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AN EU PURCHASING PROGRAMME FOR PERMANENT CARBON REMOVALS:

ASSESSMENT OF POLICY OPTIONS AND RECOMMENDATIONS FOR SHORT-TERM POLICY DESIGN

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AN EU PURCHASING PROGRAMME FOR PERMANENT CARBON REMOVALS:

ASSESSMENT OF POLICY OPTIONS AND RECOMMENDATIONS FOR SHORT-TERM POLICY DESIGN

Client

European Commission, DG CLIMA

Project

Support for the development of a strategy for the financing of permanent carbon removals

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List of abbreviations

ABBREVIATION	DEFINITON
AMC	Advance Market Commitment
BECCS	Bioenergy with Carbon Capture and Storage
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Germany)
BMWK	Federal Ministry for Economic Affairs and Climate Action (Germany)
CAPEX	Capital Expenditure
CBAM	Carbon Border Adjustment Mechanism
CCB	Carbon Central Bank
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilisation
CCUS	Carbon Capture, Utilisation, and Storage
CCfD	Carbon Contract for Difference
CDR	Carbon Dioxide Removal
CfD	Contract for Difference
CINEA	European Climate, Infrastructure, and Environment Executive Agency
CO_2	Carbon dioxide
CO_2-e	CO_2 equivalent
CRA	Canada Revenue Agency
CRCF	Carbon Removal Certification Framework
DACCS	Direct Air Carbon Capture and Storage
DEA	Danish Energy Agency
DKK	Danish Krone (Currency)
DoE	United States Department of Energy
EC	European Commission
EEA	European Environment Agency

ABBREVIATION	DEFINITON
EHB	European Hydrogen Bank
EIB	European Investment Bank
ERW	Enhanced Rock Weathering
ESABCC	European Scientific Advisory Board on Climate Change
ESR	Effort Sharing Regulation
ETS	Emissions Trading System
EUR	Euro (Currency)
GCPF	Global Climate Partnership Fund
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GHG	Greenhouse Gas
GOV	Government
ICAP	International Carbon Action Partnership
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRS	Internal Revenue Service
ITC	Investment Tax Credit
JRC	Joint Research Centre
KliK	Foundation for Climate Protection and Carbon Offset (Switzerland)
LCA	Life Cycle Assessment
LULUCF	Land Use, Land-Use Change, and Forestry
MRV	Measurement, Reporting, and Verification
MS	Member State
MSR	Market Stability Reserve
$MtCO_2$-e	Megatonnes of Carbon Dioxide Equivalent
NDC	Nationally Determined Contributions

ABBREVIATION	DEFINITON
NECCS	Negative Emissions Carbon Capture and Storage
NGO	Non-Governmental Organization
RTS	Removals Trading Scheme
SBTi	Science Based Targets initiative
TED	Tender Electronic Daily
UBA	German Environment Agency
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar (Currency)
VCM	Voluntary Carbon Market
WTO	World Trade Organization

Executive Summary

Context and report objectives

DG CLIMA is exploring options for an **EU purchasing programme for permanent carbon removals** to address a critical gap in climate change mitigation. While emissions reductions remain the primary objective of EU climate policy, achieving climate neutrality and eventually net-negative emissions necessitates the **large-scale deployment of carbon removals**. This requires the swift development and deployment of cost-effective and socially beneficial carbon removal technologies.

A key challenge for upscaling permanent carbon removals is a lack of sufficient demand. The lack of demand stems from the nature of CDR, which, as a public good, generates little private value without policy intervention. While some private actors are purchasing limited amounts of permanent CDR in line with voluntary mitigation targets and corporate reporting, the current lack of private business cases to purchase carbon removals underscores the need for public purchasing and public policy to generate demand.

Demand can be incentivised directly by public purchasing or indirectly by providing clarity on acceptable use cases. The latter could be supported through updates to the Green Claims Directive, the Corporate Sustainability Reporting Directive (CSRD) and the Science Based Targets initiative (SBTi), as well as revisions to the broader EU climate policy framework. However, there are currently no EU-wide purchasing programmes for CDR and only limited concrete policy incentives for individuals to drive CDR demand. While some private actors and Member States are purchasing carbon removals, this is not currently sufficient to drive scale-up.

To address the lack of demand for permanent CDR, this report explores the potential for an EU purchasing programme, with two focuses:

1. Identifying and assessing policy options for an EU purchasing programme
2. Proposing a detailed policy design for a purchasing-programme in the short-term (2025-2030)

We build on a literature review, expert interviews, and an assessment of fourteen relevant existing policies, to identify different policy options for a purchasing programme and evaluate them in terms of effectiveness, efficiency, and coherence – that is, their potential to support the upscaling of permanent CDR. This assessment was discussed and deepened through an expert stakeholder workshop, featuring 100 in-person and 150+ online participants on May 21st, 2025. **A key focus is the sequencing and potential role of a purchasing programme over**

time, as the technological and market readiness of permanent CDR technologies develops, and as EU climate policy becomes more ambitious.

Purchasing programme policy options and assessment

The overarching objectives of a purchasing programme for permanent CDR are to support the EU in safely, fairly, and efficiently meeting EU climate objectives. We identify the following, more specific, objectives for purchasing programme design:

- Support CDR technology development
- Support CDR market development
- Generate public and private demand for high-quality permanent CDR
- Ensure effective and cost-effective public CDR governance

We identify seven policy options for an EU purchasing programme, which offer a wide range of concrete, implementable options. To enable comparison, we present them as separate policy options but in reality, they could be combined. They offer different strengths and weaknesses and are therefore suitable for different stages of policy development. We present them in approximate order of their potential temporal appropriateness—from short-term to long-term:

1. **EU-coordinated buyers' club:** An EU-coordinated buyers' club would be implemented by a public bank, with the funding for purchases of permanent CDR provided by private funders. Operating expenses would be covered by the EU Commission, who could also provide seed funding. The club would aggregate private demand and contract current and future purchases of CDR, using a mixture of pre-purchases, offtake agreements, and ex-post purchases of delivered CRCF credits. In return for providing funding the private funders would be able to make claims using the CRCF credits purchased.
2. **EU Removals Fund:** The EU Removals Fund would be a publicly managed initiative within an existing EU institution (or contracted external authority). The fund has a mid-sized mandate to strategically procure diverse carbon removal units and shape the removals market—including for emerging technologies, building on precedents like the Innovation Fund and national schemes such as Denmark's NECCS fund.
3. **Centralised Procurement Agency:** A simple, centrally managed EU agency with a narrow mandate to aggregate and coordinate carbon removal purchases on behalf of the EU and its Member States (using auction-as-a-service approaches, similar to the EU Hydrogen Bank). This option enables economies of scale and lower transaction costs through pooled pay-as-you-go funding.

4. **Investment Vehicle:** A publicly endowed but highly independent investment fund—hosted within an EU financial institution—designed to leverage public capital with private investment to build the removals market through a flexible mix of procurement, equity, and de-risking instruments.

5. **Independent foundation:** A privately managed, non-profit institution with a mid-sized mandate and high independence, designed to flexibly procure removals and develop the market using blended public–private funding, while operating outside the constraints of typical public sector rule.

6. **Carbon Central Bank:** A separate and independent, publicly managed institution with a broad mandate to procure and manage removals, shape the removals market, and manage any link between carbon removals and the broader carbon market (e.g. ETS integration). Such a novel and complex institution could offer advantages in terms of political independence, analogous to the European Central Bank, but would imply relatively high establishment costs and would only be justified by significant changes to broader EU climate governance.

7. **Rule-based mechanism:** A tightly constrained, low-autonomy mechanism operated by an EU agency to make carbon removals purchases based on predefined rules or market conditions, aiming to stabilise prices in the removals and/or ETS markets with minimal political interference (building on the example of the Market Stability Reserve).

Different policy options will be appropriate for different timescales, as the needs for a public purchasing programme are likely to shift overtime. This is closely linked to the technology and market readiness of carbon removal technologies, as well as EU capacities (i.e., timeline for implementing more sophisticated and politically challenging policies), and the wider EU climate policy decisions regarding the role for CDR, including use in any future compliance market or other removals obligations. Accordingly, the programme would need to be adaptable to future policy evolution. We qualitatively assess the policy options against a set of assessment criteria, including effectiveness and efficiency. Based on our analysis, we propose the following sequence of policy designs for the purchasing programme:

- **Short term (2025-2030):** We propose a purchasing programme based upon the EU Removals Fund, with elements also taken from the Centralised Procurement Agency and EU Coordinated Buyers Club options. This combination offers the quickest and most effective means to generate demand incentives and support technology development. The EU Removals Fund offers a familiar institutional form, strong public oversight, and adaptability, making it swift to implement whilst also signalling public commitment to developing permanent carbon removals technologies and markets. This policy should be extended with elements of the EU

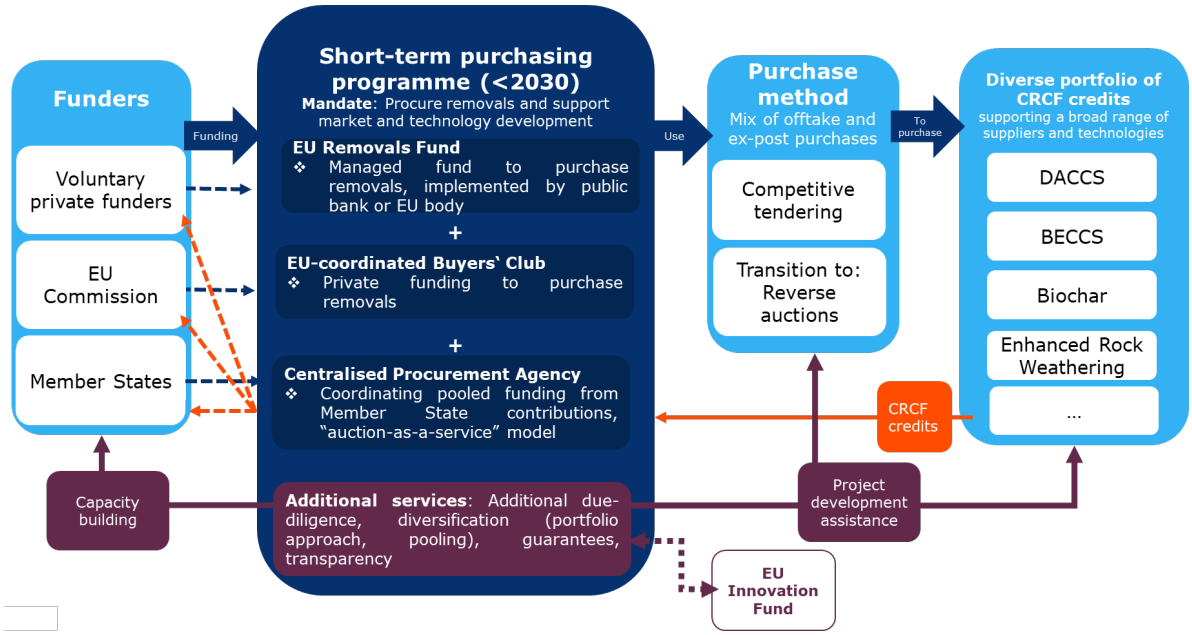
Coordinated Buyers Club and the Centralised Procurement Agency, to facilitate increased and coordinated private sector and Member State funding for the purchasing programme.

- **Medium term (2030-2040):** The preferred policy depends on the long-term carbon removal strategy, and particularly whether ETS integration, carbon removal obligations, or continued public funding of CDR is pursued. Many options, including EU Removals Fund or Carbon Central Bank may be appropriate, with the key criterion being strong backing for technology and market scaling. Other models like independent foundations or investment vehicles may be justified under specific alternative policy visions.

- **Long term (2040+):** In the long term, the design of a carbon removal purchasing programme should align with the broader EU climate architecture and depend on how responsibility for removals is assigned—whether it remains public or is shifted to emitters via obligations or ETS integration. No single policy can be recommended without clarity on this strategic direction, as all options could be viable depending on the envisioned role of purchasing and the maturity of the removals market. A purchasing programme could continue to have a role post-2050, to facilitate net negative emissions.

Policy design for a purchasing programme in the short term (2025 – 2030)

Figure 1: Policy blueprint: Recommended short-term EU purchasing programme for permanent CDR (own compilation)



We make specific recommendations for the design of an EU purchasing programme over the next five years (2025-2030). In the following section, we identify key design elements for an EU purchasing programme including expected scale and target portfolio, purchase method and instruments, institutional structure, and funding, with particular focus on crowding in private and Member State contributions, among other issues. We present design options along with their associated opportunities and risks, offer recommendations, and consider implications for the long-term evolution of the policy. Figure 1 presents a visual summary of the draft proposed policy design. While our policy design focus is for the next five years, **it is important to note that the policy would continue past 2030, with purchases possible over longer timeframes.**

Purchasing programme mandate

The **mandate** describes the purchasing programme's functions, objectives, the tools or resources it can deploy to achieve them, and what discretion it can apply in the execution of its tasks. This has important implications for purchasing programme policy design, with the mandate determining the appropriate shape and scale of purchasing programme. The optimal mandate will shift over time, as technologies and markets mature, and policy develops.

We recommend that a short-term purchasing programme should have a mid-sized mandate, going beyond simply procuring removals credits to also support the development of the removals market. Taking a portfolio approach, this implies strategic purchase of a range of removals credits to promote technology and market development (rather than just the cheapest credits) to support dynamic efficiency, and the offering of additional services to reduce risks for buyers.

Purchasing programme portfolio and investment needs

The **portfolio** refers to the target purchase mix of removals from different permanent carbon removal methods. The portfolio should balance different objectives of a purchase programme, including technology and market development and social objectives, while minimising costs. When developing a purchasing portfolio, these objectives can be weighted and balanced in various ways. We assess three potential example portfolios, including a least-cost portfolio (primarily biochar), a portfolio targeting CDR technologies in the demonstration and development phase, and a more neutral portfolio with equal budget shares for all technologies.

Investment needs: Based on the average cost estimates from the assessed portfolios, we estimate that the total investment requirement to achieve the EU's

industrial removals aspirational objective of 5 $MtCO_2$-e per year by 2030[1] would require a total investment of approximately €2.4 to €6.7 billion[2]. The upper bound of €6.7 billion corresponds to a portfolio composed exclusively of medium TRL technologies.

Given uncertainties in technology development paths, **we recommend starting with a broad portfolio, targeting many technologies. As technology and market development becomes clearer over time, this should transition** towards prioritising cost-effectiveness, whilst still considering other societal objectives including energy use, land impacts, and social outcomes. The portfolio and buying criteria established by the purchasing programme should set a best practice standard for private buyers to follow. **Ensuring quality, safety, and information sharing should be priorities.**

Purchase method

The **purchase method** entails selecting what to purchase, in what quantities, and at what prices, and how and when payments are made. Each method differs in its ability to incentivise low costs, distinguish between types of removals, and manage administrative burden.

In the short term, competitive tendering using offtake agreements should be employed, which can consider multiple criteria and therefore best make strategic purchases (e.g., supporting high potential early stage technologies); they can also be swiftly implemented. Offtake agreements should be employed to provide support before ex-post CRCF credits from lower TRL technologies (e.g. DACCS, BECCS) become available. For early-stage, CAPEX-intensive technologies, long term offtake agreements will be needed (e.g. 5+ years), due to the time required to construct the facilities.

Additional services

A purchasing programme can support additional demand from other actors by **providing additional services** such as expert support and de-risking mechanisms. **Buyers of carbon removals, both public and private, face risks that may limit their willingness to purchase carbon removals–the purchasing programme can help manage these risks to boost demand.** These risks include quality risks, delivery risks, and policy risks, among others. Different additional services will be effective to minimise or manage each of these risks, and can include services

[1] 26c00a03-41b0-4d35-b670-fca56d0e5fd2_en

[2] Note: this analysis does not consider the investments already made in CDR facilities in Sweden, Denmark and Hungary.

focused on diversification, due-diligence, project and buyer support, and guarantees.

Additional services offer **cost-effective tools to reduce buyer risk and crowd-in private buyers** and should be employed, building on existing approaches employed in the Innovation Fund.

Funding

Funding refers to the financial resources used to run the purchasing programme, including for procuring removals, incentives provided and the administrative costs of operating the program. Funding can come from a variety of sources (e.g. EU, Member States, or private), and can take multiple forms (e.g. long-term commitments, short-term funds, or resources under the institutions' own control).

To maximise swift impact, funds should be encouraged from all sources. **Initial funding should come from a combination of the EU budget and contributions from Member States, augmented or matched by private contributions.** Member State funding should be facilitated by offering an auction-as-a-service model.

Other design considerations

A number of other design decisions must be considered to ensure the purchasing programme can deliver on its objectives. We consider three additional issues:

- **Effective and just public governance** will be essential to ensure the purchasing programme supports CDR upscaling that delivers climate benefits whilst managing risks. It demands consideration of the principles of procedural, distributive, and reparative justice. Workshop participants emphasised the importance of also considering broader environmental and social impacts when designing the purchasing programme.
- **Ownership of carbon removal claims** has implications for public and private funder incentives, and the system as a whole. We present different options for ownership of claims, whose strengths and weaknesses depend predominantly on EU climate policy and national inventory reporting decisions beyond the scope of the Purchasing Programme. Whatever approach is selected, simplicity and transparency will be essential to ensure practicality and trust.
- **The EU purchasing programme will need to be compliant with EU rules on public procurement and state aid.** Differentiated approaches to different technologies should be permissible but additional legislation to provide certainty may be appropriate to speed up approval procedures.

- **Opportunities for combining public funding**: The purchasing programme should be designed in collaboration with other, related EU-funding streams to increase attractiveness to sellers and increase administrative efficiency. For example, the programme should link with the Innovation Fund, utilising its evaluation methods, experts, and results.

Longer Term Evolution of the purchasing programme

Two aspects will be crucial for the longer-term evolution of an EU purchasing programme:

- **CDR technology and market development** is uncertain; how it develops has implications for how the purchasing programme design should evolve. The purchasing programme must be designed to ensure that as technologies and markets develop, our understanding of the impacts and effectiveness of different CDR technologies, helping us to adapt the purchasing programme (and related policy) to best meet our objectives.

- The medium- and long-term development of an EU purchasing programme will be most sharply influenced by **broader developments in EU carbon removal and climate policy** (e.g., decisions regarding ETS integration of removals, removals obligation, the long-term vision for carbon removals in the EU, and developments beyond EU policy).

Short-term policy design must also respond and adapt as these decisions are met, to support an efficient and effective transition.

1. Introduction

1.1. What is the problem and why is it a problem?

The need for permanent carbon removals

There is general agreement on the necessity of carbon dioxide removal (CDR) to limit the impacts of climate change, though a lack of consensus on the quantity and type of CDR required. It is generally accepted that CDR serves three distinct temporal purposes (Smith et al., 2024): in the short term, it is needed to balance current emissions; in the medium to long term, to counterbalance residual emissions and achieve net-zero—thereby supporting the EU's climate neutrality objective; and after 2050, to reach net-negative emissions, with removals exceeding remaining emissions to reverse any temperature overshoot and to address residual emissions that cannot be abated[3]. Post-2050, achieving net-zero targets will require offsetting each unit of residual emissions with an equivalent amount of CDR. Estimates of global remaining residual emissions by 2050 range from around 2 Gigatonnes (Gt) of carbon dioxide (CO_2) under the IEA Net Zero Emissions scenario to 8 Gt CO_2 under the IPCC's high demand net-zero scenario (Mistry et al., 2024). Many have criticised the IPCC's overreliance on CDR in scenarios consistent with the Paris temperature goal of limiting global temperatures to 1.5°C (Beck & Oomen, 2021). However, it is evident that at least some volume of CDR will be necessary, and these scenarios provide some insight into the scale of the challenge required.

CDR can be delivered through nature-based approaches (such as afforestation) or technical approaches, which results in so-called "permanent carbon removals", which are the focus of this report. As defined by the EU Carbon Removals and Carbon Farming Certification Framework (CRCF), permanent carbon removal refers to "any practice or process that, under normal circumstances and using appropriate management practices, captures and stores atmospheric or biogenic carbon for several centuries".[4] Permanent carbon removals include those generated by methods such as Direct Air Carbon Capture and Storage (DACCS), Bioenergy with Carbon Capture and Storage (BECCS), Biochar,

[3] There remains significant uncertainty and disagreement on the levels of residual emissions required to achieve climate neutrality, with many sectors currently claiming inclusion in this category.

