joint Crediting Mechanism
OTC	Over the counter
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EU CRCF	EU Carbon Removal Certification Framework
CFTC	Commodity Futures Trading Commission
LULUCF	Land-use, land-use change, and forestry

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Executive summary

Ten years on from the 2015 Paris Agreement **decarbonization remains central to any credible strategy to achieve the goal of net zero by 2050**. As such, it also remains NZAOA's top priority. The quicker the world can move to a low-carbon economy, the less carbon will be emitted, and the easier temperature rise can be stopped and reversed.

However, emission reduction will not be the sole answer. Not only does the carbon dioxide concentration in the atmosphere already exceed acceptable levels, but more is set to be added—even if efforts to decarbonize were to accelerate radically. **Removing emissions from the atmosphere and storing them durably is therefore vital to achieving net zero by 2050.** Carbon reduction and avoidance can lower emission levels; but only carbon dioxide removal (CDR) can reverse them (i.e. deliver a “net negative” impact). Climate scientists adhere to this reasoning; hence, **even the most ambitious science-based net-zero paths consider CDR**.

To date, this task of removing carbon has been done by forests, oceans, and other so-called ‘natural carbon sinks’. However, land-use changes and other phenomena have dramatically reduced this function. Indeed, there is now a risk that deforestation, ocean acidification, and similar phenomena may turn these sinks into net emitters of carbon dioxide. **The very first step is therefore to urgently preserve nature: without intact land and ocean ecosystems, a net-zero future will be impossible.** Preserving nature is not equivalent to carbon dioxide removal, although it remains a crucial prerequisite for limiting global warming. Only additional and intentional nature-based removal qualifies for netting of residual emissions.

Indeed, both nature-based and technology-based CDR approaches are necessary; they are complementary. Both need to be scaled fast. Each has its pros and cons. Nature-based solutions have high scalability potential and generate significant co-benefits for society and the environment, for example; yet they face challenges around quality assurance and reversal risks (e.g. forest fires releasing sequestered carbon). In contrast, technology-based solutions tend to be easier to verify and have lower reversal risks, but they come with high costs.

Carbon markets play a vital role in the support of scaling CDR solutions. These markets split into voluntary, regulated and hybrid forms. Carbon markets make provision for CDR generated through additional nature-based solutions and new technologies, such as direct air carbon capture and storage. However, **carbon markets have so far failed to take off in the support of carbon removals** for various reasons which are discussed in this paper. **This has limited the supply of CDR projects and investor finance to CDR projects.**

This paper offers several recommendations to enhance the scalability of CDR solutions and carbon markets, based on an outline of the current CDR landscape. Key suggestions include implementing **balanced policies and regulations to mobilize financing for CDR solutions, fostering a stable demand for CDR**, and thereby encouraging the necessary investments to expand both nature-based and technology-based CDR initiatives.

The paper concludes that **transitioning to the integration of CDR project financing within regulated markets will play a crucial role**, as voluntary markets have so far proven unable to drive sufficient and stable CDR demand. Through action by policy makers, market participants and key market enablers, it is possible to make global carbon markets much more efficient and transparent as well as considerably more liquid than at present. Transformed as such, these markets can shift from their status as an underutilized market mechanism in the support of scaling CDR into a widely supported and highly effective means by which the world can "get to the net".

Introduction

NZAOA's highest priority is the urgent need for a swift and deep decarbonization across all sectors of the economy, particularly carbon-intensive industries. Secondly, it points out that decarbonization alone will be insufficient to achieve net zero.

As demonstrated by Figure 1, science-based decarbonization aligned with the Paris Agreement, shows that carbon dioxide removal (CDR) will become increasingly important over time. In part, this is due to the rise in the atmospheric concentration of greenhouse gas (GHG) emissions and other forcing agents. In 2022, GHG emissions reached 477 parts per million (ppm) of carbon dioxide (CO_2) equivalents. This is close to the upper limit of the peak level set by the Intergovernmental Panel on Climate Change (IPCC). Exceeding this upper limit will likely push the global temperature increase over the target of 1.5 degrees Celsius (°C) above pre-industrial levels established in the 2015 United Nations' Paris Agreement. To limit the increase to 1.5°C and ensure that global temperature returns to stable conditions, GHG emissions need to return to 411 (390-430) ppm by 2100.[1]

Thus, the challenge is not only to cut new emissions but also remove historical emissions. The importance of CDR is also sparked by the uncomfortable truths that certain anthropogenic carbon emissions are very hard to abate and that many will continue to exist beyond 2050. With every additional year of underperformance in emission reduction, the need for removal will become increasingly important.

1 European Environment Agency (2025). Atmospheric greenhouse gas concentrations. 2025. eea.europa.eu/en/analysis/indicators/atmospheric-greenhouse-gas-concentrations

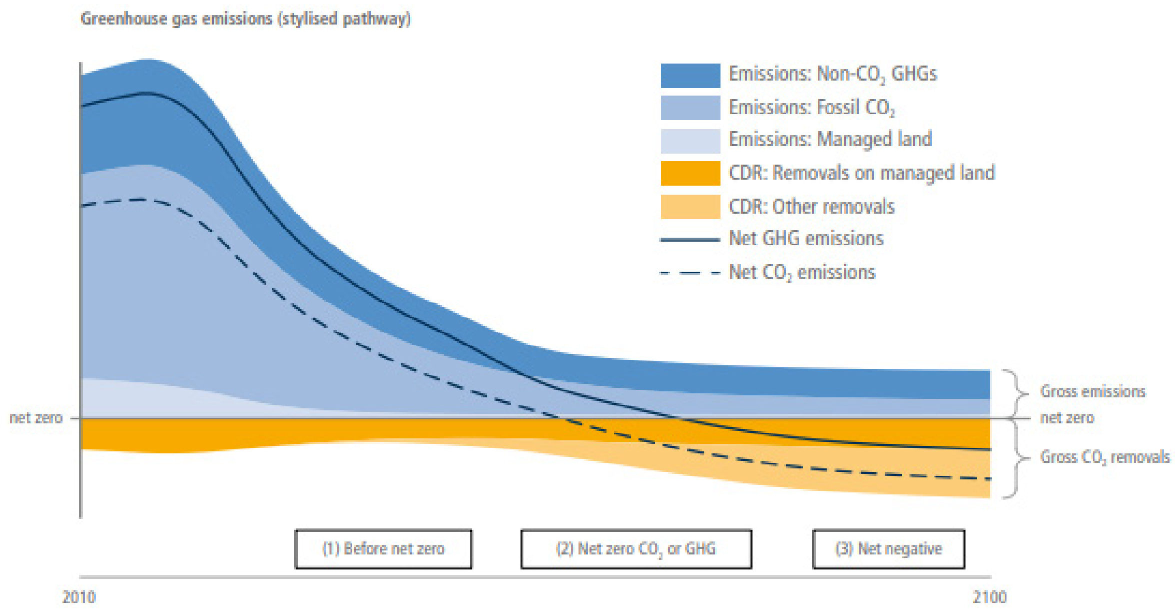

Figure 1: Beyond net zero—negative emissions required through carbon removals.
Source: IPCC AR6 WGIII Cross Chapter Box 8, Figure 2, 2022[2]

The amount of CDR needed depends on future climate scenarios. These scenarios are strongly influenced by humanity's ambition levels. Yet, whichever scenario is chosen a large and prominent gap still exists between where the world's CDR capacity is currently and where it needs to be. This is true for the short term (i.e. 2030) as well as for the medium to long term (i.e. 2040 and 2050, respectively). A rapid development and roll-out of innovative, effective, and affordable CDR solutions is therefore essential. If this fails to happen, removal capacity will simply not be up to the task required.

NZAOA's Target-Setting Protocol (4th Edition) showcases the emission reduction and net-zero commitment of asset owners of NZAOA. It clearly states that asset owners of NZAOA shall not use carbon removals for their own sub-portfolio or sector target achievement before 2030. This is to emphasize the primary focus on decarbonization. At the same time, however, the Protocol highlights the strong need for capacity-building for durable CDR, coupled with a liquid and well-regulated CDR certificate market in the medium to long term.

This paper builds on NZAOA's previous paper, The Net in Net Zero, published in 2021, which offers a general outline of the role of negative emissions in achieving climate alignment for asset owners. Following on from this explanatory overview, this current paper interrogates what enabling environment is needed to finally "get to the net". To this end, it identifies specific measures that asset owners can take on their own to contribute towards building CDR capacities. As part of this objective, it discusses the potential challenges that asset owners might face and provides recommendations on how to overcome these. It also points out how policy and regulation can help mobilize capital toward the CDR sector, noting the particular importance of having a stable regulatory landscape to govern the price of carbon.

2 Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change. (IPCC). Cross-Chapter Box 8, Figure 2, p. 1263. ipcc.ch/report/ar6/wg3/chapter/chapter-12/

According to the IPCC and other publications[3], carbon removal needs to fulfil three main criteria: 1) carbon needs to be captured from the atmosphere, not from fossil fuel-related sources; 2) it needs to be stored durably; and 3) it needs to be additional and intentional by human intervention. Carbon capture and storage (CCS) and carbon capture and utilization (CCU) share many components with CDR methods.[4] However, their application to CO_2 emissions from fossil fuels can never result in CO_2 *removal* from the atmosphere;[5] instead, these would qualify for emission reduction.

Only "true CDR" qualifies for neutralization—namely, when carbon released from the atmosphere is captured and stored permanently or at least durably with low risk of reversal.[6] Any additional reduction and avoidance activities from outside a company's value chain (e.g. reduction-based carbon credits) may qualify for compensation purposes and demonstrate a company's emissions reduction efforts. However, these activities cannot be used to net residual emissions. Not only do reduction and avoidance of GHG emissions play a vital role in compliance and voluntary markets; they also have a catalytic effect on many innovative, sustainable business models supporting decarbonization. Even so, these activities are not carbon negative and therefore cannot counterbalance the carbon released into the atmosphere. The price differential of reduction/avoidance versus removal indicates the difference in quality and use case.

3 The State of Carbon Dioxide Removal. 2nd ed. 2024. p. 23. stateofcdr.org
4 Carbon Gap (2022). The difference between CCS, CCU and CDR and why it matters.
5 United Nations Environment Programme (2023). Emissions Gap Report. P. 49. wedocs.unep.org/handle/20.500.11822/43922
6 Discussion see below chapter 3.1.

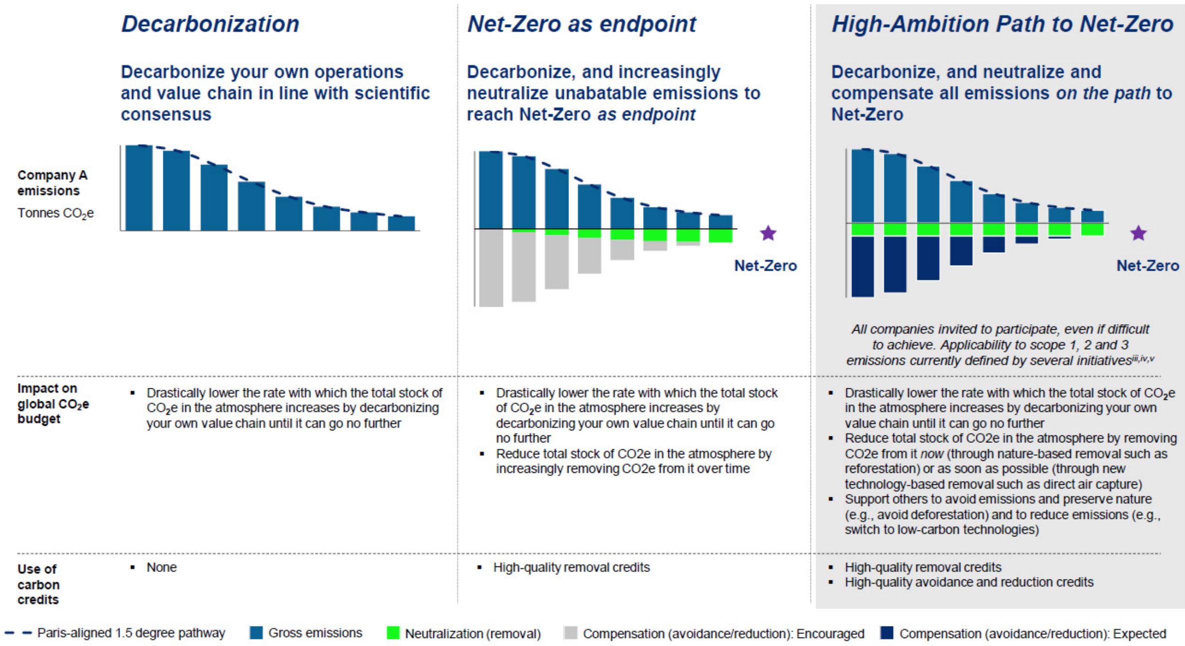

Figure 2: High Ambition Path to Net-Zero—illustrative examples[7]
Source: Institute of International Finance[8]

7 This chart is an illustrative example explaining the terms around “compensation”, “neutralization” etc..
8 Institute of International Finance, (2022): The high ambition path to net zero.

1. Overview of CDR solutions

In its broadest sense, carbon removal can be categorized into **nature-based, technology-based**, and **hybrid** solutions. The main differences between these methods relate to the way in which carbon is captured, the type of earth system and storage medium used, and the implementation option chosen.

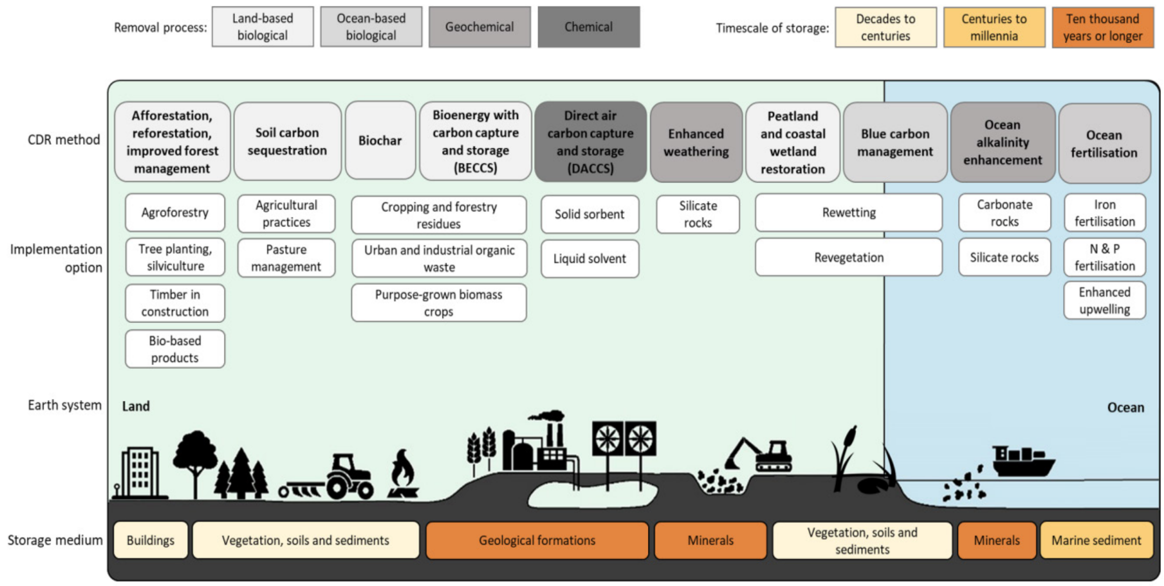

Figure 2: Carbon Dioxide Removal Taxonomy
Source: IPCC AR6 WGIII, Cross-Chapter Box 8, Figure 1 (2022)[9]

Currently, the most widely used removal types are forest and soil-based, with reforestation on degraded land showing significant potential. In general, the ability of forests and other soil-based solutions to act as "carbon sinks" grants huge potential to nature-based removal. As well as being having significant biodiversity and social co-benefits, nature-based solutions are also highly cost efficient.[10] Compared to technology-based solutions, however, they present more challenges regarding monitoring, reporting, and verification (MRV). They also pose a higher risk of carbon reversal to the atmosphere. In the case of nature-based CDR, therefore, it is necessary to consider the

9 IPCC AR6 WGIII, Cross-Chapter Box 8, Fig. 1.

10 Nature-based solutions were identified as the only one in which large-scale CDR may currently and at short term be possible (e.g. through afforestation/reforestation or soil organic carbon management). Measures with most significant potential for CDR were afforestation/reforestation (0.5 to 10.1 $GtCO^2_e\ yr^{-1}$) (*medium confidence*), soil carbon sequestration in croplands and grasslands (0.4 to 8.6 $GtCO^2_e\ yr^{-1}$) (*medium confidence*) and BECCS (0.4 to 11.3 $GtCO^2_e\ yr^{-1}$) (*medium confidence*). Source: IPCC AR6 WGIII Chapter 7.

use of buffers to reduce this risk of reversal. In addition, global high-integrity standards need to be developed. By comparison, technology-based or "novel" solutions tend to prove highly effective if captured carbon is stored permanently. A notable example of such a solution is direct air carbon capture and storage (DACCS), a good illustration of which are the Mammoth and Orca facilities run by CDR specialists Climeworks and Carbfix in Iceland.[11] Many technology-based CDR solutions are less complex to monitor. On the downside, however, they are often energy-intensive, more expensive, and not yet available at scale. At present, technology-based CDR is in an evolutionary stage, with many solutions either under development or in the demonstration phase. It is assumed that CDR policy measures will lead to an increase in demand. As soon as this happens, technological progress and economies of scale are projected to start accelerating, causing costs to gradually come down (see chapters below).

Only high-quality CDR must qualify for potential neutralization (netting). High quality criteria are outlined in the Core Carbon Principles[12] of The Integrity Council for The Voluntary Carbon Market as well as in the documentation of other credible standard setters.[13]

Carbon removal processes can be further categorized into biological, geochemical, and chemical processes. They differ, for example, in terms of:

- **Maturity level:** some solutions rely on proven processes, while others still bear various risks. Reforestation is highly mature, for example, whereas several ocean-based carbon storage solutions are still at an early stage of development.
- **Mitigation potential:** some solutions have higher mitigation potential due to their widespread natural occurrence (e.g. soil-based solutions) or scalability.
- **Durability:** different types of carbon removal have different storage timelines and thus different degrees of permanence. Geological storage (rocks and deep underground) tends to have the highest permanence, stretching out to over ten thousand years. Terrestrial storage (plants and soils), oceanic storage (biomass, deep ocean floor), and long-lived products (concrete and timber) tend to store over decades to centuries.[14]
- **Risk of reversal:** some CDR methods are at higher risk of reversal or leakage. This can occur due to unexpected climate-related events, like wildfires and floods, or to human activities, like logging, land use change, and urban expansion. Failure to mitigate these risks can reduce their potential.[15]
- **Economic cost:** cost estimates vary widely, starting from US$15-65 per ton of CO_2 (tCO_2) in high quality nature-based projects as improved forest management, afforestation and reforestation and going up to more than $300/$tCO_2$ in direct air capture (DAC).[16] The cost of technology-based CDR solutions is expected to decrease when deployed at scale, as policy measures are phased in, and as net-zero commitments are credibly implemented.