[4] The CRCF definition continues "…including permanently chemically bound carbon in products, and which is not combined with Enhanced Hydrocarbon Recovery", Item9-Provisionalagreement-CFCR_2022-0394COD_EN.pdf

Enhanced Rock Weathering (ERW), and mineralisation, among others. The term "permanent" can be misleading, as these different approaches result in different degrees of long-term storage.[5]

To reach climate neutrality by 2050, the European Commission's (2024) impact assessment for the EU's 2040 climate target projects permanent removals of 114 $MtCO_2$-e per year in 2050, a value that vastly exceeds current permanent CDR. The same modelling shows that by 2040, depending on the scenario, the EU should be generating 4-75 $MtCO_2$-e/yr (EU COM, 2024a). To provide some comparison, annual permanent carbon removals deployed and sold as removals in 2023 amounted to approximately 0.125 $MtCO_2$ globally (CDR.fyi, 2024a), mostly from Europe and North America. This represents only 2.5% of the EU's target of achieving 5 $MtCO_2$-e industrial removals domestically by 2030, and 0.11% of the EU's estimate removals of 114 $MtCO_2$-e required by 2050. Hence, there is a drastic need to establish supply and demand.

To meet climate targets in the future, there is an urgent need to invest in CDR today. Investment in innovation will be essential to scale up CDR and reduce costs, including in research, demonstration projects, and start-ups (Smith et al., 2024). These issues are especially pressing as major investments are needed now to ensure that companies are able to deliver carbon removals in the future in line with the EU's climate objectives, and to enable the necessary learning process along the way. Practical experience and ongoing research, funded today, are needed to demonstrate carbon removals at scale and bring down costs. For the innovative firms providing CDR, a lack of demand is a problem because they need guarantees of near-, medium-, and long-term demand for their businesses to survive the "valley of death" and reach the commercialisation stages of development, increasing scale and reducing costs. Demand for permanent carbon removals can generate revenue for businesses to cover both operating and capital expenses, while also improving their access to loans and attracting additional investment capital.

A key challenge is lack of sufficient demand for permanent CDR. Demand for CDR is lacking due to the nature of CDR as a public good, which generates non-excludable and non-rival benefits that all can enjoy without paying for, resulting in little private value in the absence of policy intervention. Further, permanent CDR produces few valuable secondary products.

Voluntary private financing for permanent CDR is insufficient to upscale the market. Private demand is growing, with purchases in the voluntary carbon market

[5] For example, some biochar approaches result in carbon storage with mean residence times of around 100 years (Bey et al., 2021), however, under specific conditions and strict requirements, biochar can store carbon for centuries or even millennia (Malins et al., 2024). BECCS and DACCS are expected to store CO2 for at least 1000 years (Brunner, Hausfather & Knuti, 2024).

(VCM) increasing seven-fold in 2023 compared to 2022 – though from a small base. However, the scale of purchased permanent CDR remains inadequate, with only 11.3 $MtCO_2$-e purchased in 2024 (CDR.fyi, 2024b). While some of these purchases involve removals that have already been paid for (direct credit purchases), others are structured as pre-purchase agreements—paying upfront to secure the future delivery of credits at a fixed price—or as long-term offtake agreements, in which payment for future removals is agreed in advance. Current private demand for permanent CDR is typified by the voluntary purchase of few very large actors, without sufficiently developed demand to support market upscaling. For example, Microsoft alone has purchased 8.24 $MtCO_2$-e of permanent removals sold to date (close to 70% of the total market volume), with a further 1.7 $MtCO_2$-e (or 14% of the market) purchased by the next five largest buyers (CDR.fyi, 2024b). These limited private purchases reflect that while there are some voluntary incentives for private purchases of permanent CDR – including visibility and corporate leadership, as well as linked voluntary corporate Science-based Targets Initiative (SBTi) targets and public disclosure reporting (e.g. under the Corporate Sustainability Directive - these are limited relative to the scales required to scale up needs.

The limited viable private business cases for purchasing carbon removals means that public procurement and policy will play a critical role in enabling market maturation. However, there are currently no EU-wide purchasing programmes for CDR. The EU Innovation Fund supports the development of CDR technologies and companies but does not directly aim to purchase CDR. There are national examples of such programmes, however, such as the US's Purchase Pilot Prize, and other purchasing programmes in Sweden and Denmark. Joint, EU-scale purchases could be expected to deliver economies of scale and monopsony buying power, avoiding a race to the bottom and ensuring strategic alignment with EU goals (Nicoli & Beetsma, 2024). The lack of sufficient demand within the EU is also a problem if Europe wishes to establish here a lead market for permanent carbon removals (Battersby et al., 2024). There has been competing public support from the US,[6] which poses the risks that US-based companies may become market leaders in this new technology – at the cost of EU-based firms – or even encourage EU companies to expatriate their business to the United States, if public support there is seen as more favourable. An EU purchasing programme would offer strong links to broader strategic objectives and the EU competitiveness agenda, as outlined in the Draghi report, Competitiveness Compass, and Clean Industrial Deal. A CDR purchasing programme presents the opportunity to develop technological and strategic leadership in an emerging technology, shape a growing and emerging market, and build EU resilience and value chain security.

To address the lack of demand for permanent CDR, this report explores the potential for an EU purchasing programme. A purchasing programme can take

[6] See e.g. DOE Announces $35 Million to Accelerate Carbon Dioxide Removal | Department of Energy

multiple forms – ranging from a small, light-touch fund aimed at establishing short-term demand, to a stand-alone public institution implementing large-scale, long-term purchases. Such a programme, in addition to addressing the current lack of demand, may also be able to address some other barriers to the upscaling of CDR. For example, targeted purchasing could also support research and development and streamline deployment (Merchant et al. 2022).

The role of a purchasing programme for permanent CDR will shift over time. As CDR technologies and their markets mature, the need for and role of a purchasing programme will shift, from supporting technology development and demonstration to market consolidation. In addition, shifts in EU climate policy will also change the potential role for a purchasing programme; for example, should permanent CDR be integrated into the ETS or private carbon removal obligations be established, then a purchasing programme may decrease in importance as a source of demand. In this report we consider policy options for a permanent CDR purchasing programme that may be appropriate for different phases of permanent CDR technology and market development, as well as a particular focus on policy options in the short term (next five years). Other challenges for CDR upscaling include supply-side barriers such as upfront financing, and the need for standardisation and monitoring, reporting, and verification[7]; these wider CDR policy strategy questions will be investigated in a subsequent report.

The report focuses particularly on potential designs for a purchasing programme for the short term (2025-2030). After considering designs for a purchasing programme across different timescales, in chapter 3 of this report we concentrate on the short term.

1.2. Why the EU should act

Given the nascent state of the market, there is a need for the EU to support market development from its current size to a scale capable of delivering the amount of permanent carbon removals expected to be necessary to meet 2050 net zero targets, and the EU Climate Law's commitment to net-negative emissions beyond 2050.

Due to the long lead times in technology and market development, there is a need to act in the short term to bolster demand for carbon removals – especially given the currently limited private demand for removals. This

[7] The need for standardisation and development of consistent monitoring, reporting, and verification procedures is the aim of the EU regulation establishing a Union certification framework for permanent carbon removals, carbon farming and carbon storage in products, Item9-Provisionalagreement-CFCR_2022-0394COD_EN.pdf

argument is further strengthened if Europe aims to foster EU-based companies and build expertise in this strategic clean-tech industry.

A key challenge for upscaling permanent carbon removals is a lack of sufficient demand. The lack of demand stems from the nature of CDR, which, as a public good, generates little private value without policy intervention. While some private actors are purchasing limited amounts of permanent CDR in line with voluntary mitigation targets and corporate reporting, the current lack of private business cases to purchase carbon removals highlights the significant role that public purchasing and public policy must play to generate demand.

Demand can be incentivised directly by public purchasing or indirectly by providing clarity on acceptable use cases. This was supposed to be addressed by the Green Claims Directive, however, the status of proposed law is currently uncertain; other areas where claims may be addressed include the CRCF, the Corporate Sustainability Reporting Directive (CSRD), or outside of EU policy through private initiatives including the Science Based Targets initiative (SBTi) or the Voluntary Carbon Markets Integrity Initiative. However, there are currently no EU-wide purchasing programmes for CDR and only limited concrete policy incentives for individuals to drive CDR demand. While some private actors and Member States are purchasing carbon removals, this is not currently sufficient to drive scale-up.

There is an added value in the EU undertaking a coordinated response to support the financing of permanent CDR. Climate change is a trans-boundary problem, where coordinated actions are more likely to deliver optimal outcomes than individual (or individual Member State) action. A coordinated response aligns with the regulatory level of EU climate policy, which is managed and implemented at the EU level. Given the potentially close relation between CDR purchasing and other EU-level policy responsibilities, such as managing the EU Emissions Trading Scheme (which could provide funding), EU-level coordination of removals seems appropriate. A coordinated, one-market approach may also offer strategic economic advantages, reducing duplication and competition between Member States and facilitating standardisation, while reducing transaction costs for suppliers and supporting market consolidation.

1.3. Policy objectives

The overarching objectives of a purchasing programme for permanent CDR should be determined alongside the broader objectives for permanent CDR in Europe. Most prominently, these include the permanent removal of sufficient CDR to safely, fairly, and efficiently meet EU climate objectives.

We identify the following specific objectives for a purchasing programme:

- Support CDR technology development
- Support CDR market development
- Generate public and private demand for high-quality permanent CDR
- Ensure effective and cost-effective public CDR governance

Support CDR technology development

A purchasing programme policy should support the rapid development of CDR technologies, ensuring quality and quantity of permanent CDR options. This is particularly important in the short term, given the currently low TRLs of most CDR solutions. Given the uncertainty regarding how technologies will develop (in terms of e.g. effectiveness and cost), in the early stages it will be important to support a wide range of CDR technologies in a relatively technology-neutral manner, which reduces risk by spreading funding across multiple technologies. Such an objective is particularly relevant for technologies with a low Technological Readiness Level (TRL), such as DACCS. However, the objective of technology development would also motivate support for the upscaling of more developed technologies, such as supporting large-scale (at least 1 $MtCO_2$-e) CDR facilities (i.e. beyond pilot and demonstration scale).[8] Supporting EU CDR technology development should also foster and promote EU competitiveness in an emerging clean-tech sector, and would be further justified by the positive spillover effects (externalities) of scientific advances.

Support CDR market development

Purchasing CDR should foster the development of a mature, competitive permanent CDR market, leading to an effectively functioning market with lower costs and sufficient supply and demand. This objective is particularly relevant as we move beyond the technology development phase. A key priority should be to increase market knowledge and enable learning-by-doing. Achieving this will require transparent sharing of market information—including prices, volumes, and key stakeholders—alongside the promotion of best practices and the cultivation of strong networks between buyers, sellers, and supporting service providers (e.g. storage).

[8] For reference, Climeworks' current DACC plant in operation has a capacity of 36,000t per year, with a plant under development in the USA for 0.25 $MtCO_2$-e per year, see https://climeworks.com/our-plants. Ørsted's BECCS plant in Denmark aims to deliver 0.43 $MtCO_2$-e of removals per year by 2026, see https://orsted.com/en/media/news/2023/12/oersted-begins-construction-of-denmarks-first-carb-13757543

Furthermore, a purchasing programme should enable maturation of the permanent CDR market through standardisation, consolidation, and appropriate coordination. This can be supported by providing and testing clear rules and regulations, approaches to liability and insurance, fostering market support tools (e.g. marketplaces, information providers, insurance) as well as e.g. developing standard offtake agreement templates. While some of this may be addressed by the CRCF regulation, there is still potential for purchasing programme policy to be impactful.

Generate public and private demand for high-quality permanent CDR

The purchasing programme should – directly and indirectly – generate demand for permanent CDR. Direct demand should arise through the purchasing programme's purchase of carbon removals on behalf of the European Union, and (if foreseen) by acting as a buyer on behalf of Member States and private funders. This will be justified by the public good nature of CDR, and its technological development. Such purchases can also (partially) address the need for short-, medium-, and long-term demand for CDR. Different policy options offer different speeds of intervention, and this must be considered in attempting to address the current short-term demand gap (Battersby et al., 2024). This must be paired with credible commitments to medium-term CDR demand, with a purchasing programme offering a ramp towards the expected and required scale of removals foreseen in 2040, 2050, and beyond. **The purchasing programme should also indirectly generate Member State and private demand for CDR**, " "crowding-in" additional private financing. This is important to increase total demand, the cost-effectiveness of EU funding, and support market development.[9] The generation of demand primarily aims to support the first two objectives (developing technologies and developing market).

Carbon removals must be of high quality, that is additional, permanent, robustly quantified, and without significant negative externalities on other societal objectives. The quality of permanent carbon removals should be managed by the Carbon Removals and Carbon Farming Certification Regulation, which aims to certify ex-post carbon removals in accordance with certification methodologies that establish minimum quality criteria. The purchasing programme should establish and implement buying criteria for best quality and highest impact carbon removals, setting a standard for other buyers to follow.

[9] Here, inspiration could come from example of the US DOE Voluntary Carbon Dioxide Removal Purchasing Challenge ("Challenge"), which led to Google matching DOE with $35 million purchase commitment.

Ensure effective and cost effective

The implementation of CDR policies will impact other societal objectives, such as regional development, food security, social equity, biodiversity and energy transition costs. Further, given their early stage of development and implementation, there are high uncertainties regarding the nature of these future impacts, and a need to steer their development in a manner that reduces potential negative societal impacts (e.g. related to land-use competition). Public support for CDR will be contingent on issues including societal costs, benefits, equity, integrity/fraud, and ultimately quality of removals and alignment with climate objectives. This also means that CDR can and should be approached in tandem with just transition principles and practices (Nawaz et al., 2024).[10] At a minimum, transparent public management and processes that enable effective public management and participation in decision making will be necessary to support this outcome.

A related requirement for the purchasing programme will be alignment with the EU's existing and future climate policy architecture. This requires a careful assessment of the role CDR can play various EU policies on climate change, including the EU ETS, ESR, LULUCF regulation, as well the CRCF, CSRD and Green Claims Directive.

The policy must also be cost-effective. Policies should be as simple as possible to lower administrative costs for both the EU and other affected parties (e.g. Member States). At the same time, the administrative burden for the business community should be kept low to ensure that compliance does not pose a significant barrier to investment. Finally, it will be important to ensure that public funds are used efficiently in the development of a purchasing programme.

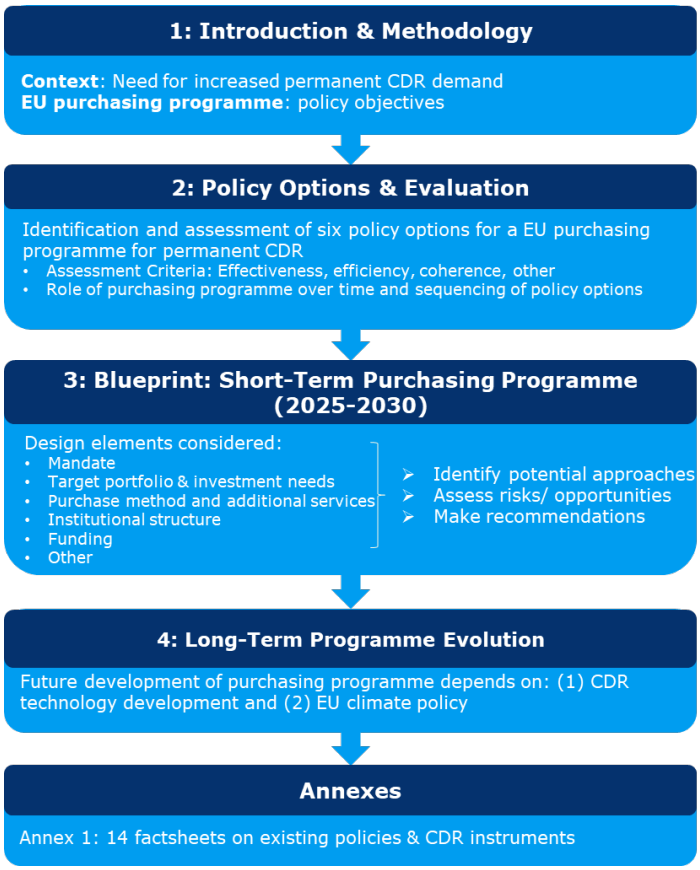
1.4. Report Overview

This report presents and assesses policy options for an EU purchasing programme. The study builds on literature and policy review related to permanent CDR and associated policies, along with targeted expert interviews (see Annex 2 for interviewees) and an expert stakeholder workshop (see Box 1). In Chapter 2 of this report, we identify different policy options for a purchasing programme and assess their appropriateness for different phases of permanent CDR technology and market development. Our assessment draws on examples of related, existing policies, and assesses policy options against key criteria of effectiveness, efficiency, and coherence. A focus is considering the shifting potential role of a purchasing programme over time, as the technological and market readiness of permanent

[10] For example, Nawaz et al. (2024) call for CDR policies to be effectively separated from the interests of the fossil fuel industry and high emitters, and clearly linked to justifiable emissions, and that CDR is approached as a public good, rather than a for-profit activity.

CDR technologies develops, and EU climate policy shifts, and the potential sequencing of policy options. In Chapter 3, we present a more detailed proposal for a purchasing programme in the short-term (i.e. next five years). Here, we examine key design elements—such as the expected scale and target portfolio, purchasing methods and instruments, institutional structure, and funding—with particular attention to leveraging private and Member State contributions, among other considerations. We present design options and their relative opportunities and risks, as well as recommendations. Chapter 4 considers the longer-term evolution of the purchasing programme. Annex 1 contains consolidated fact sheets on policies related to purchasing programmes and CDR that supported the development and assessment of policy options (also summarised in Table 1).

Figure 2: Graphical overview of report



It is important to note that a purchasing programme represents just one aspect of a policy mix that is needed to achieve key objectives, including, but not limited to:

- The long-term vision of EU climate policies, including the establishment of targets for permanent carbon removals, as well as the role of carbon removals more generally in meeting EU targets, including considerations around e.g., ETS integration or carbon removals obligations.

- Supply-side support for carbon removal companies and projects (see Witteveen et al., 2025), as well as infrastructure (e.g., development and construction of pipelines to pump captured carbon underground).

- The Carbon Removal and Carbon Farming Certification Framework Regulation (CRCF), which regulates the certification of permanent carbon removals, ensuring their quality in accordance with minimum standards, and establishing processes for verification and approval.

- Other sources of public support for permanent carbon removals, including through research funding such as Horizon Europe.

These aspects and objectives – and how a purchasing programme would contribute to their achievement – are not considered in the following report, however, they are important topics to be picked up in future work developing such a programme.

Box 1: Expert stakeholder workshop: On the 21st of May 2025, Ecologic Institute (in collaboration with the European Commission) hosted a workshop on the design of an EU purchasing programme for permanent carbon removal. The event brought experts and stakeholders – including carbon removal buyers, funders, and national-level policymakers – to discuss how a strategically designed purchasing programme can catalyse market development and scale promising carbon removal technologies. At the half-day event, the authors of the study presented the ongoing research and gathered insights from participants about the motivations behind carbon removal investments and the prerequisites for a successful EU initiative. These insights were later incorporated into this study and report. Documentation and video are available online: Public funding for permanent carbon removal in the EU - European Commission.

2. Purchasing programme policy options and assessment

A well-designed purchasing programme policy is essential for advancing EU permanent carbon removals, ensuring the achievement of both the EU's climate objectives and the broader objectives of the purchasing programme while maximising the effective use of public funds. This chapter considers the shifting potential roles of a purchasing programme over time, provides an overview of relevant example purchasing policies around the world, proposes six models for a purchasing programme policy, and assesses them as to their strengths and weaknesses. In the following chapter 3, we build upon this evaluation and its insights to propose a detailed policy blueprint for an EU purchasing programme for the short term (2025-2030).

2.1. Shifting role of a purchasing programme over time: Phases

The justification and objectives of a purchasing programme are likely to evolve over time, depending heavily on the technological and market maturity of permanent CDR technologies, as well as the progression of related EU climate policy. Three phases can be characterised:

Phase 1: Technology development phase

In the short term, the primary objective for a purchasing programme policy should be to support technological development. Here, the primary objective of the purchasing programme is to act as an innovation policy, providing meaningful support to companies and organisations developing CDR technologies, funding them to develop, test, and demonstrate CDR technologies. To increase impact, the programme should also aim to crowd in financing and funding for permanent CDR from multiple public and private sources. In this phase, the purchasing programme would be justified by the positive externalities associated with technological and scientific development: the advances would develop knowledge and push down prices, thereby reducing the overall societal cost of achieving carbon removal and broader climate targets.

Phase 2: Market development phase

In the medium term, as technologies mature and begin to generate carbon removals, the purchasing programme's driving objective may shift to supporting the development of a market. Here, the purchasing programme would aim to crowd-in private funding for carbon removals. This would involve encouraging many suppliers to continue investing in the demonstration and upscaling of now

proven CDR technologies; here, a purchasing programme may support market development by supporting large scale purchase to enable economies of scale and supporting multiple suppliers to ensure a competitive market. In this phase, a purchasing programme's objectives would further the phase 1 objectives of encouraging private buyers to pay for permanent CDR, whether this was through voluntary purchases or supporting compliance purchases.