11 Climeworks (n.d.). Orca plant; Mammoth plant
12 Integrity Council for the Voluntary Carbon Market (ICVCM) (n.d.). Core Carbon Principles
13 Carbon Direct (n.d.). Criteria for High-Quality Carbon Dioxide Removal
14 IPCC (2024). IPCC Side Event at SB60: WGII and TFI Contributions to AR7
15 Oxford Institute for Energy Studies (2024). Insight 158: Carbon Dioxide Removals
16 IPCC AR6 WGIII, CDR Factsheet

- **Co-benefits and trade-offs:** nature-based CDR solutions can have desirable side effects, such as improved biodiversity, lower fertilizer usage, and waste reduction. However, negative trade-offs need to be considered. Biomass for bioenergy carbon capture and storage (BECCS), alongside other types of terrestrial storage, can compete for land use with food crops. Sustainable biomass sourcing must be considered.[17] For technological removals, trade-offs can arise from energy and water intensity.[18]
- **Viability of business models:** the ability of CDR solutions to generate sustainable financial returns in addition to carbon removals, such as through carbon credits, is especially important for investors. Examples of such revenue streams include income from tourism, water management, and bio resources arising from carbon forestry or agroforestry. Other viable business models arise from the increases in soil fertility, agricultural productivity, and water retention that occur alongside the production of biochar. Another profitable byproduct is biochar's use as a nutritional supplement for animal fodder.

The significant need for carbon removal can only be met through a diverse mix of nature-based, technology-based, and hybrid solutions, which counterbalance the pros and cons of the different project types.[19] Deploying nature-based CDR today that is partially replaced with tech-based CDR later on is financially more attractive than suffering damages from temperature overshoot until tech-based CDR is ready to be deployed at scale.[20]

The earth's oceans, forests and soils absorb about half of all human emissions.[21] Yet, the capacity of these natural 'carbon sinks' to sequester CO_2 is nearing a tipping point. In 2023, researchers discovered that forests, plants, and soil absorbed almost no carbon when calculated as a net category. In fact, scientists calculate that continued forest loss could turn the Amazon and other tropical rainforests from carbon sinks into sources of net CO_2 emissions. It is feared that this could spark a global tipping point.[22] At the same time, the rate at which the world's oceans are absorbing carbon is slowing down alarmingly. If the concentration CO_2 in the atmosphere is to be decreased, as it must, then natural carbon sinks must be urgently preserved. The reality is unambiguous: reaching net zero is impossible without intact nature.[23]

Technology-based CDR could feasibly be phased in as demand accelerates. However, over the last decade, this type of CDR has been slow to deliver. As Martin-Roberts *et al.* (2021) state: "Using current rates of deployment, CO_2 storage capacity by 2050 is projected to be around 700 million tons per year, just 10 per cent of what is required."[24]

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17 Carbon Direct (2024). Guide to Sustainable Biomass Sourcing
18 IPCC AR6 WGIII, CDR Factsheet
19 Oxford Principles (Revised 2024), Chapter 3
20 Ecosystem Marketplace (2024). Shades of REDD: The Durability Dilemma—Navigating the Science and Politics of Carbon Removal
21 World Economic Forum (2023). Here's how carbon sinks help fight the climate crisis
22 Brienen, R. J. W. et al. (2021). Amazonia as a carbon source linked to deforestation and climate change. Nature 595, 388–393 doi.org/10.1038/s41586-021-03629-6
23 Climateworks Centre (2025). There's no path to net zero without nature
24 E. Martin-Roberts et al. (2021). "Carbon capture and storage at the end of a lost decade," One Earth, vol. 4, no. 11, pp. 1569–1584. doi: 10.1016/j.oneear.2021.10.002"

It is important to note that technology-based CDR is not in competition with nature-based CDR: they are complementary. Both deliver short-, medium- and long-term climate goals in combination.[25] Because investors have different decision-making criteria, such as their appetite for risk, their removal investment portfolios may give greater weight to one form of CDR over the other. This demonstrates individual preference and should not be read as a judgment.

As pointed out above, rapid decarbonization **and** CDR deployment are crucial to avoiding tipping points and further climate destabilization. This need for CDR as a component of a viable net-zero future will become more pronounced and urgent if decarbonization continues to lag the world's stated level of ambition. How much CDR will be needed and under which specific scenarios remain the subject of intense discussion. This is not a surprise as scientific forecasts vary significantly. What is undisputed, however, is that the substantial contribution that CDR must make for the successful delivery of both a 1.5°C and a 2°C pathway. The latest research, for example, put the figure at several gigatons of CO_2 per year (~7-9GtCO_2) over the next two decades.[26] Regardless of the pathway, therefore, the need to massively scale CDR is widely acknowledged.

Existing CDR capacity is vanishingly small. A recent report by the Potsdam Institute for Climate Impact Research and KfW Research,[27] plus *The State of Carbon Dioxide Removal* report[28], quantifies current conventional global carbon removal capacity. This mainly consists of forest-based removal, which is estimated at around 2.2 GtCO_2 per year.[29] "Novel" (i.e. technology-based) CDR solutions such as BECCS and DAC have shown rapid growth recently, but they are still in their infancy. With an estimated CO_2 removal volume of about 1.3 million tons of CO_2 (MtCO_2) per year, such solutions currently represent a tiny fraction (less than 0.1 per cent) of global CDR capacity.[30]

According to The State of Carbon Dioxide Removal, conventional CDR needs to double by 2050, but novel CDR needs to rise exponentially. Corresponding global expenditures could reach between 0.5 per cent and 2.0 per cent of global GDP in 2050 (see KfW Research).[31] An amount of this magnitude is simply too big for private or public budgets alone. The only hope of reaching this huge amount is to combine these budgets.

25 Ecosystem Marketplace (2024). Shades of REDD: The Durability Dilemma
26 State of Carbon Dioxide Removal 2024: 2nd Edition. P. 9
27 KfW & PIK (2024). Let it sink in—New governance and finance structures are needed to scale up carbon dioxide removals. P. 4
28 State of Carbon Dioxide Removal 2024: 2nd Edition
29 Please note, this number is not reflecting the market size, it is only reflecting nature's capacities.
30 State of Carbon Dioxide Removal 2024: 2nd Edition. P. 10
31 KfW & PIK (2024). Let it sink in.

2. CDR demand vs supply

Carbon certificate markets are likely to be the most efficient and transparent way of matching CDR supply and demand. Well-functioning carbon markets are vital to scaling the CDR industry. To avoid confusion, NZAOA recommends distinguishing the two different sides of the market:[32]

- The 'demand side', which refers to the buying of CDR certificates and/or offtakes; and
- The 'supply side', which refers to the developing and the funding of carbon removal companies and/or projects.

Both sides need to grow in parallel, and NZAOA recommends engaging on both fronts.

2.1 Demand side—carbon certificate markets

2.1.1 History and overview

The origins of carbon credits date back longer than many expect. Emission offsetting took root in US environmental law in the 1970s, with early experiments in carbon offset trading laying the foundations for market-based environmental regulation worldwide. Offset trading is grounded in the idea of favouring market efficiency and applying a market price on carbon emissions, instead of imposing punitive taxes or enforcing environmental regulations that constrain business. The approach found widespread support among industry, governments, and non-governmental organizations alike.[33]

Over the last half-century, carbon credit markets have evolved significantly, leading to a fragmented and complex market landscape worldwide. A rough distinction can be made between:

i. Compliance markets;
ii. Voluntary markets; and
iii. Hybrid approach.

All of these forms of carbon markets play a fundamental role in scaling CDR. This is especially true when compliance markets consider carbon removal offsets in their design. This kind of combined approach is referred to here as a hybrid carbon approach.

32 Note that in a strict sense, loose terms such as "invest in CDR" remain open which side of the market is addressed. In addition, we recognize other forms of non-market ways to create CDR demand such as reverse auction and public procurement, which is out of the context for the purpose of this paper.
33 Carbon Brief (2023). Timeline—The 60-year history of carbon offsets

Carbon markets are receiving increasingly more attention from multiple stakeholders, including institutional investors. In 2023, the trade volume of globally regulated emission rights ("carbon allowances") rose to a record of US$949 billion, which equates to 12.5 $GtCO_2$ equivalent ($GtCO_2e$) in removed emissions.[34] Most of this volume (87 per cent) comes from the European Emissions Trading System (EU ETS), which the EU Commission perceives as the key instrument for achieving the European Union's climate targets by 2050. Due to the success of (market-based) carbon pricing, more and more economic areas around the world are adopting a market-based system. As a result, almost 19 per cent of annual emissions worldwide are now covered by compliance carbon markets.[35] For now, however, compliance carbon markets are mostly geared towards fulfilling domestic Nationally Determined Contributions (NDCs). As such, they are almost exclusively targeting emissions reduction, rather than emissions removal.

According to MSCI, a leading data specialist and index provider, the voluntary carbon markets saw approximately $1.4 billion worth of credits retired.[36] While this remains modest compared to the scale of existing compliance markets, one distinguishing feature of the voluntary market is its breadth, spanning carbon credits for "reduction" and "avoidance as well as for "removal". Despite the recent growth of removal credits, however, this segment represents less than 20 per cent of the total market.[37,38] As yet, removal credits do not and hardly play a role in compliance markets so far. Recent trends in credit retirements paint a more positive story. In 2024, credits retired from removal based projects accounted for a third of value (in USD) of total retirements, according to MSCI. The data specialist also projects a bright future, with the removal market predicted to rise more quickly in value than the reduction market.[39]

Voluntary carbon markets also have the potential to scale with regulatory oversight, especially as compliance markets consider carbon removal offsets in their design in the formation of hybrid carbon approaches.

2.1.2 Voluntary vs. compliance markets

Another important division on the demand side is between behavioural demand (i.e. voluntary markets) and fundamental demand (i.e. regulated markets), and the mixture of both (hybrid markets).

34 Reuters (2024). Global carbon markets value hit record $949 bln last year—LSEG
35 World Bank (2023). State and Trends of Carbon Pricing 2023
36 MSCI (2025). Frozen Carbon Credit Market May Thaw as 2030 Get Closer
37 Certain information related to Carbon Markets historical and forecast data ©2025 MSCI ESG Research LLC. Reproduced by permission; No further distribution of MSCI data permitted
38 MSCI. Frozen Carbon Credit Market May Thaw as 2030 Get Closer
39 MSCI. Frozen Carbon Credit Market May Thaw as 2030 Get Closer

Behavioural (voluntary) demand refers to companies buying offsets to claim carbon neutrality and gain reputational advantages with stakeholders.[40] Even though there are companies using removal offsets towards interim net-zero targets as of today, most net-zero pledges do not officially come into full effect until 2040. Further, part of the existing behavioural demand is driven by end customers (e.g. compensation for flight emissions), where priorities might change. Overall, price elasticity appears high. This means that a large number of customers might be unwilling to accept larger premiums for a long time. Another issue relates to quality standards. As yet, these are not incorporated into legal frameworks. This is because they are developed by the private sector rather than lawmakers, and therefore lack legal status.

In contrast, **fundamental demand** is enforced by regulations Many of these regulations are already underway, indicating that this form of demand will likely play a much larger role in the coming years. Compliance markets are mostly developed to support national decarbonization goals. They are perceived as key instruments in achieving the 2050 net-zero targets of the regions that they cover. In this context, compliance markets either refer to Emissions Trading Schemes (ETSs) or carbon crediting mechanisms. ETSs are comprised of emissions allowances. These are artificial pollution permits issued by the governments of the respective markets, such as the European Union and the United Kingdom, with the goal of fulfilling their regulatory carbon reduction obligation. **Credit-based offset schemes or carbon credit mechanisms** (eg. Article 6 Paris Agreement or the Japanese Joint Crediting Mechanism (JCM)) work by setting mandatory emissions baselines or benchmarking approaches. The emissions reductions of companies are then measured against these. When a company's annual emissions come in below its respective benchmark threshold, it can issue carbon credits. In contrast, when a company exceeds the benchmark, it needs to buy carbon credits to surrender its surplus emissions. Notable examples of trading schemes using this approach include the Japanese GX ETS and the Australian Safeguard mechanism. For now, however, most of these markets hardly consider carbon removal. Carbon crediting mechanisms exist in compliance and voluntary markets.

Certain compliance markets allow offset credits from voluntary markets. These **hybrid approaches** blend compliance markets with elements from voluntary markets, creating regulated CDR demand. Countries like Japan (GX-ETS – phase one), Singapore, Australia, Colombia, South Korea, and South Africa, plus the US state of California, accept offset credits from voluntary markets under their national schemes.[41,42] Compliance entities are allowed to use offset projects from voluntary markets to satisfy a low amount of their compliance obligations. Also, Article 6 of the Paris Agreement represents a hybrid approach due to the interaction between voluntary and compliance carbon markets under its provisions.[43] The eligibility and proportion of credits that can be used vary by jurisdiction. The trend is toward allowing high-quality, verified credits—often with restrictions on project type, location, and standard—to ensure environmental integrity. The integration of carbon removals via the hybrid approach could soon be implemented

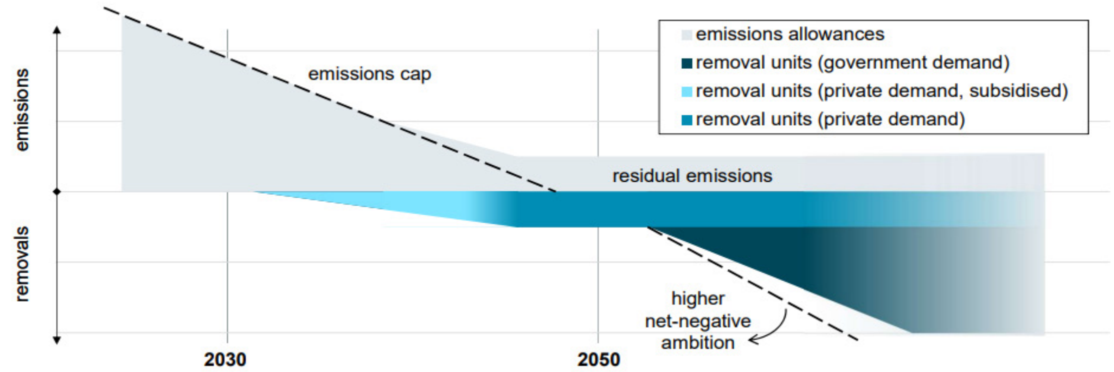
40 Find more reasons for buying offsets in section 2.2.1.

41 Verra (n.d.). The VCS in Compliance Markets

42 AlliedOffsets (n.d.). VCM Credits Eligible for Compliance Tax Schemes

43 Carbon Limits AS (2025). Linkages between Article 6 of the Paris Agreement and Voluntary Carbon Markets

in the European Union and by the United Kingdom.[44] Until now, emissions reduction was the primary objective of the ETSs in the European Union and the United Kingdom. Both of these trading schemes involve structurally decreasing the volumes of allowance units within the system over time. As regulators prepare for future emissions that cannot be reduced (i.e. residual emissions), removal credits are set to become ever more important.



	Phase 1: Road to net-zero	Phase 2: Net-zero	Phase 3: Overshoot management
Net emissions	>0	0	<0
Certificate supply	• government • removal firms (permanent)	• removal firms (mainly permanent)	• removal firms (permanent and temporary)
Certificate demand	• emitters (all)	• emitters (residual)	• government • emitters (residual)*

*Including perpetual renewal of temporary removals, which could also be mandated to removal firms.

Figure 4: Sequencing Carbon Dioxide Removal into the EU ETS
Source: CES ifo, PIK and ETH (2024), European Commission (2024)[45]

The EU Commission has proposed including removals in the EU ETS by 2026,[46] for the next trading phase (from 2031). Removal credits would then gradually replace emission allowances to net residual emissions. To safeguard the integrity of the system, the quality of eligible carbon removal certificates will be assessed using the newly published Carbon Removal Certification Framework (CRCF). This framework aims to harmonize standards for certifying carbon removal, carbon farming, and carbon storage activities in the European Union.

The rise of regulated CDR demand through hybrid markets would be a clear game changer, as a buying obligation would drive fundamental demand for CDR credits and would incentivize decarbonization as long as the cap and the carbon price were well managed.

Against the complex backdrop presented by the various carbon market types and standards, a new pattern has evolved: glocalization. This describes the increasing trend towards new global schemes basing themselves on domestic standards. Numerous reasons exist for this phenomenon, chief of which are societal acceptance, economic

44 UK Government (2025). Integrating Greenhouse Gas Removals in the UK ETS: Main Response. assets.publishing.service.gov.uk/.../uk-ets-ggrs-main-response.pdf
45 Sultani *et al*. (2024). Sequencing Carbon Dioxide Removal into the EU ETS. CESifo Working Paper No. 11173. P.10 ifo.de/DocDL/cesifo1_wp11173.pdf
46 UK has committed to legislating integration of CDR by 2028.

feasibility, and protectionism. In such circumstances, the purchasing obligation is promoted through targeted regulations concerning green claims and compliance requirements. As hybrid markets gain traction globally, they could stimulate growth in both regulated demand and supply. Such a scenario would, in turn, boost activities in voluntary markets.

The matrix in Figure 5 below reflects the breakdown of carbon markets by regulated emissions trading systems such as ETS, regulated carbon offset markets, and the voluntary carbon market (VCM). For reasons of simplification, it only shows the current status of selected markets.

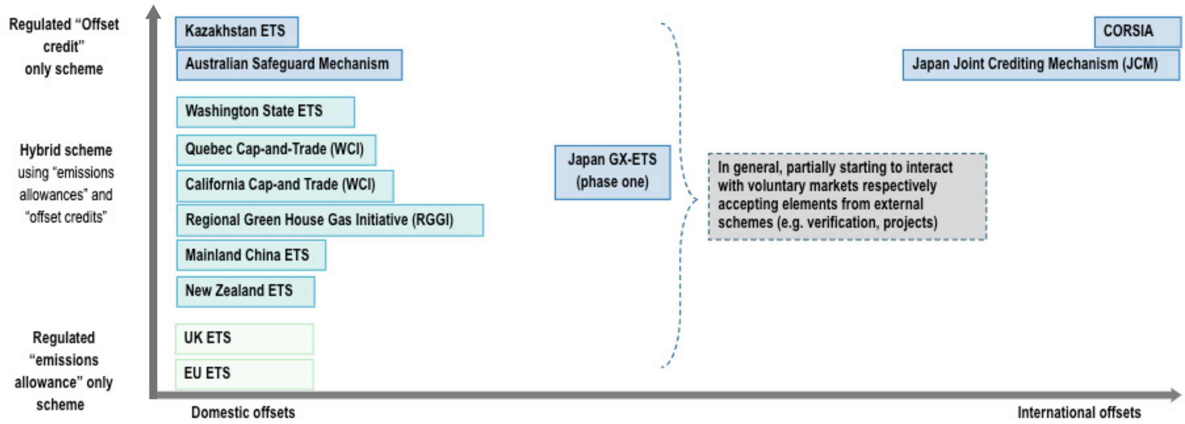


Figure 5: Driving fundamental demand by integrating voluntary offsets in regulated schemes

Source: NZAOA FinTrack Carbon Removal Investment Working Group

2.1.3 Primary vs. secondary markets

The demand side consists of a primary market and a secondary market. In the primary market, the project developer sells newly issued carbon removal certificates directly to its buyer, for instance, through bilateral direct offtake agreements. Transactions on the primary market tend to trade over the counter (OTC), are project-specific, and are not publicly disclosed.

The secondary market, on the other hand, facilitates the buying and selling of issued carbon credits. It is more transparent and companies trade carbon removal credits with each other bilaterally (OTC) or via exchanges (e.g. European Energy Exchange, CBL, etc.). Buyers in the secondary market do not interact directly with the underlying project developer. One credit typically refers to one ton of carbon dioxide equivalent (tCO_2e) removed.