Phase 3: Mature phase

Even once carbon removal technologies and markets have matured, justifications for a purchase programme will remain. In the long term, the public good nature of carbon removals may justify a purchasing programme aimed at purchasing CDR for its own sake. The necessity of such a programme would depend on broader climate policy developments and progress. For instance, if EU climate action advances sufficiently—leaving only residual emissions—it may be reasonable to expect residual emitters to bear the costs of carbon removal rather than relying on public funding. However, post-2050, when the EU Climate Law mandates net-negative emissions, a purchasing programme may become justified or even necessary, as assigning individual responsibility for carbon removals could prove challenging.[11] In this phase, purchase should prioritise cost-effective permanent CDR (i.e. low-cost[12] and high-potential delivery of CDR), while allocating minimal funding to expensive or low-potential CDR technologies or companies. **The design of a purchasing programme in this phase will depend considerably on the overarching management of CDR by EU policy**, including whether carbon removals are to be integrated into the EU ETS, carbon removals obligations are established, and the extent to which an EU-controlled purchasing programme will be used to deliver these objectives.

Given the different technological readiness levels of different CDR technologies, these different phases could overlap to a certain degree. For example, given biochar's high TRL, the EU could choose to support biochar-based CDR through its public purchasing programme in a manner consistent with Phase 3. At the same time, given the relatively low TRL of DACCS, the programme could support it in a way aligned with Phase 1, focusing on early-stage development and market formation. However, at some point in the future, as technologies and markets for permanent CDR technologies become more mature and long-term potential and costs become clearer, the objectives of the purchasing programme would shift to phase 3, focussing purchases on cost-effective CDR technologies and suppliers.

[11] Issues of residual emissions, removals obligations, and individual responsibility will be discussed in a subsequent paper.

[12] Considering also any externalities involved, including environmental impacts.

In each of these phases, a purchasing programme could also play a role as an intermediary, between suppliers of permanent CDR and those buying permanent CDR (whether the buyer be voluntary private buyers, mandatory private buyers, or public buyers). As an intermediary, an EU purchasing programme could aim to reduce transaction costs for sellers and buyers, for example by reducing search costs, credit due diligence, spreading or taking on risk, etc.

In this chapter, we consider all phases. In chapter 2.2, we identify examples of purchasing programmes for CDR or related sectors already in operation. These provide inspiration for our identification of six purchasing programme policy options, in section 2.3. In section 2.4, we assess each policy option, identifying the risks and opportunities they offer relative to purchasing policy objectives. In section 2.5, we conclude by considering the sequencing of different policy designs over time, reflecting the issues identified in this section. In chapter 3 we focus on designing a policy blueprint for a purchasing programme in the short term (2025-2030), which contains a mix of phase 1 and 2 presented here.

2.2. Purchasing programme: Example policies and key elements

Existing purchasing programme (and other related) policies around the world offer valuable lessons for designing an effective purchasing programme for permanent carbon removals. Table 1 presents a summary of comparable policies and mechanisms, including those targeting carbon and hydrogen procurement, technology investment, and market development.

Our assessment of existing policy examples identified four key elements in the design of a purchasing programme:

Element 1 – Scope of the mandate

What are the objectives of the purchasing programme? The mandate of the assessed policy examples describes the function(s) it is supposed to serve, the objectives it is intended to pursue, the tools or resources it can deploy to achieve them, and the discretion it can apply in the execution of its tasks. In the context of a permanent CDR purchasing programme, the mandate can range from narrow to broad. At the core, the most essential function of a purchasing programme will be to purchase removals (i.e. permanent CRCF certified units) that can then be used by the (public or private) buyer. Beyond this, the purchasing programme may also serve to develop the market for removals units and foster the scaling of removals as a business model – by providing the infrastructure and trading platform for such a

market, and/or by creating demand.[13] In its broadest interpretation, a purchasing programme could extend beyond the direct procurement of removals to actively managing the carbon removal market—for example, by supporting technology and market development—and potentially overseeing its integration with other EU climate policies, such as the ETS. The broader mandates include more (possibly) competing targets for the programme and therefore require greater discretion and forward planning in the execution of the mandate, greater independence, more resources and administrative capacities.

Element 2 – Purchase method:

How are removals selected for purchase, and how are quantities and prices determined? Each of the purchasing programme policy examples we asses involves the purchase of removals (or a different but relevant output). This entails selecting what to purchase, in what quantities, and at what prices. In the context of a permanent CDR purchasing programme, it is envisioned that this will primarily purchase permanent carbon removal units certified by the CRCF. Nevertheless, decisions will still need to be made regarding the specific purchasing approach, differentiation between permanent removal units, the timing of purchases, and others. In terms of approaches, this can include methods such as competitive tendering, reverse auctions, flat rate prices, contracts for difference. We also consider related approaches such as equity investment[14] and public ownership, as well additional services, such as de-risking approaches, among others.

Element 3 – Funding:

What is the form and where does the funding for the policy come from? In the context of a permanent carbon removal programme, funding refers to the financial resources available to cover the costs of the programme and meet its objectives, including procuring removals, offer additional incentives or services, and cover operating costs. Funding can come from a variety of sources (e.g. EU, Member States, or private), and can take multiple forms (e.g. long-term commitments, short-term funds, or resources under the institution's own control).

Element 4 – Institutional structure:

The institutional structure of the policy examples refers to the governing structure of the purchasing body, including the degree of political control and oversight, as well

[13] The CRCF is envisioned to have a trading platform, which could be supported by a purchasing programme.

[14] Equity investment and public ownership differs from the other purchase methods, as they are not directly linked to an amount and price for removals, but as support for the company producing the removals. We nevertheless include it in our consideration as it offers an alternative approach for using public funds to achieve ownership of carbon removal claims.

as the level of discretion the institution has to operate within its mandate. The purchasing programme could be implemented by an EU institution or by public banks, such as the EIB or KfW. Correspondingly, the institutional structure defines the capacity and resources available to the purchasing programme, in terms of financial resources, staffing and skills. In the context of a purchasing programme for permanent CDR, a programme can have a range of institutional structures, which should mirror both the range of functions and objectives, the complexity of the tasks entrusted to it, the overall financial volume it is supposed to handle and the level of discretion it is expected to apply in fulfilling its mandate.

Table 1 presents the broad spectrum of policy examples approaches that have informed this study. For each, we provide an overall description, as well as a summary of their approach to the four key design elements described above. Detailed factsheets on the policies and mechanisms can be found in the Annex of this report.

Table 1: Overview of existing procurement policies, purchasing programmes, investment mechanisms and market development tools. The table covers a broad spectrum of approaches that have informed this study. It presents each example alongside a brief description and analysis of the four key elements outlined above. Detailed factsheets on the policies and mechanisms can be found in the Annex of this report.

Example	Description	Scope + objectives	Purchase method	Funding	Institutional structure	Additional notes
Swedish BECCS	€3.1bn subsidy from Swedish government for BECCS, targeting biogenic CO2 from biomass	Moderate: goal of achieving 2 $MtCO_2$-e annual permanent removals by 2030	Reverse auction	Initial endowment / annual contributions: €3.1bn subsidy from Swedish government over 15 years	Operated by the Swedish Energy Agency	Removal providers are allowed to sell voluntary carbon credits to corporates, allowing buyers (e.g., Microsoft) to procure permanent CDR for lower than actual cost due to the subsidy
Danish NECCS	€3.9bn subsidy for capture and storage of biogenic and atmospheric CO2 to achieve negative emissions	Narrow: procure removal units for government	Competitive project-based tendering. One large supplier or consortium of small suppliers wins	Initial endowment / annual contributions: 28.7b DKK (€3.85b) subsidy from Danish government	Operated by the Danish Energy Agency	Removal providers are allowed to sell voluntary carbon credits to corporates, provided that the NDC attributes stay in Denmark. Carbon credit revenues are deducted from subsidy level
US DoE CDR purchase pilot prize	$35 million fund for purchasing CDR (DACCS, BECCS, ERW)	Narrow: procures removal units on behalf of the government	Competitive project-based tendering with multiple winners of cash prizes	Funding is in the form of a contribution from the US federal budget	The prize exists as a fund administered by an executive agency, the Office of Fossil Energy and Carbon Management at the US Department of Energy	

Example	Description	Scope + objectives	Purchase method	Funding	Institutional structure	Additional notes
USA Regional DAC Hubs	$3.5 billion fund to develop four regional hubs for direct air capture (networks of removers, transport, and storage)	Narrow: supports the deployment of DAC projects	The programme makes up-front grants to support the establishment of the hubs. To qualify, projects require at least 50% private co-financing	Contribution from the US federal budget	Budget item administered by the US Department of Energy	The choice of location for the DAC plants was strongly influenced by the potential for regional development and job creation
Canada: Carbon Capture, Utilization, and Storage (CCUS) Investment Tax Credit	The CCUS ITC is a refundable tax credit applied in Canada for qualified carbon capture, utilisation, transport, and storage projects	Narrow: fosters the development of carbon removals in a targeted manner	The tax credit is implemented as a rate on qualified CCUS expenditures - between 37.5-60% for 2022-2030, decreasing to and 18.75-30% for 2031-2040. The rates differ by technology	Funded by the Canadian federal budget as foregone tax revenue	Budget item administered by the Canada Revenue Agency	
Canada: Low-Carbon Fuel Procurement Program (LCFPP)	Through the LCFPP, Canada's Treasury Board Secretariat has committed to spending at least $10 million in carbon removal services by 2030. The LCFPP's objective is to reduce GHG emissions from federal air and marine fleets.	Moderate: purchases removal units on behalf of the government, overall program aims to develop a range of technologies.	Fixed unit price with payment upon delivery. Limit of 500 tonnes for all companies, to promote a wide range of companies and technology types.	Funded by the Canadian Government as part of the $134.9 million LCFPP initiative. The 2024 Budget expanded the scope of the program to include CDR.	Budget item administered by Treasury Board Secretariat	

Example	Description	Scope + objectives	Purchase method	Funding	Institutional structure	Additional notes
H2Global	Foundation supporting hydrogen markets through a double-auction mechanism matching buyers and sellers	Broad: supports the development of clean hydrogen markets	Hintco acts as an intermediary in the double-auction process, matching sales and purchases of hydrogen similarly to the carbon contracts for difference approach	Funded by the German government, the Bezos Earth Fund, and 71 corporate donors from the hydrogen value chain	Independent foundation. Implemented by subsidiary company (Hintco)	
45Q Tax Credit	Performance-based tax credit offered by US Internal Revenue Service (IRS) for carbon sequestration from DAC	Somewhat narrow: it aims to foster the development of carbon removals, but in a targeted manner	Flat-rate price (per tonne tax credit), ranging from $60-180/metric ton depending on the project	Funded by the US federal budget	Budget item administered by the US IRS	The 45Q provides a guarantee where the subsidy will be paid by the government even if the private buyer pulls out
Global Climate Partnership Fund	GCPF is a financing instrument that offers credit lines to local financial institutions, enabling loans for clean energy projects	Narrow: facilitates investments in climate projects	N/A - facilitates investment rather than purchases removals	Blended funding: aims to leverage public funds through private investments	GCPF is an investment company under Luxembourg law. It was established by the German government (BMUB) and KfW development bank	
The GEEREF fund	The GEEREF fund invests in private equity funds working with renewable energy and energy efficiency in emerging markets	Narrow: invests in funds investing in specific climate technologies	Equity investment in relevant sectors, rather than purchasing units directly	Initial funding came from the EU, Germany and Norway. Subsequent round of fundraising targeted the private sector	Public-private partnership initiated by the European Commission with support from the European Investment Bank and European Investment Fund	

Example	Description	Scope + objectives	Purchase method	Funding	Institutional structure	Additional notes
KliK Foundation	KliK uses funds from a fuel surcharge to support climate-friendly technologies and offset CO2 emissions from fuel use	Somewhat narrow: fulfils the legal requirements of oil companies to offset the CO_2 emissions generated by the use of their fuels	Procurement is typically done on a project-by-project basis, with KliK purchasing the resulting emissions reductions as offtakes. The pricing is a fixed price per tonne, ranging from approximately €80-200 per tonne depending on the mitigation type	Funding comes from a surcharge (a few centimes per litre) added to sales of petrol and diesel, and is passed to the Foundation which uses it as its own resource	Private organization, founded by the Swiss Petroleum Association (now Avenergy Suisse). The Foundation operates independently, and is supervised by the Swiss Federal Foundation Supervisory Authority	KliK uses myclimate (a separate climate NGO) to convert funded emissions reductions projects into certificates (emissions allowances). These are then transferred to the Swiss federal government.
Frontier Carbon	Advance market commitment enabling buyers to purchase carbon removals	Moderate: aims to foster the development of the carbon removals market, without managing the market overall	Procurement is typically done on a project-by-project basis, often through bilateral negotiations with suppliers, through offtake agreements with removals providers	Pay-as-you-go approach. Buyers can become members of Frontier (min $10 million commitment until 2030) or can purchase the Frontier portfolio fully or partially	Public benefit LLC that is wholly owned by Stripe Inc. The additional founding members are Alphabet, Shopify, McKinsey, and Meta. It is managed by a team of technical and commercial experts on behalf of buyers	Buyers' club model
NextGen CDR	Advance market commitment enabling buyers to purchase carbon removals	Moderate: aims to foster the development of the carbon removals market, without managing the market overall	Purchases are made through (short-term) offtake agreements with removals providers, with a target average price of $200 per tonne	Pay-as-you-go approach	NextGen is governed by South Pole and Mitsubishi	Buyers' club model

Example	Description	Scope + objectives	Purchase method	Funding	Institutional structure	Additional notes
European Hydrogen Bank	Financing instrument aiming to encourage private investment in the hydrogen value chain. Reliance on "auction as a service" approach to blend EU and Member State funding.	Moderate: primarily aims to scale up European hydrogen production through private investments, but is also concerned with coordination of market development	Purchases are made through an auction system via the EU's Innovation Fund. This includes an auction-as-a-service approach that mixes EU and MS funds. The purchasing approach is similar to a carbon contract for difference.	Funding for the EHB comes from the EU's Innovation Fund. Financing for the Innovation Fund comes from revenues from auctioning allowances in the EU ETS The EHB also offers an auction-as-a-service model, bringing in additional funding from Member States.	The EHB is not a physical institution, but rather a financing instrument run by the European Commission	It aims to scale domestic (EEA) hydrogen production through auctions, attracting imports of renewable hydrogen, and ensuring transparency and coordination of information
Innovation Fund	Funding programme supporting the deployment of net-zero and innovative technologies. Examples of supported projects include innovative low-carbon technologies, products and processes in industry, CCU and CCS	Narrow: financial support for a wide range of clean technologies, including carbon capture, but no remit regarding markets	The fund makes regular grants (covering 60% of costs) and competitive bidding (100% of costs). Rather than purchasing units, the Innovation Fund funds projects (with no transfer of mitigation claims)	Funding comes from revenues from the EU ETS. Depends on the carbon price, and may amount to around €40 billion from 2020 to 2030, at a carbon price of €75 per tonne	The fund is a budget item managed by the European Commission. CINEA is responsible for the bulk of the implementation. The EIB provides and manages project development assistance, i.e. financial and technical advisory	

2.3. Shortlisting policy options

Building on the example policies and the literature, below we identify a shortlist of seven policy options. They have been selected to cover the range of possible options for a removal purchasing programme policy. We have developed these policy options as complete and concrete proposals for how a purchasing programme could be implemented. We have selected a wide variety of policy options, aiming to illustrate the breadth of what is possible.[15] This is not an exhaustive list of policy options, as different attributes and elements could be combined in various ways. In fact, some of these initial policy options could feasibly be combined or could evolve from one another. However, the concrete options enable an assessment of the risks and opportunities posed by each policy option, supporting the development of a blueprint policy in subsequent steps.

Each policy option we present consists of four elements: (1) a mandate, (2) a purchase method, (3) a funding source, and (4) an institutional structure.[16] Generally, these elements are logically linked: For instance, an institution endowed with a broad mandate requires a more capable and complex institutional structure, has the capacity to carry out purchases in a variety of ways, and needs sufficient funding that is provided with a certain degree of predictability. However, in some cases, multiple options would be reasonable; we indicate this where appropriate. Table 2 summarises the six policy options, which are described in more detail below.

[15] We have excluded some policy options due to impracticality within the EU system. For example, a tax credit based upon the US 45Q tax credit would be difficult to implement within the EU because the EU has only limited direct taxation capabilities, insufficiently related to the companies implementing permanent CDR.

[16] Each of these elements and their corresponding options are discussed in greater detail in sub-chapters of chapter 3: 3.1 Purchasing programme mandate, 3.3 Purchase method and additional services, 3.4 Institutional structure, and 3.5 Funding.

Table 2: Purchasing programme initial policy options (stand-out features in bold)

	Objectives and mandate	Purchase method	Funding	Institutional structure
EU-Coordinated Buyers' Club	Mid-sized: • procure removal units • develop removals market	Competitive project tendering Reverse auction Flat-rate price	**Primarily private funding** (corporates purchasing CDR). EU provide operating costs and seed funding.	Public-private partnership, in form of financial fund implemented by public bank (e.g. EIB). • Medium autonomy • Medium capacities
EU Removals Fund	Mid-sized: • procure removal units • develop removals market	All purchase methods possible (except equity): Competitive project tendering Reverse auction Flat-rate price Carbon-contracts for difference	Own budget, endowed through **multiple-year EU budget commitments**	Public, agency housed within existing EU institution (e.g. Innovation Fund) or bank (e.g. EIB). • Medium autonomy • Medium capacities
Centralised purchasing platform	Narrow • procure removal units	All purchase methods possible (except equity)	Annual contributions from EU and Member State budgets **(pay-as-you-go**)	Public, housed within existing EU institution • Limited autonomy • Limited capacities
Investment vehicle	Mid-sized procure removal units develop removals market	All, especially **equity investment**	Initial endowment from public budget, multiplied through partnerships with private investors.	Public, independent financial fund within existing EU institution (EIB) • High autonomy • High capacities
Independent foundation	Mid-sized • procure removal units • develop removals market	All purchase methods possible (except equity)	Annual contributions from private companies and EU and Member State budgets	**Private (non-profit), standalone independent institution** • High autonomy • Moderate capacities
Carbon Central Bank	Very broad: • procure removal units • develop removals market • **manage removals and carbon market**	All purchase methods possible (except equity)	Own resource (ETS allowances/integration)	**Public, standalone, independent institution** • High autonomy • High capacities
Rule-based mechanism	Very narrow: • procure removal units (under strict rules) • **manage carbon market and/or removal market**	**Rule-based approach**, implemented through flat-rate or reverse auction	Annual contribution EU budget	Public, mechanism operated by government agency **Limited autonomy** Limited capacities

EU-coordinated Buyers' Club

Mandate: Mid-sized: procure removal units and develop removals market.

Purchase method*:* All possible

Funding: Private funders (e.g. corporates with net zero targets or wishing to make contribution claims); with operating costs covered by EU Commission (who could also provide seed funding)

Institution: Public-private partnership in the form of a financial fund, implemented by a public bank (e.g. EIB) or national public bank (e.g. KfW).

An EU-coordinated buyers' club would be implemented by a public bank (e.g. EIB, national public bank), with the funding for purchases provided by private funders (e.g., corporations with voluntary net zero targets). Operating expenses would be covered by the EU Commission, who could also provide seed funding. The EU-coordinated buyers fund would aggregate private demand and acts on the private funders behalf to contract current and future purchases of CDR, using a mixture of ex post purchases of delivered CRCF credits, pre-purchases (where suppliers receive funding up front), and offtake agreements. In return for providing funding the private funders would receive claims on the CRCF credits purchased by the buyers' club (when they are delivered), commensurate to the amount of funding they provide. This could be implemented by providing funders with CRCF credits[17] when they are delivered, which private funders could use to meet their own removals targets or sold; the ability for private funders to later sell their shares in the Fund (or the CRCF credits they receive) could offer an additional incentive to participate, if private buyers expect the value of the corresponding CRCF credits to appreciate. Additionally, the EU-coordinated buyers' club would offer services and feature attributes that make it attractive to private buyers:

Trustworthiness and expertise, which would remove barriers to new CDR buyers entering the market. This could include additional due diligence and identification of projects (drawing on expert evaluation procedures implemented by the Innovation Fund, such as the STEP Seal).

[17] These could be specific CRCF credits, or an "buyers' club" credit, that rather than an individual credit, equivalent to 1t CO2-e, backed by the portfolio of CRCF credits purchased by the EU-coordinated buyers' club.

Pooling of removals and a diverse portfolio of CDR projects and types, reducing risks for individual buyers, and smoothing out costs of different credits.[18]

Access to high quality removals, supported by economies of scale and large scale of purchases, attractiveness to sellers due to AAA credit rating and links to other funding streams (e.g. Innovation Fund), among others.

In the workshop, concerns were raised about the issue of "buyers' club fatigue," with numerous private buyers' clubs in existence, and some skepticism regarding private interest in funding a scheme over which they have little control. These issues could reduce private funder interest in investing and effectiveness of the policy; alternative approaches for crowding in private financing are discussed in more detail in section 3.6.3.