The transparency and efficiency of both the primary and secondary markets are crucial for the growth of the CDR industry. Strong demand and adequate liquidity on the secondary markets can enhance the value of carbon removal credits issued in the primary market. This, in turn, creates a virtuous cycle that attracts more investment into supply-side projects.

Carbon removal credit buyers are typically motivated by one or several of the following reasons: avoidance of penalty payments, in the context of compliance allowances markets; potential returns from price increases; portfolio diversification benefits; hedging against transition/carbon price risk; and the mitigation/removal of carbon dioxide resulting in expected environmental benefits (impact) in the context of net-zero pledges. Essentially, these credits can be banked until sold again or retired for purposes of CO_2 offsetting. In the latter case, credits are cancelled transparently in the respective registries.

Asset owners and other investors can be active in both markets. In the primary market, they can invest directly in CDR projects and/or act as direct offtakers of carbon credits. They can also participate in the secondary market for the reasons described above. Investors who invest directly in CDR projects can use the carbon credits for neutralizing residual emissions. Alternatively, they can sell them on the market, with the value of the carbon credits contributing to the investor's overall return on investment. However, in this case, the credits do not contribute to the investor's carbon neutralization as they are sold. Investors can obtain the carbon credits from both markets to net their residual emissions (Please see Figures 6–7 and Table 2 in the appendix for an illustrative example).

2.1.4 Future demand

Due to the voluntary nature of corporate net-zero pledges, it is primarily the voluntary carbon markets that are currently relevant to asset owners of NZAOA. Here, demand for CDR has been dominated by North American companies, particularly from the tech sector, but also from banking and finance, consulting, and the oil and gas sector.

Despite an impressive growth of carbon credit issuances and retirements over the last 15 years, demand has moved sideways, remaining more or less on the same level over the last four years.[47] The reasons are many and varied, ranging from negative publicity about the quality of some projects through to regulatory uncertainty, the failure to fully standardize, the lack of transparency, the infancy of technology-based CDR, and the absence of urgency among corporations.

According to MSCI's long-term estimates, the global carbon market (including avoidance, reduction, and removal credits) is poised to grow from USD 1.4 billion in 2024 to 6–20 billion in 2030 and 60–300 billion in 2050. This projection is conditional on the continuation of a favourable policy environment, plus the implementation of existing corporate and governmental climate commitments as announced. Around two-thirds of the value of carbon markets by 2050 could be removal credits, up from the current level of below 20 per cent (this low level reflects the voluntary nature of removal credits as well as the high price differential between reduction / avoidance and removal credits). Such policies include establishing hybrid markets in alignment with Article 6 of the Paris Agreement, and implementing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).[48] In volume terms, this implies an estimated total annual demand of 200–400 $MtCO_2$ for nature-based CDR and 7–24 $MtCO_2$ in 2030 for technology-based CDR by 2030. By 2050, annual demand is expected to grow to 1.2–3.0 $GtCO_2$ for nature-based CDR and 60–140 $MtCO_2$ for technology-based CDR.

47 MSCI. Frozen Carbon Credit Market May Thaw as 2030 Get Closer

48 ICAO (n.d.). Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). icao.int/CORSIA

Table 1: Long-term demand estimates

	2030 demand (per year)	2050 demand (per year)
Nature-based CDR	200–400 $MtCO_2$	1.2–3.0 $GtCO_2$
Technology-based CDR	7–24 $MtCO_2$	60–140 $MtCO_2$

Source: MSCI. As of (c) 2025.[49]

Noting that these estimates are subject to many assumptions, it is evident that the demand estimates fall significantly below the volume implied by "The State of Carbon Dioxide Removal" in Chapter 1 of for 7–9 $GtCO_2$ of carbon removal per annum by 2050—which results in an estimated gap of ~6 $GtCO_2$ in 2050. It needs to be considered though, that market-based CDR is only one part of the picture. Notably, countries' national targets include net land use, land use change and forestry (LULUCF), which for now has no market around it at all.

The dimension of the challenge becomes even more dramatic when contrasting these figures with the gap between the high number of CDR credits issued and the comparatively low number of credits being retired. This discrepancy is partially explained by the fact that only a small percentage of issued credits fulfil the requirements of high-quality carbon removal.

2.2 Supply side—carbon removal projects and companies

A prerequisite for CDR certificate origination is the presence of a sufficient number of companies or project developers providing carbon removal solutions (the supply side). These companies need upfront capital to build up their operations and scale their businesses. Capital can be secured through direct offtake agreements, forward instruments (either via pre-payments, which provide working capital, or via the use of forward offtake agreements as collateral), or direct debt and equity investments.

2.2.1 Carbon markets as a market opportunity

As shown previously, carbon removal is a major global challenge, but it also presents a unique business opportunity, for some of the reasons below:

- **Market potential:** a defining feature of the CDR industry is that it is still in its infancy. With few established incumbents and relatively low market saturation, the CDR sector offers considerable flexibility and opportunity for new players.
- **Marginal cost:** as technologies scale and mature, the marginal cost of carbon removal is expected to fall.
- **Demand for high-quality CDR:** in the wake of some industry scandals in 2021/2022, buyers are becoming more discerning about the quality of carbon projects.

49 Certain information related to Carbon Markets historical and forecast data ©2025 MSCI ESG Research LLC. Reproduced by permission; No further distribution of MSCI data permitted

- **Voluntary & compliance markets:** the successful implementation of hybrid markets will unlock significant market potential.
- **Advance market commitments:** future demand can be guaranteed by advance market commitments, which, in turn, will spur the supply side. As Frontier, an advance market commitment led by Alphabet and Meta, among others, states: "The goal is to send a strong demand signal to researchers, entrepreneurs, and investors that there is a growing market for these technologies."[50]
- **Removed carbon:** the carbon sequestered through CDR can serve as an important feedstock for long-term utilization with a level of permanence that is close to storage (e.g. in case of cement production).
- **Links to other business models:** alongside the benefits accrued through carbon markets, CDR solutions may generate additional financial returns via its ties to tourism, agriculture, and water management, among other business segments (see also chapter 1).

Due to a lot of innovative founder activity over recent years,[51] there are now more than 900 CDR developers in the market,[52] with many start-ups and also a few scale-ups looking for funding. From a venture capital perspective, the motivation behind investing in CDR project developers stems primarily from the hope of future exits at favourable valuations. In the case of later-stage asset classes, such as infrastructure equity or debt, distributions and/or interest income are more relevant.

For investors, the following additional motivations for investing in CDR play a role:

- Hedging other future potentially stranded assets.
- Building up close relations with CDR companies, given the future importance of the sector.
- Pursuing opportunities for joint business development (e.g. insurance solutions).
- Securing privileged access to offtake.
- Making strategic acquisitions (probably less for asset owners, more for industry).
- Signalling long-term thinking & boosting brand power with customers and employees.
- Mitigating reputational and (future) regulatory risk.

2.2.2 Risks

However, there are also various risks that investors need to be aware of:

- **Market risk:** The CDR market is not yet stable: it is primarily underpinned by voluntary purchases. To reach the gigaton scale, compliance-based carbon offsets and/or some form of carbon tax are necessary. In addition to regulatory developments, pricing and trading mechanisms also need to develop further. Independent measurement, reporting, and verification protocols promise to play a key role in the market's growth.

- **Policy risk:** The possibility exists that that planned or promised policies do not materialize or are postponed, resulting in lower-than-expected demand and value of carbon. Public purchasing programmes and stable regulation provide investors with confidence in policy pathways.

50 Frontier Climate (n.d.). Frontier: An advance market commitment to accelerate carbon removal. frontierclimate.com
51 State of Carbon Dioxide Removal 2024: 2nd Edition
52 AlliedOffsets (n.d.). Carbon Dioxide Removal Outlook

- **Quality risk:** Some CDR projects could prove to have low durability or lack additionality. This can and should be addressed through more harmonized and consistent international standards and MRV. The industry-led Integrity Council for the Voluntary Carbon Market (ICVCM) is playing an important role here; notably, in its Core Carbon Principles,[53] it sets out ten fundamental criteria for ensuring high-quality CDR projects.
- **Financing risk:** Technology-based solutions ensure the highest permanence, but these are often capital-intensive and tend to have long payback periods and prolonged technological risk. So-called 'first-of-a-kind' (FOAK) projects need patient capital to scale.
- **Opportunity risk:** CDR projects must avoid diverting valuable resources, such as energy and land, away from other high-potential decarbonization solutions or creating unforeseen adverse impacts.
- **Perception risk:** The potential for misalignment with broader stakeholder groups on the use of carbon removal (e.g. due to overly high-cost assumptions or greenwashing) introduces possible risk to investments in this sector. Knowledge building and the promotion of a consistent understanding of CDR can both improve prospects for widespread acceptance.
- **Delivery risk:** For every forward contract, there is a risk of delay or shortfall in the delivery of credits, and an unexpected reversal of carbon removed. This risk can be managed through the use of guarantees or carbon credit insurance (e.g. financial payout or replacement credits). While technology risk and large capital expenditure needs alone might be acceptable, the presence of additional market and regulatory risk makes overall risk acceptance difficult, requiring extraordinary upside potential to justify investments. Significant de-risking is therefore necessary before more widespread investment is possible. Besides other measures (see below), risks can be mitigated by creating diversified portfolios across various project types (e.g. nature-based, technology-based), technologies, providers, and geographies.
- **Availability risk:** In the absence of immediate investment, lack of supply of high-integrity removal credits could prove a significant bottleneck.
- **Other risks:** Additional risks relate to the integrity of claimed carbon removal (claims risk) and the creation of negative social impacts (such as projects compromising human rights, food production, or water security).

53 ICVCM: Core Carbon Principles

2.2.3 Current challenges from an investor perspective

Additional structural issues exist:

1. Investors need a clear, stable business case

As described in sections 1. or 2.2.1, other business cases aside from carbon removal can strengthen the argument for investors by diversifying sources of returns.