Sources: Such a fund would build on the example set by Frontier Climate (see section 6.6), which aggregates private demand for CDR, both for immediate (i.e. present year purchases) as well as credible future commitments, coordinating purchases on behalf of funders. In terms of structure, it could build on the example of public-private funds such as the German Government/KfW-initiated Global Climate Partnership Fund or EU Commission-initiated Global Energy Efficiency and Renewable Energy Fund, which feature some degree of public management and implementation but are funded at least in part by private contributions. A further example is provided by the EIB's Post 2012 Carbon Credit Fund, which purchased Clean Development Mechanism credits, which were then sold to EU buyers to use to meet their compliance obligations.[19] An example of a related but less formal policy approach is provided by the US DOE's Voluntary Carbon Dioxide Removal Purchasing Challenge, which resulted in both Google and Meta announced matching $35 million commitments to purchase permanent CDR in response to a DOE purchase.[20]

EU Removals Fund

Mandate: Mid-sized: procure removal units and develop removals market.

Purchase method*:* All possible

Funding: Own budget, endowed through multiple-year budget commitments from EU budget

[18] i.e. the private funders could purchase shares in the Fund at an "average" CRCF credit price, considering the portfolio of removals credits purchased by the buyers' club.

[19] Post 2012 Carbon Credit Fund

[20] DOE is Helping YOU Buy Good Carbon Dioxide Removal Credits | Department of Energy

Institution: Public institution, housed within existing EU institution, with medium level of capacity but medium degree of autonomy

An EU Removals Fund would be a publicly managed fund housed within an existing EU institution—or a mandated external body, such as the EIB or KfW—with a relatively broad mandate to procure removal units in a way that supports the development of the carbon removals market. This would entail going beyond purchasing at the lowest cost. It would involve making purchasing decisions and offering additional forms of support (e.g. financing) to advance the development of permanent removal technologies and the broader removals market. This could include providing favourable conditions for less mature removal technologies and pooling different types of removal units (varying by type, location, or vintage) to hedge against risks related to differing degrees of permanence or e.g. leakage. The Fund would be managed by an existing EU institution or agency, ensuring relatively swift and straightforward establishment. Funding would be relatively secure, giving the EU Removals Fund the ability to plan and act independently and strategically over medium time frames. Funding would come from the EU budget but would consist of multi-year commitments (not subject to regular revisions should political priorities shift) and the Fund would have the ability to roll over budget for spending in later years. Alternative funding arrangements would also be possible, especially in the longer term, including e.g. ETS allowance allocation, or revenue from removals obligations.[21]

Sources: An EU Removals Fund would build on existing policy examples and the literature. Battersby et al. (2024) propose a “pilot procurement programme,” which has a similar mandate and structure (hosted within the Innovation Fund), though their proposal has more limited funding. The Innovation Fund is governed by the European Commission, which delegates specific roles to the European Climate, Infrastructure and Environment Executive Agency (CINEA), responsible for implementing the Innovation Fund, and to the European Investment Bank (EIB), which provides financial and technical advice to projects.[22] Examples for such institutional and funding structures also exist at the Member State level, such as the Danish fund for negative emissions (NECCS).

[21] Medium-term policy options such as emissions trading scheme integration or removals obligations of different forms will be discussed in a subsequent paper.

[22] What is the Innovation Fund? - European Commission

Centralised purchasing platform

Mandate: Narrow: procure removal units, limited objectives related to market development.

Purchase method*:* All possible

Funding: Annual contributions from EU and Member State budgets (pay-as-you-go) *(note: alternative funding sources could be considered, e.g. annual EU or Member State budget contributions).*

Institution: Public institution, housed within existing EU institution, with basic capacities and limited autonomy

A centralised EU purchasing platform would be a publicly managed agency that would provide a centralised mechanism for the EU and Member States to pursue a relatively narrow mandate: to collectively manage the procurement of removals units. The agency would be a relatively simple institution, housed within an existing institution, with limited mandate and flexibility. Funding would be provided by the EU and Member States, who would mandate the purchasing platform to procure removal units on their behalf, rather than conducting the purchases directly. Centralising demand in this way would enable pooling of funding, delivering economies of scale, lowering funder transaction costs, increasing transparency, and increasing predictability of demand for suppliers. Such a central agency could also perform additional functions, such as providing transparent price information to support market functioning, providing an additional layer of certification or auditing to ensure credit quality (in addition to the CRCF process), etc. Funding for the centralised EU purchasing platform would take the form of a pay-as-you-go service, though multi-year commitments could be expected to increase the ability of the agency to make medium-term purchase plans. The specifics of its mandate would be determined by the funders, who could set parameters around the types of carbon removals units to be procured, and the extent to which procurement should prioritise objectives beyond simply purchasing the lowest-cost units. As the agency would be housed within an existing EU institution and Member State contributions would be voluntary, it could be established relatively swiftly and with minimal complexity.

Sources: A centralised EU purchasing platform would build upon existing policy examples and the literature. The limited mandate and delegation of mandate to an agency mirrors the Swedish BECCS policy, where the Swedish government has delegated the Swedish Energy Agency to distribute €3.1billion to purchase BECCS removals over the next 15 years, through annual budget payments. The centralised EU purchasing platform model also has exemplars (Nicoli & Beetsma, 2024). One example is the European Defence Agency's 2023 Collaborative Procurement of Ammunition, where 18 Member States aggregated their orders through the European Defence Agency, combined with

€1billion of central EU funding (mobilised from the European Peace Facility).[23,24] A related model is the "auction-as-a-service" approach implemented by the European Hydrogen Bank, which aims to attract additional funding for projects from Member States. Up until 2024, this had attracted funding from Austria, Spain, and Lithuania worth a total of €836 million.[25]

Investment vehicle

Mandate: Mid-sized: develop removals market (and procure removals units)

Purchase method*:* All methods possible, including equity investments in removal companies

Funding: Initial endowment from public budget, multiplied through partnerships with private investors.

Institution: Public, independent Financial Fund hosted within existing EU institution (e.g. EIB), with high degree of autonomy and capacities

An investment vehicle would be a publicly owned investment fund that would have a mandate to develop the removals market. The Investment Vehicle would be a highly independent fund, housed within an existing EU agency (e.g. the EIB).[26] Funding would be provided through an initial endowment of public funds. Its distinctive feature would be its wide range of approaches to developing the removal market, not limited to removal procurement, but also extending to equity investments in removal companies, and to de-risking actions to support private investors. The investment vehicle would aim to optimise the removals generated through the public funding, whether these are produced by (partially) publicly owned companies, or through credit procurement. Public funding would be augmented by private investment through investment partnerships, where the investment vehicle and private investors could collaborate to invest in removals companies. To facilitate its role as an investor, the Investment Vehicle would be highly independent and would have a high degree of professional

[23] EDA brings together EU countries and Norway for Joint Procurement of Ammunition

[24] An alternative centralised model is offered by the EU Energy Platform's AggregateEU mechanism, which aggregates demand and centrally negotiates gas contracts for EU companies, on a voluntary basis. This is implemented by a private service provider; no contracts or purchases are made by the service provider or Aggregate EU, but between demanding companies and gas providers (European Commission 2024b).

[25] Over-subscribed European Hydrogen Bank auction receives 61 bids for Innovation Fund support, including 8 maritime projects.

[26] An investment vehicle could also be managed by a CCB, should that option be selected.

(investing) capacities, which would take a medium amount of time to establish within an existing institution.

Sources: An Investment Vehicle could build on existing policy examples. One example is the Global Climate Partnership Fund, which was established by the German government as a stand-alone investment fund with a mandate to loan money for climate-friendly investments. In terms of crowding in of private financing, a potential model is offered by the EU Innovation Fund's cooperation with the private Breakthrough Energy Foundation on the Breakthrough Energy Catalyst programme, where the public and private actors' partner to invest in green technologies.[27]

Independent foundation

Mandate: Mid-sized: procure removal units and (to some degree) develop removals market.

Purchase method: All purchase methods possible

Funding: Annual contributions from private companies and EU and Member State budgets (pay-as-you-go). *Alternatively, through removals obligations.*

Institution: Separate and independent institution, privately managed (non-profit), with a high degree of independence and moderate capacities

An **independent foundation** would be a privately managed institution with a mandate to procure removal units and to develop the EU removal market (a similar mandate to the EU Removals Fund). It would be established by the European Union but act as a private, non-profit institution, with a high degree of independence to fulfil its charter, as established in its founding statutes.[28] Similar to the centralised purchasing platform option, it would be open multiple investors, in this case private companies as well as public actors (e.g. Member States and EU). Its governance structure would be determined by who invests or carries out their purchasing through the foundation. Its independence and position as private non-profit institution may give it some advantages in terms of greater flexibility in how it meets its mandate (e.g. be less subject to state aid or WTO considerations, or inflexible public purchasing requirement), though this would be accompanied by considerably less public oversight than other policy options. Establishing an independent foundation would require a moderate amount of time. While creating a new entity would be more complex than

[27] Commission and Breakthrough Energy Catalyst partnership

[28] As a private institution, it differs from the other public procurement policy options we consider. However, we include it as an alternative policy approach to address the same policy objectives. Following the KLIK model, the claims to the purchased removals (or a portion of them) could be transferred to the EU to contribute to EU climate targets.

hosting it within an existing EU institution, it would still be simpler than setting up an entirely new EU body—such as a Carbon Central Bank. The long-term and independent nature of the foundation, and the difficulty of revising its purpose and legal documents once established, would justify the necessary time and care taken. Funding would be sourced from private companies, the EU and Member States, who would contract the independent foundation to purchase units on their behalf (and develop the removals market), rather than making these purchases themselves. An alternative funding arrangement would be for funding to be based upon removals obligations, with these obligations (and necessary funding) transferred from those with removals obligations.

Sources: The independent foundation builds on existing policy examples. One example is the KliK Foundation, which was founded by and is governed by Swiss petrol companies and mandated to fulfil their legal requirement to offset a portion of CO2 emissions generated by the use of their fuels (this offset obligation could be analogous to a removal obligation). A second relevant example is the H2Global Foundation, which was established by companies from the hydrogen value chain, with support from the German government and the Bezos Earth Fund, which aims to facilitate clean hydrogen markets. Finally, two private, independent foundations aim to support carbon removal market development and facilitate private buyers of carbon removals: Frontier Carbon and NextGen CDR.

Carbon Central Bank

Mandate: Very broad: procure removal units, develop removal market, and manage removal and carbon markets (i.e. ETS integration)

Purchase method*:* All possible

Funding: Own resource (independent source of funding directed to the institution, e.g. fixed share of ETS auctioning revenue)

Institution: Separate and independent institution, publicly managed, with high degree of independence and capacities.

A **Carbon Central Bank** would be a separate and independent, publicly managed institution with a broad mandate. In addition to procuring removal units on behalf of the EU, it would have a mandate to actively develop the market for removals. This would entail going beyond purchasing at lowest cost, instead making purchasing decisions and offering additional support (e.g. financing) to support permanent removal technology development and removals market development, such as granting favourable conditions to less mature removal technologies, in addition to pooling different types of removals units (types, locations, vintages) to hedge risks related to differing degrees of permanence or e.g. leakage. As a separate institution, the CCB would have considerable autonomy and independence, offering long term stability insulated

from short-term political changes. Further, the Carbon Central Bank would have a mandate to manage both the removals and carbon markets. Multiple designs would be possible; such a mandate could e.g. see it playing a similar role to the current MSR, which manages the total number of allowances in circulation (this could include removal-linked units, if integration of permanent removals into the ETS was foreseen). As a new stand-alone institution, it would be relatively demanding in terms of setup time and complexity. Funding could be raised through a form of ETS integration, e.g. either by auctioning removals units into the ETS or through earmarking of auction revenue; this funding source follows logically from the mandate of managing the carbon market.

Sources: The Carbon Central Bank policy option builds upon existing policy examples and literature. Such an approach has been proposed in the literature by e.g. Edenhofer et al. (2023) and Rickels et al. (2022), with some differences. In terms of institutional structure, it could echo the European Central Bank, with specific tasks and responsibilities delegated to it under the Treaty of the European Union, and considerable independence to fulfil its role; the European Central Bank is governed by its Governing Council, made up of a six-person executive board and the governors of the national central banks in the euro area. In terms of funding, a Carbon Central Bank's funding could echo that of the Innovation Fund, which is allocated a set number of ETS allowances, which it then auctions off to generate financing.[29] A related approach has been taken to finance the Social Climate Fund, based on auctioning of allocated ETS2 allowances.[30]

Rule-based purchasing mechanism

Mandate: Narrow: procure removal units and manage the carbon market and/or removals market under strict rules

Purchase method: Rule-based mechanism for purchases, implemented through simple purchase method (e.g. flat-rate price or reverse auction)

Funding: Budget would come from public budget and/or through ETS integration.

Institution: Mechanism operated by EU body (e.g. DG CLIMA), with basic capacities and limited autonomy.

A rule-based purchasing mechanism would be a publicly managed mechanism with very limited autonomy. Its mandate would be to purchase

[29] 530 million allowances, expected to raise approx. €40 billion at ETS prices of €75, over 2020-2030, What is the Innovation Fund? - European Commission

[30] ETS2 allowance allocations resulting in a maximum amount of €65 billion over 2026-2032, Social Climate Fund - European Commission

carbon removal units based upon a set of rules or observable parameters. It would do this in order to manage the number of units in the removal market and/or the ETS market, depending on the development of other climate policy (e.g. if ETS integration was foreseen, the rule-based mechanism could buy removals and release removals-backed credits into the ETS). In this way, such a policy would represent a significant revision to existing EU climate policy architecture (e.g. to operation of ETS Market Stability Reserve).[31] Relative to such a task being performed by an independent institution such as a Carbon Central Bank, the use of strict rules for removals purchases (and release to the ETS) increases predictability for the ETS and removals markets and shields the mechanism from political influence. Such a model could also manage purchases within the removals market without ETS integration, e.g. the purchase of removals could be triggered by failure to meet climate targets, or when removals prices fall below a certain point. The implementing body would have very limited discretion, matching its limited mandate that would not extend to otherwise developing the removals market. Corresponding to its limited mandate the implementing body would have simple capacities. The mechanism would need to have access to the necessary funding, either from the EU budget or a separate fund (or from ETS revenues or allowance allocation).

Sources: The rule-based mechanism approach builds on the example of the Market Stability Reserve, which alters the number of allowances made available for auction in the EU ETS over the next year. The rule-based purchasing mechanism would differ in that purchasing removals units would likely require more capacities than the MSR (which simply alter the number of auctions to be released in an already existing auction), so would require a somewhat more sophisticated institution (unless the removals market is highly liquid and mature).

2.4. Policy option assessment

2.4.1. Assessment criteria

To qualitatively assess the opportunities and risks posed by each of the policy options, we develop assessment criteria based upon the policy objectives identified in section 1.3:

- Support CDR technology development
- Support CDR market development

[31] For example, the purchasing volume (and release of removals-backed allowances to the ETS) could be derived from the gap between EU GHG emissions targets and actual EU emissions, depletion of the Market Stability Reserve, or ETS trading volume triggers.

- Generate public and private demand for high-quality permanent CDR
- Ensure effective and cost-effective public CDR governance

To make these broad objectives tractable for the assessment, we disaggregate them into specific indicators. Further, we draw on EU Better Regulation Guidance evaluation criteria to also identify additional assessment criteria.

Following our comparative evaluation of the policy options, in section 2.5 we consider the sequencing of policy options across time, considering the potential for a shifting role for a purchasing programme over time (as discussed in 2.1).

Effectiveness

- CDR technology development and innovation support
    - Capacity to support the development of multiple technologies / removal types[32]
    - Ability to support large-scale facilities (>1 $MtCO_2$-e)
- CDR market development
    - Capacity to develop market (e.g. coordination, standardisation, etc.)
    - Ability to crowd in private finance: Suitability for ETS integration
- Generate public and private CDR Market demand: short/medium/long term
    - Ability to generate permanent CDR market demand in short term (e.g. next five years)
    - Ability to generate permanent CDR market demand in medium-long term (after five years)
- Public governance
    - Public oversight and ability to directly affect purchasing policy.

Efficiency

- Administrative costs: Low administrative costs for EU and affected parties (Member States)
- Administrative burden: Low compliance costs for business community, also SMEs

[32] It may be useful to break down this assessment criteria further, to consider whether some policy options will more effectively support low TRL technologies relative to high TRL technologies.

- Dynamic efficiency: Policy supports lowering of costs of removals, incentivising the implementation of low-cost removals over time.

Coherence

- Avoids major policy changes: The policy proposal avoids requiring major changes to the present EU climate regulatory framework

Subsidiarity

- We do not compare the policy options in terms of subsidiarity; see section 1.2 on why the EU should act.

Proportionality

- We do not compare policy options in terms of proportionality. This is principally determined by the budget apportioned to the purchasing programme, rather than the policy option. Budget needs are discussed in section 3.1.

In Table 3, we qualitatively assess the risks and opportunities posed by each policy option against the assessment criteria. We use expert judgment. The assessment uses a 5-point scale (--, -, 0, +, ++). All assessments are relative, that is, they compare across the different policy options to assess the specific indicator/question. A description of the assessment and justification for scoring is provided in the following sections.

Table 3: Qualitative assessment of purchasing programme policy options

Assessment criteria	Sub-criteria	Indicator	EU Buyers' Club	EU Removals fund	Centralised purchasing platform	Investment vehicle	Independent foundation	CCB	Rule-based
Effectiveness	CDR technology development and innovation support	Support technology development	++	++	0	++	++	+	-
		Support large-scale facilities (>1 $MtCO_2$-e)	+	+	0	+	+	+	-
	CDR market development	Crowd in private finance	++	0	0	+	+	0	-
		Capacity to develop market	+	++	0	+	+	++	-
	CDR market demand: short/medium/ long term	Short-term CDR demand	+	++	+	0	0	--	-
		Medium/long-term CDR demand	0	+	0	0	+	+	0
	Public governance	Public oversight	+	++	++	0	-	+	0
Efficiency	Administrative costs	Low administrative costs	-	-	-	-	-	--	+
	Administrative burden	Low compliance costs	0	+	0	0	0	+	+
	Dynamic efficiency	Low-cost removals over time	++	++	+	+	++	++	0
Coherence	Avoids major policy changes	Limited regulatory framework change	0	++	+	0	-	--	0

2.4.2. Effectiveness

Capacity to support technology development: An EU Removals Fund offers high potential to support technology development, given its ability to be implemented relatively quickly and its relatively high level of autonomy and capacities. An EU Buyers' Club would also have a high level of autonomy and capacity to support technology development. Similarly, both an Investment Vehicle and an Independent Foundation score highly, due to their

independence and autonomy. A CCB, while offering significant autonomy and capacity, would only be able to support technology development once operational—something that may take considerable time given the complexity of establishing a new EU institution. The narrow mandate and less certain funding of a Centralised Purchasing Platform would limit its ability to effectively support technology development, while a Rule-based Mechanism would have no ability to develop technologies given its lack of discretion and relatively slow implementation time.

Ability to support large-scale deployment: Supporting large-scale deployment is determined by the policy options' ability to selectively support individual facilities, facilitated by independence and capacity. Accordingly, the EU Buyers' Club, CCB, EU Removals Fund, Investment Vehicle and Independent Foundation score relatively highly, while Centralised Purchasing Platform and particularly Rule-based Mechanism score lower.

CDR market development

Ability to crowd in private finance: The policy options have different abilities to crowd in private finance (excluding through ETS integration or removals obligations, which are discussed below). An EU Buyers' Club offers the most potential for crowding in private finance as its purpose is to make private contributions as easy as possible. An Independent Foundation also offers potential for crowding in private financing, as private actors could have more ownership of such an institution. An Investment Vehicle would also offer potential for crowding in private finance, with its focus on profitable investments. CCB, EU Removals Fund, and a Centralised Purchasing Platform offer limited potential to crowd-in private finance without accompanying policies to foster private investment through coordination or other flanking policies. The Rule-based Mechanism would be unlikely to crowd-in private finance, given its technical, non-discretionary approach to purchases.

Capacity to develop market: The policy options' ability to develop the removals market depends on their mandate and their capacity and autonomy to act. The CCB has a high capacity and autonomy, and with its authority as an EU institution, could effectively shape the removals market. The EU Buyers' Club and Removals Fund has lower capacities but would have some authority and ability to shape the market. An Investment Vehicle and Independent Foundation would both have high degrees of autonomy and reasonably high capacities, so could be effective. The limited mandate and capacity of a Centralised Purchasing Platform give it a limited ability to develop the removals markets. The Rule-based Mechanism would have no real capacity to develop the market, given the uncertain demand signal it would generate, and its lack of capacities or independence.

CDR market demand

The policy options' ability to **generate short-term demand** for permanent carbon removal units depends on how swiftly such policies can be implemented. An EU Removals Fund and a Centralised Purchasing Platform can be swiftly established within an existing EU body. Given that an EU Removals Fund depends solely on EU decision-making, this could support swift decision making and some certainty over funding levels (though these could depend on EU multi-annual funding decisions).The Centralised Purchasing Platform offers less certainty and speed, due to its reliance on Member State contributions. Similarly, the EU Buyers' Club would be swift to implement but it is not clear how much private finance would be forthcoming, so scores lower. An Investment Vehicle and Independent Foundation would require more time to establish though could feasibly be implemented to generate demand before 2030. The linking of a Rule-based Mechanism to the ETS and the CCB would require relatively time-consuming political processes, with the need to establish a new, stand-alone institution meaning a CCB would take longer.

All policy options would be able to generate **medium- to long-term demand** for CDR (limited by the availability of public, Member State, or private funding made available to the policy options). Medium- to long-term demand would be less certain for a Rule-based Mechanism (as the demand would depend on purchases being triggered by market conditions); the Centralised Purchasing Platform would also offer less certainty due to reliance on Member State financing, as would the EU Buyers' Club, with its reliance on private funding. The medium-long term demand from an investment vehicle would also be unclear, as this policy prioritises upfront investment over medium-term demand.

Ensure effective and cost-effective public CDR governance

Public governance: EU Removals Fund and Centralised Purchasing Platform score highly for public governance, given their direct management within EU agencies and limited autonomy. As a public institution, the CCB scores well; however, its high level of independence implies slightly lower public oversight. The EU-coordinated Buyers Club scores moderately highly, as while coordinated by the EU, there is potential for influence from private funders. The Rule-based Mechanism would be established through a political process but would then operate without political influence, giving it a neutral score. An Investment Vehicle receives a neutral score: It is publicly managed by an EU executive agency but has a high degree of autonomy. An Independent Foundation has low public oversight after its establishment, so scores poorly.

2.5. Sequencing of appropriate policy options

Different policy options will be appropriate for different timescales, as the needs for a public purchasing programme are likely to shift over time. As discussed in section 2.1, the needs for a public purchasing programme should reflect the status of CDR technologies. Current CDR technologies exhibit different levels of technological development and market readiness levels and therefore require different types of support. For example, Enhanced Rock Weathering has a relatively low TRL of 3-4 and is still in the technology development phase, while BioCCS has a higher TRL of 6 and is to a greater extent in the market development phase (ESABCC, 2025). Especially in the near term, a public purchasing programme will need to deliver incentives to support different types of CDR at different phases of their development. This will shift over time, as CDR technologies develop, and their long-term potential and cost become clearer.

The EU will also have different capacities and opportunities to develop policies over time. In the short-term, a purchasing programme will be limited by what can be realistically implemented quickly, while in the longer term it will have more flexibility to implement more complex or ambitious policies. In the medium and long term, there will also be shifts in wider EU climate policy, which may in turn make the policy options considered more or less attractive. For example, if ETS integration of carbon removals is envisioned, then purchasing programme policies that facilitate this will be most appropriate; if, alternatively, removals obligations are envisioned, then a purchasing programme that aligns with this approach would score more highly.

We identify the following priorities for a purchasing programme over the following timescales, and which policy options can best address them. We also consider the potential for path dependencies. These evaluations support our prioritisation of a short-term purchasing programme policy for more detailed policy development, which follows in the section 3. In that section, we draw on the favoured policy options but adapt them to make a recommended “policy blueprint” for a short-term purchasing programme for permanent CDR.

2.5.1. Short-term policy options

Short-term policy objectives:

- **Simple policies** that can be **swiftly implemented** should be preferred in the short-term, to ensure that demand incentives can be achieved in this time period.
- Policies that can best **support technology development** are preferred, with a secondary focus on **market development** (for those CDR technologies that are more advanced)**.**

Recommended short-term policy: Given these objectives, the strongest policy option is a combination of the EU Removals Fund with aspects of the Centralised Purchasing Platform and EU-coordinated Buyers' Club.

The EU Removals Fund could generate short-term demand incentives the quickest, given the centralisation of decision making with the EU and its avoidance of requiring major policy change. Additionally, given the relatively high capacities of the Fund, it has the ability to effectively support technological development through targeted purchases. The strong degree of public oversight and ability to incentivise low-cost removals over time may be important characteristics for building public support at this early stage of removals policy. Further, the EU Removals Fund has the advantage of offering a familiar institutional form and strong public oversight and adaptability, making it swift to implement and signalling public commitment to the development and management of permanent carbon removals.

A second option would be a Centralised Purchasing Platform. It has some of the benefits of the EU Removals Fund, including strong public oversight and a quick set-up time. However, given its significant reliance on pay-as-you-go contributions from Member States, it offers less certain short-term demand. As this policy option is described above, its lower capacities and independence also mean it is less likely to be able to effectively support technology development.

The third option would be an EU-coordinated Buyers' Club. It can be quickly established and with its moderately broad mandate and independence, can effectively support technology development and deliver dynamic efficiency. The policy alone poses some important relative weaknesses due to the uncertainty of the scale of private funding that would arise and accordingly the level of demand it would generate.

In section 3, we consider how the policy option designs can be combined and adapted to develop an effective short-term purchasing programme policy.

None of the policies is likely to establish problematic path dependencies, as both could feasibly be developed as short-term, time-limited approaches that will be subsequently replaced by a more long-term policy. Given the slightly higher capacities and sophisticated institutional structure of the EU Removals Fund, it would require more investment and therefore may have a greater gravity on future policy than the more lightweight Purchasing Platform policy. However, it would also lend itself to transforming in the future, given the lack of significant regulatory or policy architecture required. An EU-coordinated Buyers Club could support transition to later compliance policies, due to its early inclusion of private buyers.

The other policy options are less attractive, given their greater complexity and accompanying poor ability to generate short-term demand.

2.5.2. Medium-term policy options (2030-2040)

Medium-term policy objectives:

- Policies that support technology development will remain a priority.
- There will be an increasing need for market development and crowding in of private finance (potentially through flanking policies, such as removals obligations or ETS integration).
- Greater acceptance of complex policies, including those that are politically challenging to implement, if expected benefits are significant.
- Generally, policies will need to be able to deliver larger scale incentives to match the larger amounts of carbon removals envisioned in the 2030s. This will depend on the extent to which a purchasing programme is expected to cover necessary demand, relative to flanking or substitute policies, including broader EU climate architecture policies such as ETS integration or removals obligations.

Recommended medium-term policy: The optimal medium-term policy depends on the longer-term carbon removals strategy.

Considering only the removals objectives, if ETS integration is envisioned, as well as the EU Removals Fund, a Carbon Central Bank could be an appropriate option. Given its high level of independence and capacity, it will be able to effectively develop removals technologies and the market, including large-scale facilities, as well as efficiently incentivise low-cost carbon removals over time. However, its relatively high set-up and operational costs—combined with the complexity and political challenges associated with significantly adapting the EU climate policy architecture—mean that it would only be justified if accompanied by, or leading to, the integration of carbon removals into the ETS. In this context, the model is well-suited, given its broad mandate to manage both the ETS and the carbon removals market. Such a model could also be used to manage carbon removals obligations, should they be the medium-term policy for removals. However, it is important to note that any decision regarding ETS integration would need to prioritise ETS operation, with impacts on removals markets secondary to ensuring the ongoing effectiveness of the ETS; accordingly, a separate assessment of the CCB against other ETS adaptation options would be required before such a policy could be recommended.

If no ETS integration is envisioned, then an EU Removals Fund would be most appropriate. It offers cost and complexity advantages relative to the Carbon Central Bank model, in addition to the strengths already discussed. It offers an equivalent ability to generate permanent CDR market demand in the medium-long term.

Two other policy options may also be justified by alternative long-term policy visions. If a removals obligation is established, an independent foundation

(based upon the KLIK foundation model) may be justified, though a removals obligation could also be implemented through either the CCB or EU Removals Fund, if with less independence. If equity investments and public ownership of carbon removal facilities are envisioned, then an investment vehicle could also be justified; this may not be sufficient as a standalone policy but could be a useful accompaniment to other options.

2.5.3. Long-term policy options (2040+)

Long-term policy objectives

- In the long term, purchasing programme policy design should be most determined by **policy coherence**, which in turn will depend on broader development of EU climate architecture and removals strategy. A key consideration will be the assignment of responsibility for carbon removals, and the extent to which this remains a public obligation or is transferred—through mechanisms such as removals obligations or integration into emissions trading schemes—to residual or historical emitters.
- Another key determinant will be the **ability to deliver at scale**: If purchasing is envisioned to play a significant role, then by 2040+ the policy option must be able to effectively purchase large amounts of carbon removals.

Recommended long-term policy: It is not possible to recommend a long-term policy option without previously making decisions about the long-term direction of EU removals and their role in EU climate policy, with all policy options potentially justifiable under different visions. Even the rule-based mechanism may be appropriate in the longer term, once the removals market has matured sufficiently – at least in combination with, e.g., a CCB-type policy. Beyond policy coherence, all policy options have relatively similar abilities to deliver large scale demand incentives, with this primarily determined by long-term vision issues such as ETS integration, carbon removals obligations, or other sources of beyond EU-budget funding.

2.5.4. Post-2050 policy options

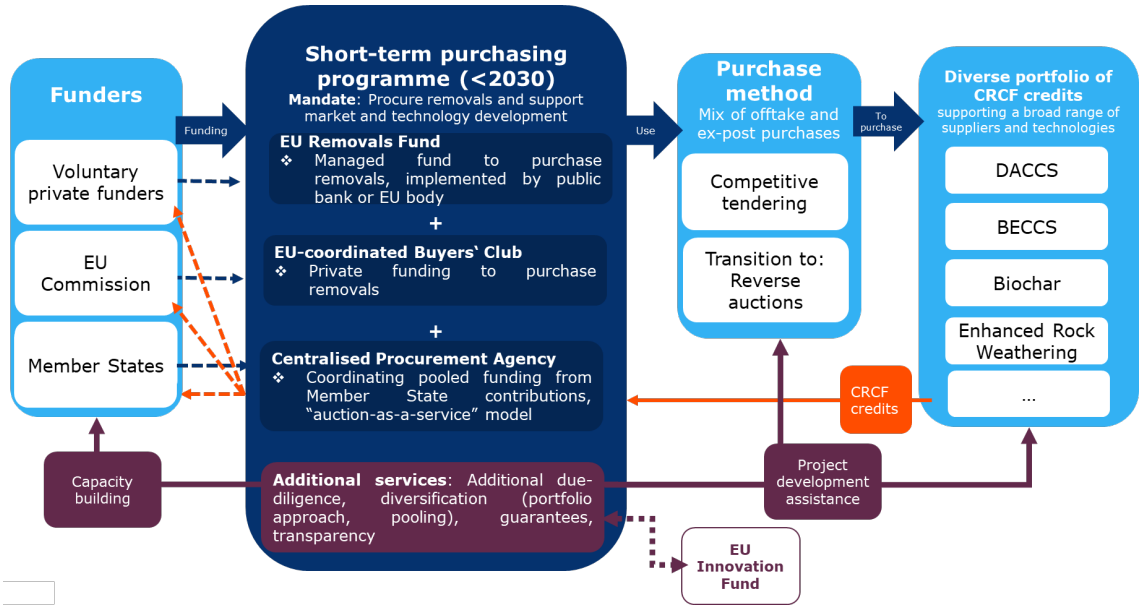
The EU Climate Law's commitment to net negative emissions post-2050 may justify a continued role for purchasing removals. Here, too, a key element will be the extent to which private actors are made are able to be held responsible for carrying out removals. Accordingly, the appropriate design of a purchasing programme in particular will hinge on decisions around removals obligations and ETS integration, and therefore the extent of direct public purchasing required to meet EU climate objectives.

3. Policy blueprint: Short-term purchasing programme for permanent CDR

In this chapter, we develop a policy "blueprint" for a short-term purchasing programme for permanent CDR. This policy is motivated by the problems and objectives identified in chapter 1, particularly the need for bolstering short-term demand for permanent carbon removals. Based on the identification and assessment of policy options in Chapter 2, the blueprint concluded that the optimal policy option in the short term was an EU Removals Fund combined with elements of the Centralised Procurement Programme and EU-coordinated Buyers' Club options. We draw on the high-level description of these policies from Chapter 2 but develop them in more detail, presenting potential approaches and recommendations related to key design elements. This includes consideration of the necessary scale of a purchasing programme, target portfolio, purchase method and instruments, institutional structure, and funding, as well as other key issues.

The primary objective of the blueprint policy is to boost short-term demand for high-quality permanent CDR. This should support attainment of the policy objectives identified in Section 1.3, particularly to support CDR technology and market development in the short term. We consider short term as being the time period 2025-2030, meaning that to have impact, this policy would need to be implemented relatively swiftly. Longer-term policies must also be developed, and indeed, current market development should be supported by the signal of significant long-term demand generated by post-2030 policy commitments, e.g., committing to post 2030 ETS integration, the creation removals obligations, or a large and long-term public purchasing programme. While consideration of these alternative longer-term policy options is beyond the focus of this report, in our discussion of potential approaches and their strengths and weaknesses we discuss approaches that could be implemented in medium- or long-term policies. Chapter 4 explicitly discusses the potential evolution of a purchasing programme policy over time.

Figure: 3 Policy blueprint: Recommended short-term EU purchasing programme for permanent CDR (own compilation)



3.1. Purchasing programme mandate

Mandate: The mandate describes the function a purchasing programme is supposed to serve, what objectives it is intended to pursue, which tools or resources it can deploy to achieve them, and what discretion it can apply in the execution of its tasks. This has important implications for purchasing programme policy design, with the mandate determining the appropriate shape and scale of purchasing programme. The optimal mandate will shift over time, as technologies and markets mature, and policy develops.

Recommendation: **A short-term purchasing programme** should have a mid-sized mandate, going beyond simply procuring removals credits to also support the development of the removals market. This implies strategic purchase of a range of removals credits to promote technology and market development (rather than just the cheapest credits) to support dynamic efficiency, and the use of pooling and guarantees to reduce risks for buyers.

In the **longer term,** a purchasing programme's mandate may extend to include ETS market management, depending on other climate policy developments.

3.1.1. Mandate options and strengths and weaknesses

The objectives for policy to support permanent CDR were discussed in section 1.3, and include

- Support CDR technology development
- Support CDR market development
- Generate public and private demand for high-quality permanent CDR
- Ensure effective and cost-effective public CDR governance

In this section, we consider options for the specific mandate of a purchasing programme. The mandate describes the function(s) it is supposed to serve, what objectives it is intended to pursue, which tools or resources it can deploy to achieve them, and what discretion it can apply in the execution of its tasks. The mandate of a purchasing programme is decisive in its design, largely determining the shape and scale of the programme.

We focus our discussion on the mandate for a purchasing programme in the short term. The mandate for a purchasing programme will also be expected to shift over time, as permanent CDR technologies and markets develop, and as other climate policies evolve. Given our focus on the short term, we focus on mandates for the next five years that will support near-term attainment of the objectives. However, we also discuss mandates that may only be implementable in later phases, post-2030.

Mandates can range from narrow to broad, where broader mandates incorporate and extend narrower mandates. At the core, the most essential function of the body is to purchase removals (i.e. permanent CRCF certified units) that can then be used by the (public or private) buyer. Beyond this, the body may also serve to develop the market for removals units and foster the scaling of removals as a business model – by providing the infrastructure for such a market[33], and/or by creating demand. In the broadest interpretation, a purchasing programme may serve to actively manage the market for removals, and possibly even their integration with existing carbon markets. The broader mandates include more (possibly) competing targets for the body and therefore require greater discretion and forward planning in the execution of the mandate, greater independence, more resources and administrative capacities. The different functions that could constitute the mandate of a purchasing programme are explained in the following, grouped into three main categories: procurement, development of the removals market, and managing the carbon market. Only the narrow and mid-sized mandates are realistic mandates for a short-term purchasing programme, with the broader mandate a consideration for later policy development.

1. Narrow mandate: Procure removal units

Under this mandate, the core function of a purchasing programme is to purchase removals units within specified parameters or under defined constraints. These specifications may apply to the cost of removal units, to certain minimum standards (e.g. related to broader sustainability standards), or to requirements regarding the removal types, vintages or geographical origin). The specifications also directly reflect the objectives of the regulator, and by extension the purchasing programme: For instance, if the main objective is to reduce the burden on the public budget, the body could be mandated to procure a given amount of units at least cost. The procured units would then be used by the funding bodies – these could be national or regional governments that use removal units to comply with their climate neutrality goals, but (in principle) also private entities that use removal units to meet compliance obligations or meet climate neutrality targets that they have committed to voluntarily.

2. Mid-sized mandate: Support the development of the removals market

The mid-sized mandate extends the narrow mandate, with the purchasing programme would not only serve to purchase allowances but would also support the development of the market for removals. The objective of this mandate could be, for instance, described as ensuring a growth of removal suppliers that results in sufficient supply or removal units to meet market demand and a liquid market for such units, and in scaling effects that lead to

[33] Alongside the CRCF and its trading platform.

decreasing costs. Fostering the market development can be achieved through different functions, such as:

- **Create demand for different removal types and providers**: Technology and price development uncertainties mean we do not know today what CDR options will be lowest cost and highest benefit (e.g. considering externalities) in the future. To manage this risk, a short-term purchasing programme can purchase multiple types of removals (i.e. not just the cheapest price). To support the development of competitive markets, the programme can also purchase from multiple providers.
- **Create predictable demand for removal units:** To trigger private investment into removals activities, there needs to be a clear business case – and that hinges on the expectation that there will be sufficient demand. One function of a purchasing programme can therefore be to signal that there will be predictable demand for removals units. While a short-term policy can offer only limited assurances for medium to long term demand, it will still provide a signal, including regarding expected prices.
- **Guarantee / derisk credits derived from removal units:** If removals are to be traded on a market in the form of credits, either on the carbon market or on a separate market for removal credits, these credits may initially carry a risk premium. This can be the case, for instance, due to uncertainties about the permanence of removals. A purchasing programme could take over some of this risk, e.g. by performing due diligence for purchases, or providing a guarantee in case of failures.
- **Pooling different types of removals to hedge risks and manage prices:** To hedge and distribute risks associated with specific types of removal units, a purchasing programme could also purchase and pool removals units from different removal types, vintages or geographic origins, and on the basis of the procured units issue new credits / financial products that are backed up by a blend of different removal units. In addition to reducing the risk, such pooling can also be beneficial as it averages out the price of different removal types (the average price of removals in the pool will be lower than e.g. high cost DACCS credits), allowing buyers to balance number and type of credit purchased.

3. Broad mandate: Manage the carbon market, including removals

The broadest mandate for a purchasing programme would be to go beyond purchasing CDR credits and managing the removals market, to also manage the role of removals as part of the EU's wider climate policy, including the relative role of carbon removals and emissions reductions to meet EU climate objectives. For example, this could include a mandate to manage trading levels and emissions reductions in the EU ETS, or the optimal number of removals

through an alternative policy approach (e.g. removals obligations). This mandate would be out of scope for a short-term purchasing programme, but we do include here, as it may be a desirable role for a purchasing programme in later phases of removals policy development. This could involve the following roles:

- **Managing the phase-in of removals into an emissions trading scheme:** Any arrangement for integrating removals in an emissions trading scheme would need to arbitrate between two conflicting objectives: allowing the removals market to scale up and achieve maturity and cost decreases, while simultaneously avoiding mitigation deterrence, i.e. emitters abstaining from emission reduction activities that are considered feasible and desirable (or, in fact, necessary) to achieve a structural change of the economy consistent with climate neutrality pathways, to instead purchase removal units. Navigating the trade-off between too slow and too rapid scale-up will be an ongoing (and challenging) management task, which could fall under the remit of a procurement body. In the long term, as the ETS cap declines, the management of available removal credits will play a crucial role in maintaining market liquidity—potentially serving as a replacement for the ETS's market stability reserve. These ETS integration roles are not relevant for a short-term purchasing programme and would only be relevant in the case that in the medium- to long-term removals are to be integrated into an ETS.
- **Managing removals obligations:** Should, as an alternative or complement to ETS integration, the medium- to long-term policy for removals be the development of removals obligations or a removals trading market, the management of this policy could also fall under the purchasing programme's mandate. This would include policy setting and administration of removals obligations, pooling of financing and demand, and purchasing of credits, among other tasks. This could take multiple forms, e.g. requiring current emitters to remove carbon at a later point in time, so-called clean-up certificates.[34]

3.1.2. Key considerations and risks and opportunities of different mandates

The different mandates offer different risks and opportunities, making them appropriate for different time scales. A purchasing programme could begin with a narrower mandate, and extent this over time. **In the short term, either the**

[34] See Lessmann et al., 'Emissions Trading with Clean-Up Certificates'.

narrow or mid-size mandates would be implementable, while the broad mandate would be implementable in the medium to long term.