2. Long-term investment focus is needed

Investments in asset classes such as venture capital or growth equity require a long-term investment horizon. Life insurance companies or pension funds are good examples of entities that have such a long-term investment horizon. Whereas private equity catalyses the industry, private debt is needed to bring it to scale.

3. Limited capacity and investment experience

Some large asset owners have the resources and capabilities to invest in asset classes such as venture capital and infrastructure equity. However, building such dedicated in-house teams may not be cost-efficient for smaller asset owners. Further, the market for qualified employees with the required skills is scarce. In general, the due diligence costs associated with CDR tend to be high compared to better-known technologies.

4. Limited availability of risk capital

Most asset owners are highly regulated entities. As such, only a small part of their assets under management can be allocated to higher-risk asset classes. Another constraint is that portfolio restructuring is often highly complex and lengthy in the case of illiquid asset classes. The largest part of the investment opportunity is still in early-stage, venture capital-type assets. However, as companies mature, late-stage asset classes such as infrastructure equity and debt will become more important.

5. Adequate risk/return profiles

Similar to other types of investments, asset owners can only invest in CDR solutions if returns adequately compensate for the risks that they incur. Long-term economic viability is therefore a prerequisite for asset owners to make such investments.

3. How to get to the “net”?

In the first two sections, this paper elaborated on carbon markets and demand and supply aspects, discussed primary and secondary carbon markets as investment opportunities for asset owners, and related risks and difficulties. In this next section, the report looks to how capital can be unlocked and how demand and supply for carbon removal can be generated. To this end, the section proposes a number of practical measures for asset owners, policy makers, and carbon market enablers.

Whatever the type of carbon market in question, it is crucial to clearly distinguish between carbon removal and carbon reduction/avoidance in order to ensure integrity and fair pricing.

3.1 What measures can institutional investors take on their own?

3.1.1 Organizational and strategic measures

- **Build up expertise on CDR:** CDR is an evolving market with multiple unknowns. To invest successfully, investors need to build up relevant technical and investment expertise. This will require flexibility and agility in how knowledge is built up and applied within investment organizations.
- **Rethink the organizational design of investment teams:** Due to the unique nature of CDR investments, a combination of skills specific to evaluating private equity/venture and real assets/infrastructure is required. Having a favourable organizational design in place can help investment teams develop these niche skillsets.
- **Consider carbon removal investments from a portfolio context:** Central to such a perspective is considering CDR’s diversification benefits. These can come from adopting a balanced approach to different project types (nature-based and engineered), geographies, and policy regimes. From an asset class perspective, investing in managed funds reduces risk exposure to individual projects as compared to direct investments.
- **Consider carbon removal investments as a means to diversify risks associated with direct and indirect carbon exposures:** Steps that investors can take include:
  - Adequately reflecting long-term risks and benefits.
  - Sufficiently hedging the portfolio against the adverse effects of climate change.
  - Increasing exposure to natural capital and carbon-negative investments.
  - Sufficiently investing in future technology, given the current speed of transition.

- **Utilize financial instruments and innovative structures:** Examples of de-risking CDR investments in this way include:
  - Securing long-term offtake agreements with creditworthy buyers for the netting of GHG emissions. This can be achieved by combining equity investments and offtakes via so-called 'procurement funds'.
  - Aligning with public investors and other capital providers to develop suitable blended structures and to promote the use of catalytic capital, guarantees, and carbon insurance.

- **Invest in carbon removal sector enablers and other support services:** Examples of investments in this category include transport infrastructure (e.g. pipelines) and storage facilities that can be used for both carbon capture and removal, thus reducing supply chain-related costs.

- **Invest in projects with multiple revenue streams:** This provides additional revenue for investors and spreads the risk of being solely reliant on the sale of carbon credits. Nature-based solutions that generate agricultural products for sale provides an illustrative example.

- **Participate in syndicated deals:** Such deals enable investors to pool the resources and expertise necessary for early-stage investments with asset managers and insurers as well as other investors. Deal partners, for example, can share best practices between one another concerning relevant issues, such as the procurement of high-quality CDR credits.

3.1.2 Engagement and stewardship

- **Engage with institutions, agencies (including rating agencies), and policymakers:** Strong rules and regulations are central to developing high-integrity, liquid, and well-functioning CDR markets. Building and maintaining relationships with the entities responsible for these rules and regulations enables investors to feed into this market-framing process.

- **Engage with investee companies** actively removing their residual carbon emissions which are not avoidable, transparent gross reporting and engaging with policy makers and CDR market enablers on robust standards and frameworks.

- **Participate in sharing with peer-learning and capacity-building efforts:** This should be done in full compliance with applicable antitrust laws, preferably hosted by neutral conveners such as NZAOA.

- **Cooperate closely with governments:** Almost all carbon removal themes, whether nature- or technology-based, come with political risk. As such, it makes sense for investors to establish channels to engage meaningfully and transparently with government legislators and civil servants in the support of efficient, aligned and transparent carbon markets.

3.2 What measures would help institutional investors to mobilize more capital?

3.2.1 The role of regulation and policies

Regulatory frameworks and standardization

- **Stable regulatory frameworks, with commonly agreed definitions:** Globally standardized quality criteria, rooted in science and robust MRV, are pivotal. The EU Carbon Removal Certification Framework (EU CRCF) marks an exemplary step in this direction.

- **Consolidation and harmonization:** The establishment of globally recognized standards and frameworks will significantly mitigate reputational risks and reduce uncertainty for investors. This is a crucial prerequisite for developing a global carbon market.

- **Fast, robust, and efficient certification processes:** The effective certification of CDR solutions will support regulatory oversight of market integrity while also driving up market confidence in the quality of such solutions. In the case of MRV, clear certification standards are beginning to emerge. Examples include the European Union's Carbon Removal Certification Framework (CRCF) as well as recommendations from the global standard setter IOSCO and Washington DC-based Commodity Futures Trading Commission (CFTC).

Policy enablers and considerations

Policies in the support of nature

- **Implement policies that protect nature and preserve natural carbon sinks.** By incentivizing investments in high-carbon and biodiversity ecosystems, such policies play an essential role in reducing atmospheric GHG emission levels and achieving net-zero emissions.

- **Do not discriminate against urgently needed but less durable CDR (e.g. nature-based CDR):** While it is important to scale permanent technology-based removal, nature-based removal with low to moderate risk of reversal must also qualify if core carbon principles[54] are fulfilled. As the revised Oxford Offsetting Principles state: "high integrity nature-based approaches—that respect local rights and support biodiversity—can also store carbon for centuries across a range of ecosystems."[55] At present, CDR methods are typically prioritized according to the single criterion of durability: **this approach is excessively narrow.** Instead, multiple dimensions need to be considered, such as climate impact (short-term and long-term), deployment readiness, costs and benefits, and sustainability.[56]

54 ICVCM: Core Carbon Principles
55 Oxford Principles (revised 2024)
56 Ecosystem Marketplace, (2024): Shades of REDD: The Durability Dilemma

Policies in the support of CDR target setting

- **Recognize the importance of separate CDR targets within countries' decarbonization plans and NDCs.** In particular, it is important to ensure that net-zero targets are transparent. Critical to such transparency is the separation of emission reductions and the level of emissions removals with respect to target setting and reporting. Comprehensive and coordinated public strategies underpinned by a mix of policy measures are pivotal, as is having a secured implementation plan and budget.

- **Establish separate targets and reporting for technology-based CDR and LULUCF** (land-use, land-use change, and forestry). Also, within LULUCF, it is vital to distinguish between avoided emissions and removals.

Policies around carbon markets

- **Carbon pricing** is a key component of the policy mix needed to achieve net-zero emissions and plays a significant role in the development and effectiveness of CDR markets. Instruments such as cap-and-trade systems and carbon taxes establish a financial incentive for reducing emissions and can make CDR technologies more economically viable by assigning a value to the removal of carbon from the atmosphere. While CDR markets can develop independently, robust and predictable carbon pricing can enhance their growth by creating certainty and driving demand for carbon removal solutions.[57]

- **Set an enabling policy framework that includes CDR (technology-based and nature-based) in the compliance/regulated markets:** This will drive demand-side certainty and provide liquidity, thereby supporting long-term investments into CDR solutions. These policies should be introduced at a global level so as not to discriminate against local markets. Prices will need to be managed effectively; i.e. high enough to incentivize reduction, yet not so high as to penalize industries. This strategy will also encourage the deployment of CDR solutions as removal credits progressively replace emission allowances for allowance markets.

- **Link the use of carbon removal credits directly to solid and transparent decarbonization:** this approach will ensure transformation of businesses. Removal is to be applied only for residual emissions that cannot be further reduced or avoided.

- **Foster policies that ensure the global CDR spot and futures markets are transparent and standardized.** Most credible CDR transactions currently occur over-the-counter (OTC). Therefore, a stable and transparent global CDR spot and futures market does not yet exist. At present, accurate risk/return assessments are hindered by the presence of fragmented, heterogeneous markets, many of which lack proper governance.

- **In 2024, the United Nations introduced new requirements related to carbon markets under Article 6.4.** This marks an important step toward generating a credible supply of carbon dioxide removal. However, further developments must ensure the integrity

57 UN-convened NZAOA (2024). Updated Position on Governmental Carbon Pricing. unepfi.org/.../NZAOA-Updated-Position-on-Governmental-Carbon-Pricing_final.pdf

of CDR projects. It is essential to develop and uphold robust, credible global standards and maintain transparency.

Other policy measures in the support of CDR

- **A range of additional policy interventions and products exist that can play a positive role in both the short and medium term:** Notable examples include investment subsidies for first movers and contracts for difference ("CfDs") to protect versus price risks. Other measures comprise price floors on carbon price traded on an exchange, and demand guarantees through linking with a compliance market. The use of reverse auctions also have great potential. These work by companies bidding on the amount of CO2 that they can capture and store, and the government then awarding support to those projects that require the lowest amount of public support (e.g. planned in Sweden).
- **Consider public procurement of CDR and public purchasing programs:** These twin measures—which are currently being discussed by EU policymakers—[58]will create a demand signal and thereby provide confidence for this maturing market. They also promise to unlock private co-investments. Still, **public overfinancing should be avoided in the long run** as this might inflate valuations. Not only would this make financing rounds less attractive to private investors: it would also increase the burden on start-ups to find follow-on financing in later rounds.
- **Encourage the reform of insurance products:** Most insurance policies are between 1–3 years, which fits poorly with the insurance needs that arise from the long-term risks associated with carbon storage. This problem could be addressed by passing the liability to the relevant governments where storage facilities are located.
- **Support public grants and fundamental research, and combine private and public money in a smart fashion:** It is important that public money complements private investment, rather than compete with it. Two good models of the smart application of public support are guarantee instruments and blended finance vehicles.
- **Ensure positive local benefits:** A benchmark for ensuring that CDR project generate positive outcomes for local communities is their alignment with the UN Sustainability Development Goals.
- **Improve education and create acceptance:** It is important to develop smart ways to involve the local population and to find suitable incentives and models for their active participation.

3.2.2 The role of carbon market enablers

- **Introduce carbon insurance:** This increases the bankability of CDR projects.
- **Work with experienced asset managers:** In what is an evolving field, experience on the part of asset managers plays a vital role; e.g. providing a diversified fund structure that fits with the individual needs of a specific institutional investor.

58 European Commission, DG CLIMA (2025). Pre-read for EU Carbon Removal Certification Framework Event

- **Consolidate small projects:** Consolidation and diversification is a route to making CDR projects more attractive to institutional investors as well as delivering greater scale.
- **Develop clear, aligned, and comprehensive certification standards:** These should cover both technology-and nature-based CDR. While it is obviously important that they ensure quality, they should avoid being overly complex so as not to hinder innovation.
- **Consider maintaining an open-source, publicly available registry of credits:** A registry of this kind would contribute to a proper, efficient, and transparent certification system. It should contain full details of credits that are generated, certified, and independently verified.
- **Provide proper and recognized certification:** Registries could play a role for exchanges as they do for commodities and financial trade.
- **Ratings for projects:** These must become a universal standard.

4. Conclusion

In addition to emission reduction, scaling CDR solutions—including those that are technology-based, nature-based—is essential and must occur quickly as GHG emission concentration in the atmosphere is already peaking. Both demand and supply of CDR must increase at high rates in order to match science-based residual emission forecasts. **While voluntary net-zero targets and pledges helped catalyze the CDR industry initially, this type of demand is not stable or large enough to scale CDR as needed.**

Going forwards, **regulated demand is set to play a crucial role**. This demand should be created through compliance markets and policies that support the development of an efficient CDR market. Such an approach should include policies that encourage early adopters.

There is interest in CDR among large global asset owners with long-term investment horizons, such as insurance companies and pension funds. This is because their **assets are directly endangered by damage events and the consequent loss of income and reduced potential for future financial returns.** As such, it is of utmost importance that **asset owners have a reliable enabling environment that support economically viable business models for CDR over the long term**. In such an event, asset owners can help accelerate the adoption of CDR technologies through niche strategies (e.g. venture capital) as well as through the activation of large capital pools such as private equity or infrastructure debt and equity.

Key enablers can work together to drive the mobilization of CDR solutions through the following priority measures:

- **Continuing and extending CDR positive policies worldwide** to ensure consistent and reliable CDR supply and demand at a level needed to net residual emissions; e.g. by including CDR in the compliance/regulated markets and through policy interventions (at least in the short and medium term) that support demand for reliable CDR.
- **Introducing CDR targets within countries' decarbonization plans and NDCs.**
- **Helping provide a stable carbon pricing policy environment and CDR market** at both the local and global levels.
- **Integrating credible nature-based and technology-based CDR into regulated carbon markets. Exclusive reliance on technology-based CDR should be avoided.** Instead, nature-based CDR should be recognized for its high scalability, availability and its positive social and environmental co-benefits, while immediate challenges related to MRV and permanence need to be addressed.
- **Combining globally-aligned accounting standards** that are robust, credible and **transparent, together with independent third-party verification** and assurance, harmonized MRV processes, and the use of transparent certification and registries.

- **Working with rating agencies, verifiers,** CDR operators/intermediates, and other market actors to promote knowledge-sharing and capacity-building for investors and other relevant actors in the real economy.

As this analysis of the current CDR landscape clearly demonstrates, this evolving sector is expanding but it also faces a number of significant barriers to reaching the kind of scale required to meaningfully address climate change. With the right strategies, these barriers are surmountable. This paper presents a series of practical solutions to address these complexities and ensure the timely and sufficient deployment of CDR projects. The success of these solutions will ultimately depend on different sectors coming together in a coordinated and sustained fashion—a process that NZAOA welcomes and is committed to advancing.

Asset owners of NZAOA remain strong advocates for accelerated decarbonization and protection of the earth's natural carbon sinks. Limiting global warming without intact nature is impossible. Introducing balanced policies to mobilize finance for CDR solutions is the linchpin here as this will create stable demand for CDR traded in carbon markets—thereby incentivizing the investment needed to take nature- and technology-based CDR to genuine scale, ultimately getting to the 'net' of net zero.

5. Appendix

Investment for returns

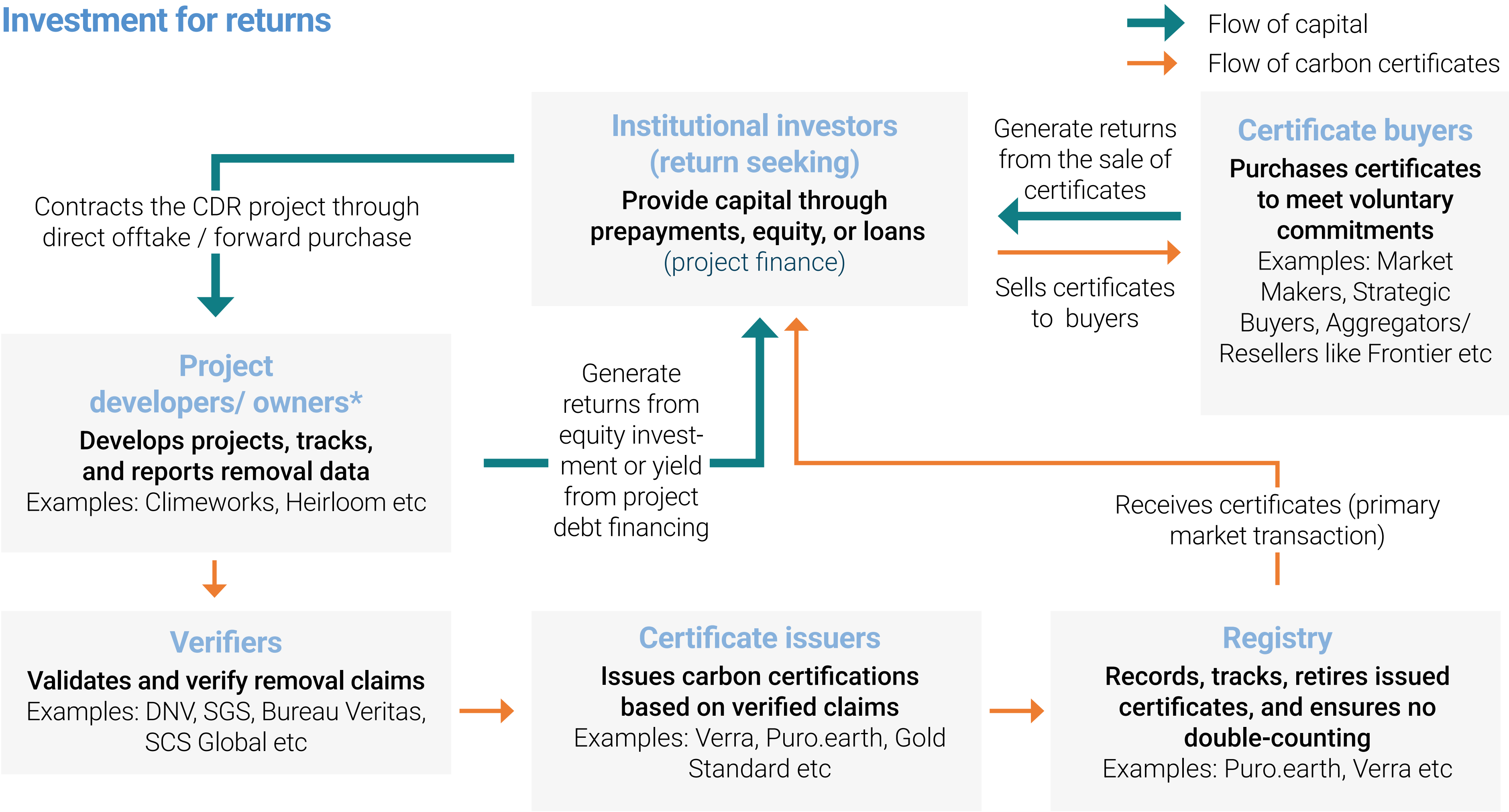


Figure 6: Investment for returns (an illustrative example)
Source: NZAOA FinTrack Carbon Removal Investment Working Group