The key advantage of a **narrow mandate** is the simplicity and speed with which it could be implemented, and its ability to generate some demand for removals. However, it offers only weak support for other policy objectives: due to its limited focus on purchasing removals credits, it would provide only limited support for CDR market and technology development.

In the short term, a mid-sized mandate seems most appropriate to meet policy objectives. The focus on developing the removals market, by purchasing a range of removal credits from a range of suppliers offers greater opportunity for fostering technology and market development, with the aim of lowering long-term removal costs. In addition to strategically purchasing removals credits, the wider mandate would push the purchasing programme to also offer additional services to further bolster demand, including market monitoring and reporting, financing, performance evaluation and control, more complex tendering procedures, and pooling and insurance. This would come at greater cost and institutional complexity, but these should be offset by the opportunities already identified. To speed implementation, for the short-term policy, the initial year or two years could focus on a narrow mandate of simply making removal purchases, with this broader mandate implemented by the late 2020s.

The broad mandate option would not be implementable in the short term but offers additional opportunities in the longer term. The additional complexity entailed by the broadest mandate make it impractical for a short-term purchasing policy. Above all, this concerns the interactions with the architecture of the EU Emissions Trading System – such as the ETS cap or the provisions for market stability (MSR) – or the creation of a new set of carbon removal obligations. The legal and institutional arrangements required to fulfil this broad mandate would require significant administrative capacities. In the longer term, the additional costs may be justified by the opportunity such a broad mandate would offer to ensure climate policy coherency across emissions and removals.

3.2. Purchasing programme portfolio and investment needs

Portfolio: A CDR portfolio refers to the mix of removals from different permanent carbon removal methods purchased. It is a strategic mix of carbon removal approaches aimed at balancing different objectives of a purchase programme, including technology and market development and social objectives, while minimising costs. For illustration, we consider three potential portfolio types: a least-cost portfolio (primarily biochar), a portfolio targeting medium TRL (4-6) technologies, and a more neutral portfolio with equal budget shares for all technologies.

Investment needs: Based on the average cost estimates from the portfolios, we estimate that the total investment requirement to meet the EU's ambition of permanently removing and storing 5 MtCO2-e annually by 2030, is in the region of €2.6-6.1 billion, with the higher bound of €6.1 billion associated with a portfolio that invests solely in removals with medium TRL (4-6) technologies.

Recommendation: Given the uncertainties in technology development, we recommend starting with a broad portfolio that covers a range of technologies. As the direction of technological progress becomes clearer over time, the focus should shift towards market development prioritising cost-effectiveness, whilst still considering other societal objectives, such as energy use, land impacts, and social outcomes. The portfolio and buying criteria established by the purchasing programme should set a best practice standard for private buyers to follow. Ensuring quality, safety, and information sharing should be priorities.

3.2.1. Purchasing programme portfolio

As discussed in Section 1.3, the objectives for a purchasing programme for CDR should be determined based on the broader objectives for permanent CDR in the EU. Four key objectives were identified: supporting technology development, supporting market development, purchasing sufficient high-quality permanent, and ensuring effective and cost-effective public governance.

When developing a purchasing portfolio, these objectives can be weighted and balanced in various ways. For example, if the key objective is purchasing permanent CDR, maximising the short-term quantity of deliveries of the lowest cost removals, the portfolio is likely to be heavily weighted towards biochar. This approach is cost-effective and scalable in the short term but offers limited long-term upscaling potential or support for technology development. Alternatively, if the focus is more on developing CDR technologies and markets, the portfolio could be evenly divided in terms of the money spent or tonnes

delivered per technology group. These approaches would have different results in terms of the total tonnes of CO2 removed (Battersby et al., 2024).

Another approach to portfolio development focuses on the future role of CDR, rather than its immediate impact. The goal here is not to maximise current removal volumes, but rather to identify high-impact opportunities that can accelerate long-term solutions and grow the industry as a whole. This type of high-risk, high-impact strategy has been dubbed a "catalytic" approach by proponents such as Höglund (2025). Here, we see that the focus is not on CDR market development or purchasing a large volume of removals, but rather on the development of specific technologies through targeted investment and purchasing. For example, medium TRL levels could be supported (e.g., 4-6). Such an approach is inherently more complex and management intensive than strategies that equally divide costs between technologies or removals tonnage. Should the purchasing programme pursue a catalytic approach, this may require a rethinking of how targeted support for technological development is currently delivered, drawing on lessons from the Innovation Fund and the European Investment Council.

Additional buying criteria could include scalability (future potentials), or co-benefits (e.g., on biodiversity, resilience, soil health, ownership by local communities). To ensure high quality of removals, the purchasing programme would primarily rely on the Carbon Removal and Carbon Farming Certification Framework Regulation.[35] Additionally, availability of supply should also be considered when determining the portfolio mix, considering what can realistically be purchased now or at envisaged dates in the future when the removals should be delivered. It is quite likely that there will still be limited supply of low-medium TRL removals by 2030. Hence for some technologies, purchase quantities may need to be constrained by how much could realistically be delivered.

The purchasing programme should also consider how many projects or tonnes per project should be procured. For example, in Canada's draft purchasing programme design, they limit the quantity of procured removals to only 500 tonnes per project. Purchasing even small amounts (from many projects) could still have a catalytic impact due to the signal provided that the government purchases from the suppliers. On the other hand, some projects (e.g., CAPEX intensive technologies) may require larger commitments to get the facilities constructed. If this is the case for many CDR technologies, then it may be preferred to purchase larger amounts from a smaller range of projects. Furthermore, larger purchases can support demonstration and testing, which

[35] The purchasing programme could carry out additional due diligence and quality checks, see discussion in section 3.3.5. This will be necessary in the case that the purchasing programme carries out pre-purchases or offtake agreements with carbon removal providers ex ante, at which point the removals will not have been generated and therefore will not have been certified; see 3.3.2 for discussion of purchase timing.

can potentially be more catalytic for technology development. An option would be for the purchasing programme to follow the example of the Innovation Fund and have separate procedures for large and small projects.

The EU should establish buying criteria that other buyers can follow. In addition to the range of TRLs between the technologies, there are many other considerations including costs, mitigation potential, co-benefits, and negative side-effects. Chiquier et al. (2025) investigate the trade-offs between environmental and economic impacts of diversified CDR portfolios. A diversified portfolio can reduce and distribute land or energy impacts, but it may still face challenges related to logistics and accountability. For example, BECCS and biochar have distinct impacts on land, with biochar requiring twice as much (to cultivate bioenergy crops) to remove the same amount of CO_2 (Chiquier et al. (2025). Such land-use pressures, in turn, can have effects on crop prices and thus food security. Impacts on energy are a further consideration, with DACCS and ERW requiring electricity for their operation, while BECCS and biochar produce electricity. Given the wide range of potential considerations and portfolio priorities, the EU could significantly support private buyers by establishing standard buying criteria that other buyers can follow. This means that the EU can lead by example and potentially steer buyers towards purchasing portfolios that align with the EU's objectives for developing the nascent CDR sector.

An important consideration with respect to the choice of portfolio strategy is to consider the "positive knowledge spillovers" that will accrue beyond the direct beneficiaries/technologies. Research and development lead to technology spillovers that have the potential to increase the productivity of other companies or researchers working on similar technologies. Further spillover effects may occur in terms of long-term growth (Bloom et al., 2013); in this way, such a portfolio could support the objectives set out in the Draghi Report and EU Clean Industrial Deal, which aim to foster growth sectors in the EU, particularly in the area of green development. Spillover effects are observed to be especially high for "clean" technologies, which have more general applications and are seen as more novel than incremental ("dirty") innovation (Dechezleprêtre et al., 2013). Finally, scaling up and demonstrating promising technologies and developing a carbon market will lower the price of removals, creating social (co-)benefits that will be experienced across society. Maximising positive spillovers implies a portfolio that targets removal types (and projects and companies) that show most promise for technology development, rather than cheapest short-term options. To promote knowledge spillovers, purchasing programmes can accompany targeted portfolio investments with selection criteria that prioritise companies with open innovation models, or set requirements for sharing intellectual property (Nawaz et al. 2024).

Costs of CDR technologies also influence portfolio mixes, as these determine how many tonnes of CO_2 can be procured from the portfolio given a specific public budget. Conversely, these costs are also needed to determine

the expected costs of achieving a target of removals in tonnes. We rely on estimates from Witteveen et al. (2025), who researched CDR costs; Table 4 provides an overview.

Table 4: Overview of CDR costs by technology (Witteveen et al. 2025)

CDR tech	**Current cost of removal (EUR2023/tCO_2)**	**Estimated cost of removal in 2030 (EUR2023/tCO_2)**	**Estimated cost of removal in 2035 (EUR2023/tCO_2)**
Biochar	**83-251**	*66-215*	*50-175*
BECCS	**172-314**	*167-261*	*163-228*
Other BioCCS (unspecified)**	**55-692**	*44-305*	*37-170*
DACCS	**462-1,256**	*288-567*	*201-402*
In-situ mineralisation	**168-747**	*132-141**	*113-122**
Ex-situ mineralisation	**232-747**	*195-400**	*172-350**
Enhanced Rock Weathering (ERW)	**94-740**	*94-250**	*92-200**
Ocean-based CDR technologies	**38-302**	*No data**	*No data**

*Estimates on mineralisation and ocean-based CDR capacity are highly uncertain due to the early stage of the technology and limited available data on announced projects. Additionally, due to the high-level of uncertainty on estimated current capacities for both mineralisation approaches are estimated provided for both combined instead.

**BioCCS includes technologies such as bio-oil storage, biomass sinking and BECCS to fuel, as well as unspecified BECCS (both fuel and electricity/heat based BECCS).

The portfolio refers to the target purchase mix of removals from different permanent carbon removal methods. The portfolio should balance different objectives of a purchase programme, including technology and market development and social objectives, while minimising costs. When developing a purchasing portfolio, these objectives can be weighted and balanced in various ways.

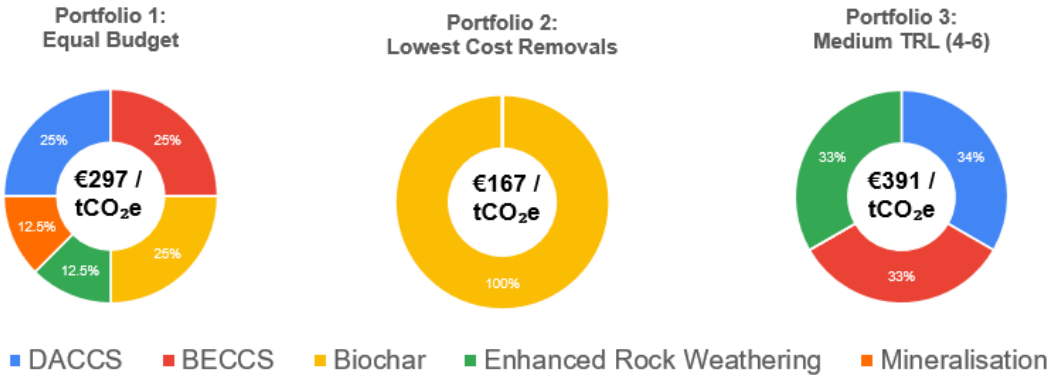
If the key objective is purchasing permanent CDR to maximise the short-term quantity of deliveries of the **lowest cost** removals, the portfolio is likely to be heavily weighted towards a small subset of CDR approaches. This approach is cost-effective and scalable in the short term but offers limited long-term upscaling potential or support for technology development. Alternatively, if the focus is more on developing CDR technologies and markets, and maximising scaling potential, the portfolio could be broader—for instance, **evenly divided in terms of the money spent or tonnes delivered** per technology group. Another option is to focus on **specific technologies**, for example, DACCS, BECCS, and mineralisation technologies with mid-level TRLs. Many other potential objectives exist, reflecting that in addition to the range of technology readiness levels between the technologies, there are important difference with respect to cost, mitigation potential, co-benefits, and negative side-effects.

While the purchasing programme will rely on the Carbon Removal and Carbon Farming Certification Framework Regulation for quality control, portfolio selection allows other policy priorities to be taken into account, including land and energy impacts, or administrative simplicity.

Taking the aforementioned considerations into account, we decided to select three portfolios for illustration[36] (see Figure 3 for an overview):

1. **Equal Budget** portfolio, which divides the portfolio funding equally across technology groupings.
2. **Lowest Cost Removals** portfolio, which purchases the maximum volume of tonnes given a specified budget.[37]
3. **Medium TRL (4-6)** portfolio, consisting of a blend of DACCS, BECCS and Enhanced Rock Weathering, all of which are in the demonstration and development phases.

Figure 3: Overview of three selected CDR portfolios for the purchasing programme in terms of portfolio shares by technology and average costs of the portfolio (own compilation)



For each of the portfolios, we calculate average portfolio costs by taking the midpoint of the cost ranges. Figure 3 illustrates the average costs per CDR portfolio, showing they range widely from €167/tCO_2-e for the lowest cost removals portfolio to €391/tCO_2-e for the medium TRL portfolio. Figure 4 also demonstrates the wide range of potential portfolio costs based on individual

[36] Costs per technology are based on a review carried out by Ramboll in this project (forthcoming report)

[37] This approach purchases 100% of the currently cheapest available CDR technology. This would be dominated by biochar removals in the short-term. We exclude BioCCS and ocean-based CDR due to the wide price range, limited supply, and lack of specificity regarding the range of technologies covered under this umbrella term. Additional CDR approaches could be envisaged for the short-term purchasing programme.

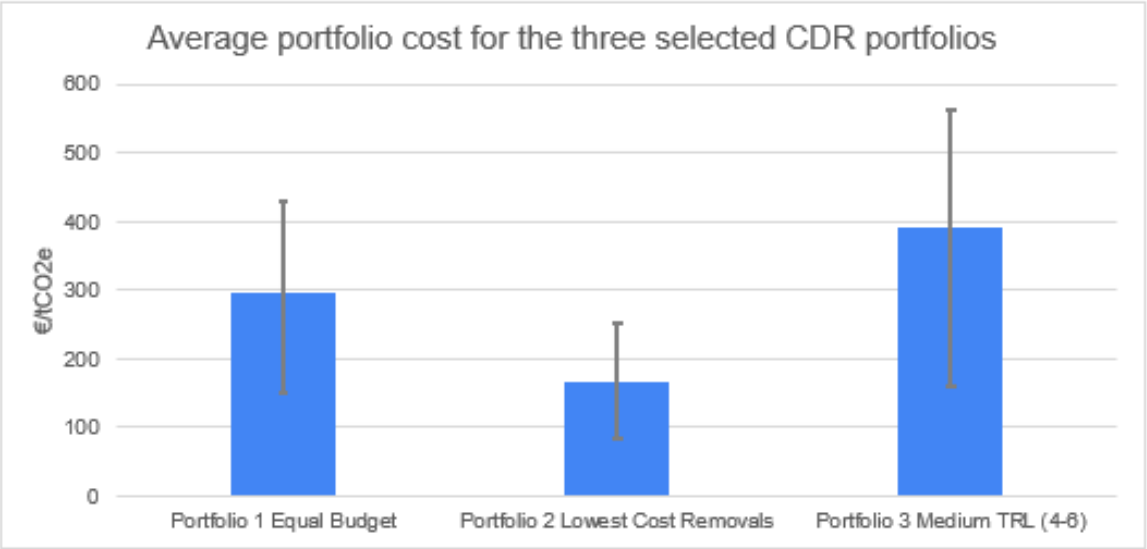
CDR method ranges, showing that there is significant uncertainty regarding technology cost developments. Cost variations include €152-430/tCO_2-e for the Equal Budget portfolio, from €83-251/tCO_2-e for the Lowest Cost portfolio, and from €230-563/tCO_2-e for the Medium TRL portfolio.

The first portfolio distributes funding equally across different CDR technologies defined as permanent removals in the CRCF regulation – including DACCS, BECCS, Biochar, as well as Enhanced Rock Weathering (ERW) and carbon mineralisation grouped together. Each technology family is allocated a quarter of the budget (25% each for DACCS, BECCS, and Biochar, and 12.5% each for mineralisation and ERW). A key reason for choosing this portfolio is that it gives each technology family roughly equal chances and it is relatively quick and easy to implement (with some modifications) alongside the release of the CRCF methodologies. This portfolio has the benefit of supporting the greatest range of technologies—promoting technology and market development.

The second portfolio supports achieving the EU's short-term removal ambitions at the lowest cost. This is achieved by purchasing credits from the cheapest current CDR removal technology, which is biochar. Such a portfolio supports fewer technologies, resulting in less technology development, and increasing risk due to focus on one technology, which also has limits in terms of long term scalability due to e.g. land and biomass restrictions, among others.

The third portfolio focuses on the importance of technology development of carbon removal technologies. This portfolio targets technologies in the development and demonstration phases. By focusing on less mature technologies, this portfolio can generate positive knowledge spillovers and encourage more R&D expenditures to support technologies to move up the TRL scale. Providing such support can help the EU establish lead markets for these technologies, boosting competitiveness.

Figure 1: Average portfolio cost for the three selected CDR portfolios, including ranges for the upper and lower bounds of these estimates (own compilation)



Despite our selection of three illustrative portfolios, there are many other valid reasons for choosing alternate portfolios. Additional priorities could include focussing on companies that already have existing support (public and private); number of active suppliers in the EU; potential for scaling overtime; CDR methods with high permanence; and co-benefits for the surrounding communities. Portfolios could also be aligned with the timing of the EC's release of CRCF methodologies. For example, there may be an initial funding call for DACCS, BECCS and biochar, followed by additional funding for ERW/mineralisation after the methodologies have been approved later (Battersby et al., 2024).

The results of the workshop held on the 21st of May 2025 included many contributions arguing that the short-term purchasing programme should not focus on purchasing removals at the lowest cost today but rather be an innovation policy that focuses on strategically developing technologies. It was also clear from the workshop that there is a need to assess the **social and environmental impacts** of the technologies beyond emissions removed, and that the quality of removals is essential. Portfolios and buying criteria should also be adaptable overtime as innovation of CDR technologies accelerates.

3.2.2. Investment needs and public purchasing programme scale

An important determinant of the ability of a short-term purchasing programme policy to deliver on its objectives is the scale of the policy—particularly its budget and quantity of removals purchased. This depends on the total amount of removals that are needed, the total investment necessary to purchase those

removals, and the share of that investment that is to be met by the public purchasing policy. In addition to its implications for the public budget, the scale of the purchasing programme has implications for policy design. Larger budgets come with greater responsibilities, requiring additional governance. They also offer economies of scale that can support more sophisticated purchasing programme institutions, with greater capacities.

To estimate the investment needs, we take as a starting point the EU's 2030 aspirational objective of permanently removing and storing 5 $MtCO_2$-e annually by 2030, set in the EU Commission's Sustainable Carbon Cycles Communication.[38] We draw on the methodology carried out in Carbon Gap's pilot purchase programme policy brief (Battersby et al. 2024), and calculate the costs of the different example technologies using data on costs per technology from Witteveen et al. (2025), reported in Table 4.[39]

We assume that the EU's permanent CDR capacity will grow continually until 2030, from almost zero today to 5 $MtCO_2$-e of CDR annually by 2030, requiring a gradual scale-up of capacity over time.[40] At present, it is important to note that there is a lack of supply for most CDR technologies. For instance, there are currently no operational DACCS and BECCS plants in the EU. The Stockholm Exergi BECCS plant is not expected to start capturing CO_2 until late 2028. Out of the permanent CDR technologies, only biochar is available within the EU at a large scale currently, with producers in several member states (EBC, 2025). Therefore, at least from 2025-2027, it is not possible to procure large volumes of DACCS and BECCS removals in the EU. Hence, to enable a medium TRL portfolio in the short term, it may be required to make prepayments or offtake agreements for future delivery. For mineralisation technologies such as ERW, the development of robust standards for monitoring, reporting, and verification will likely take time, and the CRCF methodologies may not be available until after 2027. Even then, supply will likely be limited.