Investment for residual emissions neutralization

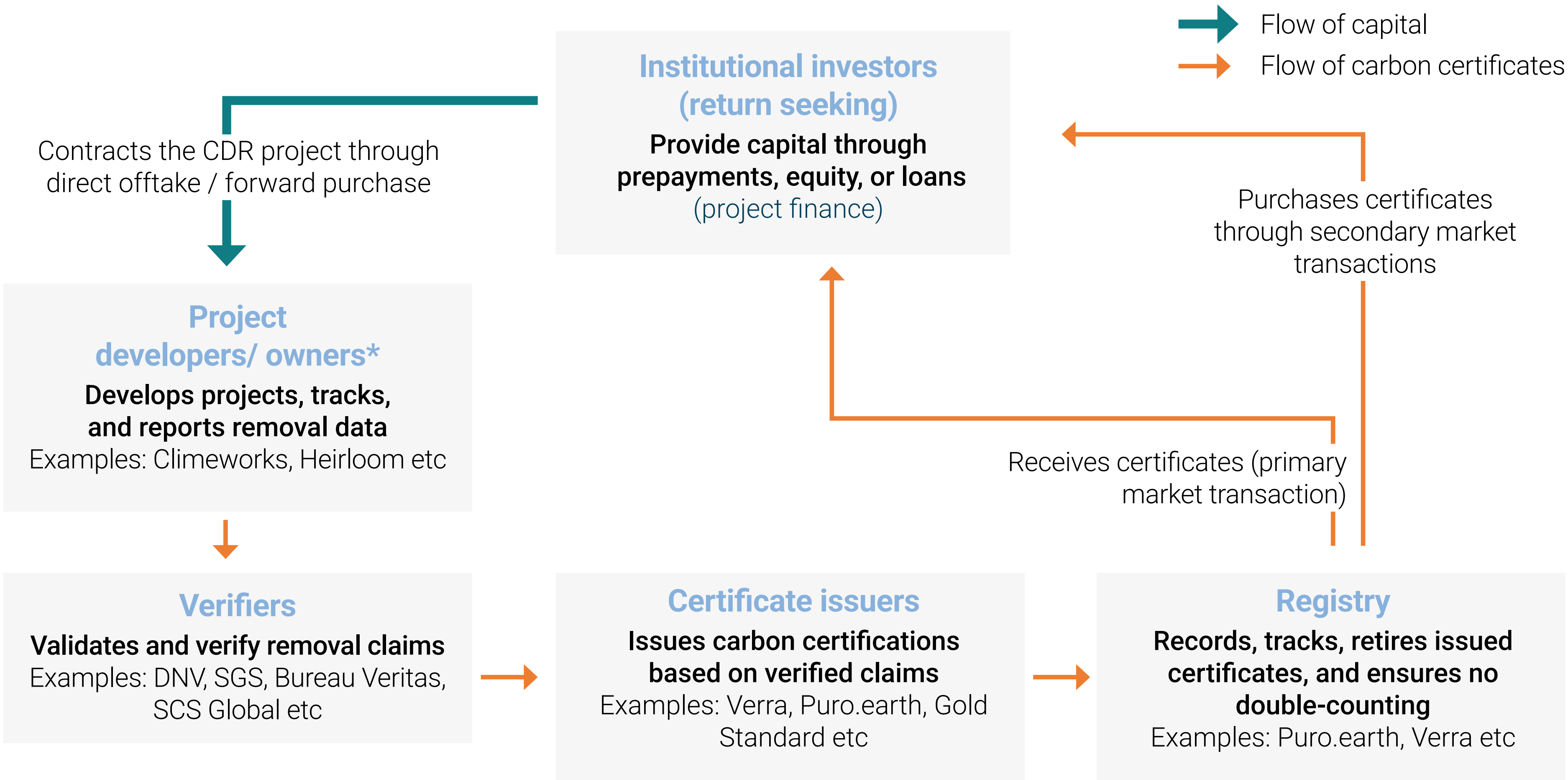


Figure 7: Investment for residual emissions neutralization (an illustrative example)

Source: NZAOA FinTrack Carbon Removal Investment Working Group

Table 2: Summary of ways institutional investors can engage in the CDR market

	Investment for returns	Investment for residual emissions neutralization
Purpose	To generate revenue from the capital deployed	To generate carbon removal certificates to neutralize investors' residual emissions
Benefits	Return on investments from sales of credit, sale of equity holdings, dividends generated from project equity, and yield generated on project debt financing	Climate benefits, reputational claims
Treatment of credits/ certificates	Certificates can be sold to generate returns	Certificates will be kept and retired to meet climate goals

Source: NZAOA FinTrack Carbon Removal Investment

Glossary

Avoidance credits are a type of carbon credit that represents the reduction or prevention of greenhouse gas (GHG) emissions that would have otherwise occurred. These credits are typically generated through projects or activities that avoid emissions rather than directly removing carbon dioxide (CO_2) from the atmosphere. Examples include renewable energy projects, energy efficiency improvements, and the prevention of deforestation.

Carbon allowances are tradable certificates that grant the holder the right to emit a specified amount of GHGs, typically measured in tons of carbon dioxide equivalent (CO_2e). These allowances are a central component of cap-and-trade systems, which are designed to limit overall emissions and incentivize reductions.

Carbon certificates are tradable permits or credits that represent the right to emit a certain amount of CO_2 or other GHGs.

Carbon credits exist in carbon crediting mechanisms and are used to represent one metric ton of carbon dioxide ($MtCO_2$) or the equivalent amount of another GHG that has been reduced, avoided, or removed. Carbon credits are used as part of efforts to reduce global GHG emissions. Carbon credits are generated by projects that either reduce, remove, or avoid emissions, such as renewable energy, reforestation, or methane capture initiatives.

Carbon offsets are measurable reductions, avoidance, or removals in CO_2 or other GHG emissions that are used to compensate for emissions produced elsewhere. The main purpose of carbon offsets is to "neutralize" or "offset" the impact of emissions.

Carbon insurance is a risk management tool designed to protect carbon offset projects against unforeseen events that could lead to underperformance or failure in delivering the anticipated carbon credits. Carbon insurance enhances the financial stability and credibility of carbon markets.

Carbon dioxide removal (CDR) refers to the process of extracting CO_2 from the atmosphere and storing it in a way that prevents the captured CO_2 from contributing to climate change. This can be achieved through various methods, including nature-based, technology-based, or ocean-based solutions. The goal of carbon removal is to reduce the concentration of CO_2 in the atmosphere, thereby mitigating the impacts of climate change.

Compliance markets are regulated systems where entities are required to meet specific environmental standards, such as emission reduction targets. They work through mechanisms like cap-and-trade programs that coordinate the purchase and sale of allowances or credits to ensure adherence to legal obligations.

Contract for difference (CfD) is a financial agreement where the government or another entity guarantees a fixed price for carbon credits, compensating the difference between the market price and the agreed-upon price in order to stabilize revenue for carbon reduction projects.

European Union Emissions Trading System (EU ETS) is the European Union's main policy tool for reducing GHG emissions, operating as a "cap and trade" system. The total allowed emissions (the cap) is reduced each year. Companies can trade allowances to cover their emissions in the most cost-efficient way.

Hybrid Carbon Dioxide Removal refers to approaches that combine different methods or technologies to remove CO_2 from the atmosphere. These hybrid systems aim to enhance the efficiency and effectiveness of carbon removal by integrating various techniques, such as biological, chemical, and physical processes. For example, a hybrid CDR system might combine direct air capture (DAC) technology with bioenergy carbon capture and storage (BECCS).

Monitoring, Reporting, and Verification (MRV) is a framework used in various contexts, including environmental and climate policy, to ensure that activities such as emissions reductions or carbon capture are accurately tracked, reported, and verified. MRV processes are crucial for maintaining transparency, accountability, and credibility in efforts to address climate change and meet regulatory or voluntary commitments.

Nationally Determined Contributions (NDCs) are climate action plans submitted by countries under the Paris Agreement, outlining their respective commitments to reduce GHG emissions in line with the global goal of limiting temperature rise to 1.5ºC and adapting to the impacts of climate change. The Paris Agreement requires that NDCs are updated every five years with increasingly higher ambition, taking into consideration each country's capacity.

Net-zero carbon dioxide (CO_2) emissions are achieved when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO_2 removals over a specified period. Net-zero CO_2 emissions are also referred to as "carbon neutrality".[59]

Neutralization respectively netting refers to the practice of balancing the amount of carbon dioxide emitted with an equivalent amount removed from the atmosphere in order to achieve net-zero emissions.

Novel CDR solutions refer to innovative and emerging technologies or methods designed to capture, store, or utilize atmospheric CO_2 so as to address climate change. As the name suggests, they typically go beyond traditional (i.e. nature-based) approaches. Often "novel CDR" is used interchangeably with "technology-based CDR".

59 IPCC (n.d.). Annex I: Glossary. In: Global Warming of 1.5°C. ipcc.ch/sr15/chapter/glossary/

Offtake agreements are contracts between a buyer and a project developer, wherein the buyer commits to purchasing a specified amount of carbon credits or removal services over a set period, providing financial certainty to support the project's development and operation.

Procurement funds refer to financial resources allocated by an organization or government for acquiring goods, services, or assets to meet operational needs or strategic objectives.

Reduction credits represent verified decreases in GHG emissions achieved through specific projects or activities. These credits are generated by initiatives that directly reduce emissions at their source. Examples include energy efficiency projects and industrial process improvements.

Residual emissions are the GHG emissions that remain after all feasible mitigation efforts have been implemented, often associated with "hard-to-abate" emissions.

Scale-up is a business that has moved beyond the start-up phase and is experiencing significant growth, often characterized by expanding operations, increasing revenue, and scaling its market presence.

Voluntary Carbon Credit (VCC) registries/verifiers are tools/organizations that help with the certification and tracking of carbon offset projects. They contribute to the credibility and transparency of the carbon credits that are traded in voluntary markets with a view to helping entities offset their emissions.

UN environment programme

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UNEP Finance Initiative brings together a large network of banks, insurers and investors that collectively catalyses action across the financial system to deliver more sustainable global economies. For more than 30 years the initiative has been connecting the UN with financial institutions from around the world to shape the sustainable finance agenda. We've established the world's foremost sustainability frameworks that help the finance industry address global environmental, social and governance (ESG) challenges.

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unepfi.org

info@unepfi.org

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