As illustrated in Figure 5, based on the average cost estimates from the portfolios, we estimate that the total investment need between 2025 and 2030 to meet the EU's industrial removals target of 5 $MtCO_2$-e by 2030 annually

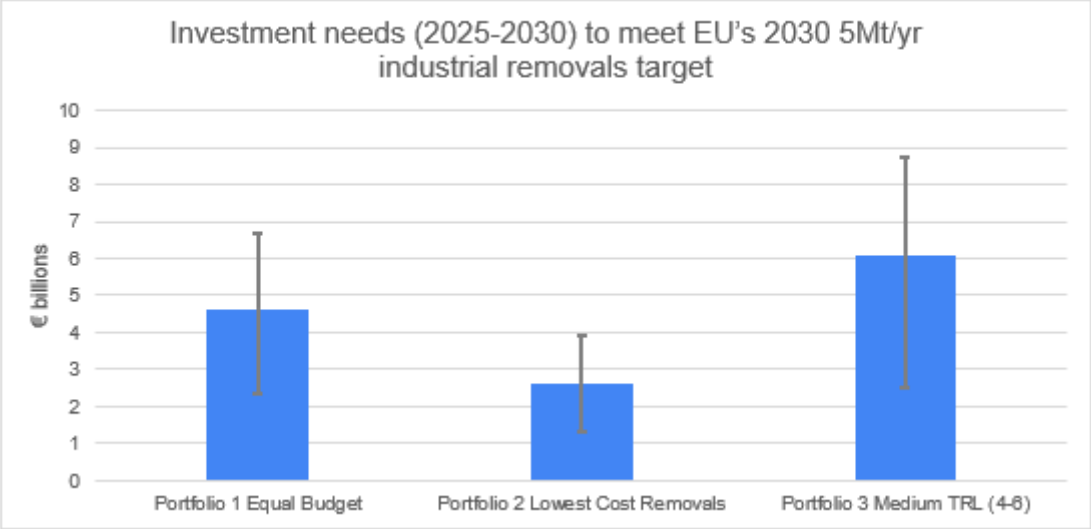
[38] 26c00a03-41b0-4d35-b670-fca56d0e5fd2_en

[39] We assume that current costs remain constant from 2025 until 2030. In reality, it should be expected that there will be some cost degressions for CDR technologies until 2030, as has been estimated for Task 1. Hence, our estimates of total investment needs by 2030 likely represent a slight overestimation.

[40] We assume that the EU implements permanent removals of 0.5 $MtCO_2$-e in 2025, 1 Mt in 2026, 2 Mt in 2027, 3 Mt in 2028, 4 Mt in 2029, and 5 Mt in 2030 (target achievement). The investment need is the cumulative cost of achieving this target in 2030.

ranges from €2.6-6.1 billion, depending on the portfolio selected[41]. If we consider price uncertainty, the range is wider: for example, the investment needed to meet the target through the medium TRL portfolio ranges from €2.5-8.7 billion. The average cost of €6.1 billion associated with the Medium TRL portfolio is high—the remaining demand needs to be filled either through increased private and MS funding, or via the purchasing programme.

Figure 5: Investment needs (2025-2030) to meet EU's 2030 5Mt/yr industrial removals target (public and private financing)



It is a political decision as to how much of these investment needs should be covered by the purchasing programme. In addition to political priorities, this decision should be reached considering the expected other demand for permanent CDR over 2025-2030, e.g. from Member States and the private sector. Since 2020, the EU has already provided €2.3 billion in public funding to CDR and enabling infrastructure (Witteveen et al. 2025). EU Member States have provided some more funding in pilot initiatives. Private demand is also growing, with purchases in the voluntary carbon market (VCM) increasing seven-fold globally in 2023 compared to 2022, though from a small base. Moreover, in the EU, VCM sales of permanent removals (both for immediate or future delivery) have increased from almost nothing in 2021 (0.01 $MtCO_2$-e) to 5.7 $MtCO_2$-e in 2024 (CDR.fyi, 2025; ECNO, forthcoming). Of that, 98% was driven by BECCS, mostly via offtake agreements with suppliers in Denmark and Sweden. Only a small fraction of these removals will be delivered by 2030, as the agreements are usually made for removals to be delivered over a long

[41] Note: this analysis does not consider the investments already made in CDR facilities in Sweden, Denmark and Hungary.

timeframe (e.g., 15 years)[42]. Given current constraints on public budgets, it is clear that current private demand is insufficient, and this will need to increase rapidly to help the EU reach its 5 $MtCO_2$-e target. If the EU maintains its funding at €2.3 billion (like in the past five years) the remaining €3.4 billion (60% of total) to reach the investment needs of the Medium TRL portfolio will need to come from private contributions and MS financing.

3.3. Purchase method

Purchase method: This entails selecting what to purchase, in what quantities, and at what prices, and how and when payments are made. Different purchase methods vary in their ability to incentivise low costs, differentiate between carbon removal types, projects, or companies as well as in their administrative complexity and cost. Accordingly, the purchase method impacts the effectiveness and efficiency of the purchasing programme and its ability to drive technology and market development.

Recommendations: In the short term, the purchasing programme should purchase removals through competitive tendering, which can consider multiple criteria and therefore best make strategic purchases and can also be swiftly implemented. Recognising the different needs of different technologies, different funding rounds should be run for different technologies. Offtake agreements should be employed to provide support before ex-post CRCF credits from lower TRL technologies (e.g. DACCS, BECCS) become available. For early-stage, CAPEX-intensive technologies, offtake agreements will likely need to be made for longer time periods (e.g. 5-years+), due to the time required to construct the facilities.

In the medium term, the purchase method should shift to Carbon Contracts for Difference, with subsidies allocated through a reverse auction. This will increase cost-effectiveness of the purchasing programme but relies on a clear reference price for carbon removals, which will depend on compliance market integration.

The central activity of a purchasing programme is to purchase permanent carbon removals. This entails selecting what to purchase, in what quantities, and at what prices, and how and when payments are made. It is envisioned that an EU purchasing programme will primarily purchase permanent carbon removal units certified by the CRCF. Nevertheless, decisions still need to be made regarding the specific purchasing approach, differentiating between permanent removal units, the timing of purchases, and other factors. In this

[42] Despite biochar removals representing almost all (94%) of removals implemented in the EU to date, this technology is not seeing high levels of investment towards 2030 (CDR.fyi, 2025; ECNO, forthcoming).

section, we consider the needs of different CDR technologies, the potential timing of purchases, and identify purchase method options and key considerations when selecting between them. We also consider additional services that a purchasing programme can offer to support the development of CDR technologies and the market for permanent CDR. Issues related to EU procurement rules (including state aid regulations) and the ownership of credits are discussed in section 3.6.

3.3.1. Different needs of different CDR technologies

To ensure that the purchasing programme achieves its goal of not only purchasing carbon removals, but also to drive technology and market development, **different purchase methods and additional services may be appropriate for different types of CDR.** This reflects that different types of CDR technologies have different access to the funding and financing they need to scale up. Demand from a purchasing programme can be an important source of funding, and influence CDR projects' ability to raise finance. This has implications for the type of purchase approaches that will best support different CDR technology and market development, and the types of additional support they require. [43] Key determinants for CDR technologies' access to and need for funding and financing are their TRL level, the scale of upfront capital investment required to realise projects, and their ability to capitalise on other revenue streams (e.g. electricity or heating).

A CDR method's technology readiness level (TRL) is an important indicator of the method's needs. For example, low technological readiness level technologies (e.g., first of a kind DACCS facilities) pose greater risk of non-delivery for buyers, meaning there is a greater need for targeted support and de-risking mechanisms during an initial market-and-technology building phase, as these companies are less capable of obtaining cash flows. For a purchasing programme, the uncertainties posed by these more novel permanent CDR types may also demand more involved purchase approaches that include more detailed assessments of offers. Technologies with higher TRLs (e.g., biochar) do not pose the same risks. For these higher-TRL credits, a purchasing programme should focus more narrowly on the direct procurement of credits, using simpler and lower cost purchase approaches that focus on cost-effectiveness and market development, rather than potentially distorting competition through targeted approaches. Even though no permanent CDR technologies have reached commercialisation TRL levels yet, the more mature technologies already have a stronger track record of obtaining cash flows from

[43] In this section we focus on additional services related to boosting demand for permanent carbon removal credit purchases. Carbon removal companies also face challenges supplying credits, which should also be addressed through additional policy interventions. Discounted loans, investment guarantees, and other policy options may be appropriate; they are discussed in detail in Marton et al (2025).

credit sales and relatedly will face fewer challenges obtaining financing. As these technologies mature over time, the purchase method may shift to treat all technologies equally, prioritising cost-effectiveness.

A second key difference between different CDR types is the scale of upfront investment required to realise projects. The financing scale required is also significant when determining the appropriate purchasing method—particularly whether a technology is CAPEX (capital expenditure) or OPEX (operating expenditure) intensive. CAPEX-intensive technologies require greater upfront expenditure, which may pose challenges for purchase approaches and create requirements for additional services. For example, upfront CAPEX investment for a BECCS plant can range from USD 100 million (€92m) to USD 5 billion (€4.6 billion), whereas upfront investment required for biochar can range from USD 1-10 million per pyrolizer (ClimeFi, 2024).

To get a sense of which technologies require targeted support, and of the financial scale involved, it is worth considering the technology readiness levels and relative CAPEX/OPEX intensities of the CDR approaches. Drawing on Marton et al (2025). DACCS is the most CAPEX intensive, with its large upfront costs to build facilities relative to its (also significant) operating costs, which are primarily electricity and water feedstock but also transport and storage of CO_2. BECCS is also CAPEX intensive, requiring large upfront investments; however, the sourcing and transporting of biomass also represents a significant operating expenditure for BECCS. Biochar requires significant CAPEX to be established, but the OPEX for biomass feedstock and transport represent the most significant cost components. OPEX represents most of the expenditure for Enhanced Rock Weathering (ERW) and several ocean-based approaches (e.g., ocean alkalinity enhancement), where costs are concentrated on the collection and transport of the feedstock materials.

Alternate revenue streams can make it easier for permanent CDR technologies to obtain revenues and financing. For example, electricity revenues from BECCS facilities can offer a stable, predictable revenue stream, forecasted on established markets for electricity. Biochar product sales can also be forecasted, as there is a longstanding market for this as a soil amendment. Biochar could also be used in construction in the future, with a variety of potential uses (e.g., as a concrete additive or insulation material) currently being researched. Biochar and BECCS can also deliver heating. However, other technologies that are mostly reliant upon revenue from sales of carbon removal credits (e.g., DACCS and ERW) may be more reliant on long-term solutions (e.g., offtake agreements). It may also hold that for a purchasing programme, these technologies require long term commitments from governments to become viable.

CAPEX-intensive removal technologies are often characterised by having only a limited number of suppliers in the EU. It is therefore important that the selection process inherent within the purchasing method is rigorous. The risks

are again lower for OPEX-intensive technologies that are more distributed by nature and therefore have more suppliers.

Addressing different CDR technologies through separate calls or purchase rounds can help address their different needs. Given the substantial cost differences between technologies, including these all under one funding call may disproportionally favour technologies with the lowest cost—failing to support early stage, high potential technologies. To provide this targeted support during the initial technology-building phase, it may be preferable to run separate calls for separate technology groupings (e.g., for each CRCF technology). For example, different CDR technologies could be purchased in separate rounds, e.g., one week for the purchasing of DACCS units, another week for BECCS, and another for biochar, etc. Some technologies could be grouped together if they have comparable costs and associated risks (e.g., permanence). This model has been applied for renewable energy auctions. The timing of these rounds could also be linked to the staggered release of CRCF methodologies, with the first round of purchases for carbon removal technologies that have the earliest approved CRCF methodologies, and later rounds organised when additional CDR technology methodologies are approved.

3.3.2. Timing of purchases

A key design question for the purchasing of CRCF-certified removals is the timing of purchases. Three options are available, each of which have different strengths and weaknesses.

- **Pre-purchase agreement:** The purchasing programme pays a CDR supplier upfront in exchange for a commitment from the CDR supplier to deliver carbon removal certificates in the future. However, pre-purchase agreements pose risks for the regulator, particularly the potential failure of suppliers to deliver the agreed removals–for example if the company goes bankrupt[44] or if the company is too optimistic in its calculation of the technical potential when making the agreements. If the EU enters into pre-purchase agreements with suppliers, it may be necessary to include liability mechanisms to lower the financial risk for the EU. For example, penalties could be introduced for non-delivery, which would encourage compliance with the agreement but may also discourage participation in the purchasing programme. A strength is that pre-purchase agreements can provide CDR suppliers with upfront funding and liquidity in the short term to invest in production facilities, which can be particularly important to support the technology and market development of high CAPEX and low TRL technologies. Pre-purchase agreements also enable the buyer

[44] Running Tide is an example of an ocean-based CDR company who went bankrupt after making offtake agreements with large corporate buyers including Microsoft and Shopify.

to receive a discount relative to ex-post payments, which, as Supercritical (2025) report for the biochar market, can range from 19-31% (Supercritical 2025).

- **Offtake agreement**: The purchasing programme makes a contractual agreement with a CDR supplier, agreeing to buy a specific amount of future CDR credits at a specific price at a specific time in the future, with the payment made on delivery. Offtake agreements can include additional elements, including conditions, warranties, ranges, etc. (Tech for Net Zero 2024). These agreements typically occur before the construction of the production facility, providing the supplier with a guarantee for the project's economic future that can be used to obtain financing from banks or other investors. Compared to pre-purchase agreements, offtake agreements pose fewer risks for the purchasing programme, since suppliers only get paid once the agreed carbon removals are delivered. A downside of offtake agreements and pre-purchase agreements is that these agreements can switch the suppliers focus away from R&D towards securing the agreed removal quantities, hindering technology development. This is a greater issue for immature technologies like DACCS than more mature technologies like BECCS and Biochar, that are more about execution and less about R&D (Höglund, 2025). The purchasing programme should consider offering some degree of flexibility to suppliers to adjust or deviate from their offtake agreements, to reduce supplier risks and avoid creating barriers to participation. A combination of base offtake price and additional payments for delivery on time could be considered.
- **Ex-post payments:** The purchasing programme purchases CRCF credits once the removals have occurred and have been certified. This payment approach is the simplest and most straightforward method for the purchasing programme, with no risks related to non-delivery, and no requirement for agreements or contracts beyond purchases of the CRCF credits. However, it is unlikely to be sufficient to swiftly develop CDR technologies with low TRLs and high CAPEX requirements, as these technologies may struggle to secure the necessary financing without pre-purchases or contractual agreements to buy future deliveries. Accordingly, ex-post payments are most appropriate for high-TRL technologies.

Combining different payment timings is also possible. For example, offtake agreements could be established with a share (e.g. 25%) paid upfront, balancing the suppliers' needs for funding and liquidity. This ensures that they can invest and develop their technologies and infrastructure so that they can deliver carbon removals in the future but poses additional risks for the purchasing programme.

Recommendation: To drive removals from approaches with relatively low TRLs, such as DACCS and BECCS, the purchasing programme will have to

provide some security in the form of offtake agreements, at least in the short term. Workshop participants expressed a clear preference for the use of offtakes. Supply of these CRCF units is likely to be limited for several years, until 2028 at the very earliest when the Stockholm Exergi BECCS plant becomes operational (ECNO, 2024). For other more mature and abundant permanent CDR approaches (such as biochar), exclusively purchasing ex-post CRCF units will be simpler and lower cost. As low TRL technologies mature, the purchase timing for these technologies can also shift to ex-post purchases.

3.3.3. Defining purchase methods

Purchasing programmes can carry out their purchases using several different approaches. We consider five options:

1. **Competitive project-based tendering** involves individual projects competing for funding, in exchange for providing units to the government at agreed date(s) in the future.
2. **Reverse auction**: tendering procedure where the removals contracts are awarded to the cheapest qualifying bids until the budget is exhausted.
3. **Flat rate price**: The purchaser commits to purchasing any number of removals that can be delivered at a given, pre-determined price.
4. **Carbon Contracts for Difference (CCfDs)**: the purchaser commits to purchase removals at an agreed minimum price (strike price) in the future, if the market price at that point in time is below the minimum price.
5. **Equity investment and public ownership**: The purchaser provides funding in exchange for partial ownership or shares in a project or company.

Each of these approaches can be adapted to meet the different needs of different CDR technologies, while different purchase methods imply different timings for payments, as we describe in more detail in this section.

Competitive project-based tendering

Competitive project-based tendering in the context of permanent CDR involves individual projects competing for funding in exchange for providing units to the government at agreed point(s) in the future, for example when the facility becomes operational. Suppliers submit closed bids to the purchasing programme. These are then judged by the purchasing programme, based not only on the price per tonne removed but also additional criteria. Possible criteria for determining the successful bidder(s) include the price, quality, permanent

removal type, as well as broader criteria such as potential for regional development and job creation. The procuring authority is in return guaranteed a volume of carbon removals to be purchased, at the price proposed by the successful bidder(s). Separate tenders can be run for different technologies, in order to ensure a diverse portfolio. Competitive tenders are generally run ex ante, before removals are delivered (or investments confirmed), and are therefore most appropriate for pre-purchase or offtake agreements.

A modification of the competitive tendering option is to provide “prizes” to the successful bidders, where the prize takes the form of a purchase of removals units from the winner. This model has been applied in the US with its purchase pilot prize, which had multiple rounds with different requirements and assessment criteria at each stage, aiming to foster technology development in multiple carbon removal technologies (US DoE, 2024).

Reverse auction

In reverse auctions, the purchase programme defines the quantity of removals (i.e. CRCF permanent carbon removal units) that it will procure and/or the budget for purchases. Suppliers that meet prequalifying criteria[45] then make bids, specifying the volume and price of removals they can provide. Reverse auctions can have open bids, incentivising suppliers to offer lower prices. The procuring authority then selects winning bidders, starting with the lowest price offers until the procuring authorities CDR quantity target has been met (or the budget is exhausted). The ‘reverse’ aspect refers to the auctions structure, where multiple sellers compete to sell to a single buyer, rather than the other way around.

Reverse auctions can be structured in many ways. For example, it is possible for the auctioneer to select winners based on their marginal abatement costs (rather than setting a fixed quantity cap), to avoid efficiency losses arising when the supplier bids at the price point where the cap is reached and hence cannot sell all of their removals (Fridahl et al., 2024). The length of contract is another important design choice–shorter contracts involving high capital costs typically result in higher per tonne costs, however, longer contracts involve greater uncertainties on the price development of inputs (Fridahl et al., 2024).

The Swedish BECCS support scheme provides an example of a reverse auction for permanent CDR. The Swedish government has allocated €3.6 billion to the auctions targeting BECCS operators, paid over the period 2026–2046. The scheme allows suppliers to also benefit from carbon credit sales, though this is then factored into the decision of the subsidy that is paid. Fridahl et al.,

[45] Possible pre-qualifying criteria could include, for example, project size, CDR technology, CRCF criteria.

(2024) explores the different options for reverse auctions and evaluates their strengths and weaknesses in the context of the Swedish BECCS example.

Similarly for competitive project-based tendering, it should also be possible to have separate calls for separate technologies under the reverse auction format. If this means that there are few suppliers per technology, the reverse auction may not be an efficient purchase method, as there would be limited competition to drive the price down.

Flat-rate price

A flat-rate price involves the purchaser committing to purchase any number of removals that can be delivered at a given, pre-determined price. The available subsidy is unlimited, or until the available budget is exhausted, and is awarded on a first-come, first-served basis. The purchaser sets an equal price per tonne of CO_2 paid to all suppliers who meet defined quality criteria. It may also be possible to differentiate flat-rate prices between different types of CRCF units, with different rates set for different CRCF activities. Flat-rate prices operate as a price floor for CDR suppliers, increasing revenue certainty and decreasing investment risk. They are payments ex post, though if there is confidence that they will continue into the future, they can also be equivalent to offtake agreements.

Similar to a Feed-in-Tariff (FiT), the flat-rate price could be agreed on through a long-term contract, potentially drawing on experiences with procuring renewable energy. For example, these contracts could contain mechanisms to adjust prices overtime (Meyer-Ohlendorf et al., 2023). Denmark has these mechanisms in place for subsidies from its CCS fund.

Flat-rate prices can also be delivered in the form of tax credits. An example of this for CDR can be seen in the 45Q tax credit in the US, providing USD 180 per tonne of CO_2 for all DACCS plants. This policy enables removers to generate a removal, receive a tax credit, and sell the carbon removal in the voluntary carbon market. This lowers costs for carbon removers (and buyers, as it acts as a subsidy), and also reduces remover risk, as they have a guaranteed tax credit regardless of whether they can sell the permanent carbon removal. Luxembourg is considering a CDR flat-rate subsidy, where suppliers can enter projects with the government and benefit from payments granted per ton of CO_2 captured and stored durably during the term of the contract (Meyer-Ohlendorf et al., 2023). A key design question for flat-rate pricing is whether the government wants to procure the units to bank for its own use or reduce production costs to the point where the units can be purchased by private companies on the voluntary carbon market. If the answer is the former, tax credits may not fulfil this role. If the priority is the latter, then tax credits could be desirable (Meyer-Ohlendorf et al. 2023). Given the European Union's very limited tax base (unlike USA, or Member States), and the challenges posed by the requirement for

unanimity in the European Council for tax proposals, a tax credit does not seem appropriate at the EU-scale.

Carbon Contracts for Difference (CCfDs)

A more complex purchase approach is offered by Carbon Contracts for Difference (CCfD). In this model, the purchasing programme commits to purchasing removals at an agreed minimum (strike price) in the future if the reference price falls below this level over the duration of the contract. A key challenge with CCfDs is establishing the reference price, which requires a functioning removals market to determine it. In the context of renewable energy production, the reference price is often based upon carbon market prices (e.g., EU ETS unit price). The strike price is then determined based on expected production costs and market prices for carbon. If ETS market prices are too low to effectively incentivise renewable energy (i.e., market prices for electricity are below the strike price), then the CCfD tops up the price received by suppliers, for as long as the market price remains below the strike price. Different CCfD reference prices could be established for different types of carbon removals. CCfDs are particular types of offtake agreements, with payments made on delivery of removals.

There is currently no compliance carbon market price for permanent carbon removals, so no obvious reference market price. Even though a voluntary carbon market could potentially be used to establish a reference price, there currently is no voluntary carbon market specifically tied to EU carbon removals. This differs from other current examples of CCfDs in sectors like hydrogen and renewable energy, where there are established products with significant underlying market value. Moreover, using voluntary carbon market prices as a reference point is complicated by the lack of transparency in the VCM. Furthermore, it is also unclear what impact CCfDs would have on the VCM. Removers would be willing to sell removals units for lower market prices (as they would be topped up by the contract for difference). This should increase private quantity demanded of carbon removals but may raise issues of non-additionality.

Hence, CCfDs are likely more of a medium- to long-term option for the EU, to be implemented once a removals market is better established, whether this is through integration into the ETS, carbon removals obligations, or a more established voluntary carbon market for removals. One option to get around these challenges and provide support in the short term would be for the CCfD to activate only when there is a compliance market for removals in operation: in this situation, the purchasing programme would pay in the future the agreed strike price minus the compliance market price (i.e. the CCfD). In the case that in the future, no compliance market exists, the purchasing programme would be obliged to pay the full value of the agreed strike price for the volume of

removals specified in the procurement contract. This approach could be a feasible commitment mechanism for the EU to create a market for removals.

An important design feature for CCfDs is that when the market price of the removal rises above the strike price, the purchasing programme is (or can be) compensated by the supplier (two-way CCfD), e.g. the supplier sells CRCF credit at the market price but if this is in excess of the strike price, some or all of this difference is paid to the purchasing programme. By reducing risks, this design can be attractive to both the purchasing programme and the CDR supplier, even if it limits the potential profits made. It provides revenue stability for suppliers, lowering financial risks for investors. It also provides the purchasing programme the opportunity to receive some money back from the policy, which could help ensure public acceptance, and increase the purchasing programme's ability to purchase additional removals in the future. Two-way CCfDs have been applied in the UK context for renewable energy (UK Government, 2017). In Sweden, a reverse auction model for carbon removals is used where companies bid to provide removals at the lowest cost, the strike price is set competitively, and ex-post mechanisms allow excess payments to be recovered to avoid overcompensation. On the other hand, given the early stage of the permanent CDR sector in the EU, it may also be considered to provide firms upside chances (and thus higher profit incentives) by not requiring suppliers to pay back the difference when the market price exceeds the strike price. This is the approach of H2Global's Hintco scheme to ramp-up clean hydrogen (H2Global, 2025).

Studies have noted how CCfDs could be introduced as a mechanism to scale CDR (see e.g., Mistry et al., 2024; La Hoz Theuer et al., 2021; Tamme and Becks, 2021). However, no concrete proposals exist on how this might look in practice, nor studies on whether CCfDs would be preferable to other purchasing methods. Carbon CfDs are already in force in the Netherlands for CCS and CCU technologies (up to €400/tCO2) tied to the EU ETS price. However, these technologies are for emissions reductions, not removals (for more info see IEA, 2022 and Netherlands Enterprise Agency, 2020). CCfDs have also been implemented in Denmark under the CCS fund and are being prepared in Germany and France (DG CLIMA, 2022). The UK is also considering a CCfD design for carbon removals where the reference price could be linked to either the UK ETS or the voluntary carbon market (UK Government, 2023).

Equity investment and public ownership

An alternative approach that can also support permanent CDR upscaling is through equity investment in a company, providing a source of funding rather than directly procuring CRCF removal units. With this approach, the purchaser provides funding in exchange for partial ownership or shares in a project or company, with the expectation that the project or company will generate removals within the EU in the future and giving the purchaser (e.g. the EU)

governance and profit-sharing rights. This equity investment could range from partial ownership of commercial companies, publicly owned companies run as for-profit companies, to fully publicly owned permanent CDR projects or companies. The purchasing programme could take multiple forms, whether as an investment vehicle with for-profit objectives (such as the example policy option described in 2.3.3), or the form of a public agency that receives dedicated funds to generate (rather than purchase) carbon removals on behalf of the EU. Equity investment could be made across a diverse range of CDR technology companies or projects, to balance against risks and support development of multiple technologies. In terms of purchase timing, equity investment offers some of the same risks and benefits as pre-purchases of CDR.

France's longstanding ownership of Électricité de France (EDF), which operates its nuclear plants, provides an example of how equity investments can allow a government to support strategically important industries, providing capital to scale operations but also enabling the government to benefit from the success of the company or technology, whether through low-cost provision of services or goods or shares in any financial returns if the technology becomes commercially successful. Another example is offered by the US DOE's Office of Environmental Management, which carries out environmental cleanups on behalf of the US federal government, with a dedicated mandate and budget (Larsen et al. 2019).

3.3.4. Key considerations and risks and opportunities of different purchasing methods

Different purchasing methods for permanent CDR offer distinct advantages and disadvantages, depending on their specific design, making them more appropriate for different phases of CDR development and implementation. For an overview, see Table 6 below.

Key strengths of competitive project-based tendering include the option to purchase based upon multiple criteria, such as price, quality, potential for regional development and job creation as well as other sustainability aspects. Through this approach, the procurer can differentiate between different types of permanent carbon removals, enabling the procuring authority to achieve specific objectives of the purchasing programme. Furthermore, competitive project-based tendering may be better suited to a new, under-developed market, as it may offer **greater security to sellers** (who may receive upfront project funding or purchase commitments before they make significant investments, rather than relying on uncertain CRCF credit purchases ex post). They can also provide information to purchaser, which may be valuable early in market development. A key benefit of competitive project-based tendering is that it can be implemented very quickly, for example using procedures already

implemented by the existing Innovation Fund, potentially providing support to technologies even before CRCF credits are released from the registry.

Competitive project-based tendering imposes moderate administrative costs. On the one hand, there is already a well-established evaluation procedure under the Innovation Fund that can be immediately used. On the other hand, a significant amount of time is still required to set criteria and evaluate proposals based on these. The purchaser can face **financial risk** of potential supplier default, though liability mechanisms can help to manage this risk, as can a careful approach to avoid overreliance on expensive projects when supply is limited. The Innovation Fund already has a procedure for assessing the financial maturity of projects, which is a key criterion for the awarding of a contract. In some cases, the Innovation Fund also requires that projects obtain guarantees beforehand. For example, to apply for the European Hydrogen Bank auctions under the Innovation Fund, there is a requirement for projects to secure guarantees of 8% of the maximum grant amount from a financial institution (EGEN, 2025). Additional financial guarantees by Member States are also possible under the Innovation Fund.

Reverse auctions offer potential efficiency benefits by incentivising suppliers to bid at prices close to the marginal cost of production, which is helpful when the regulators lack knowledge of production costs (Fridahl et al., 2024). This approach **lowers the financial risk for purchasers**: a greater share of the risk remains with the supplier, which will mean (in the optimistic case) cheaper removal units than competitive project-based tendering. Reverse auctions also **lower the administrative burden** as the contracts are won by the cheapest bids, rather than carrying out multi-criteria assessments. Considering these relative strengths, Bowman et al. (2023) argues that reverse auctions are the optimal tool for CDR procurement.

However, reverse auctions do pose some risks. For example, the **emphasis on low cost can come at the expense of quality**, resulting in the procurement of low-quality CDR if quality standards are not enforced. While the quality of CDR should be ensured by the CRCF, a purchasing programme may have additional criteria that go beyond the quality requirements the CRCF establishes (e.g., strategic focus on particular technologies, projects or companies judged to have offer most significant technology and market development potential, geographical distribution). Moreover, reverse auctions may stifle innovation by favouring established, cost-effective technologies over novel approaches that may have higher initial costs but greater long-term potential. One solution to this issue is to use competitive project-based tenders for more novel technologies, while purchasing mature technologies through reverse auctions. This could also evolve over time: it may therefore be preferable to start with project-based tenders using existing procedures until technologies have reached higher maturity levels, before introducing separate reverse auctions for different removal technologies, which would enable different prices to be established for different technologies. Another risk of reverse auctions is that, by focusing on

the procurement of units instead of projects, there is a greater **risk that projects are not built** in the first place, leading to price increases. A final issue is that large-scale technologies such as BECCS and DACCS face additional challenges in this framework, as they may need to bid for suboptimal capacities to fit auction constraints, causing potential efficiency losses (Fridahl et al., 2024). Encouraging broad participation while maintaining fraud prevention and quality control is essential to ensure the success of this method. While reverse auctions can establish entry criteria, this is a less effective way to select CDR purchases with multiple criteria than competitive tendering.[46]

It is likely possible for all purchasing methods (apart from equity investment) to have separate calls for separate technologies, though with varying degrees of administrative burden. Separate procedures would likely be easiest for competitive tendering, where less needs to be defined before issuing the call in comparison to other purchasing approaches. The purchase pilot prize option for competitive tendering provides support to a range of high TRLs through a competitive process. Reverse auctions on the other hand require specifying tons (or budgets) to be procured for several calls. This requires detailed knowledge of available EU supply per technology grouping. Similarly, for CCfDs and to a lesser extent flat-rate pricing, knowledge of current supplier costs is necessary to set purchase prices. Lastly, equity investment can support a range of technologies, for example by investing in VC portfolios that have diverse holdings in CDR companies.

Carbon Contracts for Difference (CCfDs) are an appealing option for both suppliers and procuring authorities. By guaranteeing a minimum price, CCfDs provide **revenue certainty** through long-term demand signals for suppliers, reducing investment risk and establishing a minimum price for removals. CCfDs encourage the development of high-risk, early-stage technologies that require market support. CCfDs **lower financial risks** for suppliers from carbon market volatility. CCfDs also have the potential to **lower fiscal costs for governments**, as suppliers may return surplus revenue if carbon prices exceed the strike price, creating a net potential net income.

The primary challenge of requiring a reference price for removals is the reason why **CCfDs will likely only work well alongside ETS integration**, or another type of compliance removals trading system (e.g., removals obligations). When applying for CCfDs, typically there is a lower competitive incentive due to the production price guarantee. Competitive bidding on strike prices (e.g., through auctions) could help address these concerns but may reduce the stability and predictability that make CfDs attractive to suppliers in the first place. Given the

[46] Reverse auctions should be strict enough to keep fraudulent or unserious suppliers from bidding but should avoid imposing so many barriers that reduces competition and undermines efficiency (Fridahl et al., 2024). However, too stringent entrance criteria can reduce the number of participants and the efficiency of reverse auctions. Strict entry requirements favour large incumbent

significant cost differences between different types of permanent removals, and the need to ensure scaling of immature but high potential technologies, there may be a need to provide different CCfD subsidy levels for different technologies. **CCfDs could potentially be implemented using reverse auctions**, where the cheapest bids win the CCfDs until all the tonnes have been exhausted. Separate auctions and CCfDs could be implemented for different technologies with different strike prices available. This represents a cost-effective way forward for supporting removal technologies. However, it is a complex mechanism that requires significant work with setting strike prices and auction rules. It is therefore only logical to implement such a mechanism under a sufficiently large purchasing programme that makes this work worthwhile. To determine whether a complex purchasing mechanism should be justified, investment criteria could be defined for the purchasing programme. For example, what are the available funds, and what are the price points for privates to engage.

Flat-rate pricing offers a **straightforward and transparent** approach by setting a pre-determined price for all qualifying removals. This method has a **lower administrative burden** than competitive tendering approaches and provides suppliers with clear revenue expectations which encourages investment. It is relatively easy under this approach to set the same price for all technologies, or separate prices for separate technologies. It is possible for several purchasing methods to be combined in the calculation of a subsidy rate. As an example, the Danish CCS fund bases its subsidy level depending on EU ETS prices as well as revenues obtained through the sale of carbon credits on the VCM. Designing a flat-rate price like a feed-in-tariff, where rates are guaranteed over long-term contracts, can be better tailored towards a variety of technologies. However, these schemes can be expensive, distort market signals and be challenging to set appropriate prices over long periods. It requires balancing market rates, production costs, and policy goals. Misaligned rates could either overcompensate suppliers, wasting public funds, or fail to attract sufficient participation, hindering permanent CDR development. Adjusting flat rates over time to reflect changing market conditions adds another layer of complexity, particularly as this approach fails to reveal cost information. On the other hand, flat-rate systems are less likely to conflict with international procurement rules under the WTO or EU state aid rules (discussed in section 3.6.3).

However, flat-rate pricing has significant weaknesses due to the high burden placed on the public budget and their lack of targeting. Offering flat-rate subsidies through long-term contracts can support a variety of carbon removal technologies with different price points but setting and adjusting the prices overtime can be costly. This can also come as a large expense to the

public budget, where it would be preferable if linked to the carbon market through a CCfD so money can be returned if carbon prices rise substantially.[47]

Equity investment is a significantly different form of "purchase method", making direct comparison with other methods challenging. It offers significant potential benefits in the form of public-ownership of public-good generating projects and companies. However, at the EU level, examples of such forms of public ownership are relatively limited, with the exception of the EIC Fund, the venture arm of the European Innovation Council.[48] There are many more examples of Member State public ownership, including e.g., utilities. This can offer advantages in terms of public governance and alignment of carbon removals with broader societal objectives.

Both the competitive project based tendering and reverse auction approaches are able to **incentivise removals at the least cost** (static efficiency), since they encourage suppliers to decrease their bids in competition. The flat-rate price may not incentivise production cost decreases as much due to the lack of competitive bidding for the subsidy. Similarly, standard CCfDs faces the same challenge, though they can be designed to allocate subsidies competitively. Competitive project-based tendering and reverse auctions offer more potential to reward operators close to the marginal costs of deployment, hence revealing knowledge of production costs and lowering the risk of overcompensation of public money (Fridahl et al., 2024).

A key benefit of the project-based tendering, reverse auction options, and flat-rate pricing options is that they work in absence of (or ahead of) a well-functioning removals market (e.g. ETS integration or some form of removals market), which is required for CCfDs. It is also unlikely that such a market will exist within the next 5 years. Given that the most effective flat-rate pricing option, tax incentives, is not possible in the short term, it is logical to start with competitive project-based tendering and reverse auctions in the first technology building phase. There is a risk of overcomplicating the procurement process with multiple purchasing methods. This would only make sense if the procurement purse were sufficiently large. While CCfDs and reverse auctions represent the most efficient options, they will be difficult to implement in the immediate term but will become more attractive once carbon removals markets are established.

We recommend starting with competitive project-based tenders while carbon removal technologies are still at relatively low maturity levels. This

[47] In the case of tax credits, it will likely be infeasible to implement a flat-rate subsidy at the EU level due to constraints on spending and the need for agreement across Member States. Nevertheless, this could be a feasible technology-neutral option for Member States to incentivise carbon removals.

[48] More information on the EIC Fund can be found online at https://eic.ec.europa.eu/eic-fund/about-eic-fund_en

approach allows for the inclusion of multiple criteria and policy objectives, which is particularly important for permanent CDR. It was also the generally preferred option at the workshop (alongside carbon contracts for difference). Other instruments are less attractive in the near term due to their relative complexity or limited ability to differentiate effectively between early-stage projects and companies. Looking ahead to the medium and long term, assuming the introduction of compliance market incentives (e.g., through ETS integration or a removals obligation), we recommend transitioning to reverse auctions combined with CCfDs. This would help ensure the cost-effectiveness of the purchasing programme while maintaining adequate incentives for high-cost carbon removal technologies that may not yet be competitive with expected market prices.

Table 5: Evaluation of purchasing methods

Design Considerations	Competitive project-based tendering	Reverse Auction	Carbon CfDs	Flat-rate price	Equity investment
Administrative complexity of the tool (and admin costs)	Medium: complex and time consuming to evaluate proposals	Medium: cheapest offers win the bids	High: need to select the strike price and assess the price differential across time	Low: simple transparent subsidy for removals. Less conflict with state aid and WTO rules	High: Buyer must identify funds, companies and is involved in ongoing management
Fiscal burden / cost to the regulator of support	Medium: competitive process but with a financial risk from potential supplier default	Low: risk of financing upfront costs remains with the supplier	Low: possibility of net income for government.	High	Medium: ability to earn profits but comes with financial risk
Does the method require carbon market integration/removals market	No	No, but could be used to allocate CCfDs, which depend on integration	Yes: removals need to have a price and may need to be permitted for compliance uses	No	No
Ability to differentiate between different types of projects, ensuring quality of removals	High: can evaluate based on multiple criteria	Low	Low	Low	Medium: can invest in particular firms and then influence their removal supply
Appropriateness for supporting different technologies	High: Scope to support a range of technologies through selection criteria	Medium: Approach favours cost-effectiveness over innovation support	Medium: Detailed auction rules need to be determined for each call (i.e., strike price)	Medium-high: Flat-rate subsidies require specifying rates per technology	Medium-high: could invest in climate diverse portfolios in CDR, but administratively costly

Design Considerations	Competitive project-based tendering	Reverse Auction	Carbon CfDs	Flat-rate price	Equity investment
Risk sharing (which supplier risks are potentially covered by the instrument, which not)	Upfront costs and demand guarantee for output	Demand guarantee for output	Demand guarantee for output	Upfront costs and demand guarantee	Low: Investment focussed on few projects (which may or may not be lowest cost)
To what extent does the method deliver least costs / drive down future costs	High: incentive to provide lowest price in offer	High: incentive to provide lowest price in offer	Medium	Low	Unclear

3.4. Additional services, including de-risking mechanism

Additional services such as guarantees, pooling of removals, and transparent reporting can be cost-effective tools to reduce buyer risk and crowd-in private and other buyers. Longer-term policy certainty will be most decisive but is beyond the scope of the purchasing programme.

Additional services offer **cost-effective tools to reduce buyer risk and crowd-in private buyers** and should be employed, building on existing approaches employed in the Innovation Fund. We **recommend** that additional services for the demand side of the removals market are considered with and linked to additional services tailored to the supply side.

In addition to purchasing carbon removals itself, a purchasing programme can support additional demand from other actors by providing additional services such as de-risking mechanisms. These additional services can be a cost-effective way for the EU to support technology and market development. Our focus in this report is on generating demand for carbon removals, and we therefore focus on additional services that support the demand side of the market. There is also significant need for supply-side support for carbon removals projects and companies, since they can find it difficult to obtain financing due to the innovative nature of their activities and the lack of proven demand for carbon removals. Marton et al. (2025) provide a detailed overview of options for supply-side support measures to support permanent carbon removal upscaling, including e.g., discount loans, loan guarantees, insurance, tax credits, and equity investment; we do not discuss these supply-side options further in this report. It is critical, however, that additional services offered for the demand and supply sides of the removals market are considered in parallel

and linked in some form. Packaging these additional services together provides an opportunity to maximise their impact.[49]

3.4.1. Buyer risk

Buyers of carbon removals, both public and private, face risks that may limit their willingness to purchase carbon removals–the purchasing programme can help manage these risks to boost demand. These risks include quality risks, delivery risks, and policy risk. Different additional services will be effective to minimise or manage each of these risks. Below we define each risk type, and present potential options related to each risk:

Quality risk: A key concern is reputation, as companies fear being labelled as greenwashing, especially if the removals they purchase are later shown to be of low quality or are not delivered. Possible solutions include:

- **The EU CRCF Regulation** already aims to address primary concerns related to accurate quantification, additionality, long-term storage and sustainability of carbon removals by setting minimum standards and certification processes. Ensuring that the CRCF is sufficiently robust will be essential for a high-integrity carbon removals purchasing programme.
- **Additional due-diligence and stamp of approval:** Buyers could also benefit from the programme carrying out the due diligence process for them, through procurement of high quality and high potential projects. For example, if the programme procures high quality removals, this provides a seal of approval and signals that these projects can be invested in, reducing the need for due diligence checks from the buyers who may lack the expertise to carry out these assessments effectively. This type of quality stamp can increase buyer confidence and simplify buying decisions.
- **Quality guarantee**: The purchasing programme could guarantee CRCF credits, promising to replace CRCF credits if the quality turns out to be insufficient at some point in the future. Some private examples of quality insurance already exist, e.g. Kita Insurance, which for a fee indemnifies the buyer of carbon credits against loss of credits due to poor quality or other reasons.[50]

[49] Supply-side support can be offered, for example, by the European Investment Bank through lending, project development assistance, R&D financing, etc., and institutions like the German Development Bank (KfW) can act as capital provider with attractive long-term, patient repayment terms for project developers. These institutions can also offer blended finance, such as a combination of grants and long-term offtake agreements, which can also support market development.

[50] https://www.kita.earth/

- **Transparent reporting**: The purchasing programme should transparently report purchases, prices, and impacts, both in terms of mitigation and broader social and environmental impacts. This would increase buyer knowledge and support market development.

- **Pooling of removals:** To mitigate and distribute risks associated with specific types of removal units, a purchasing programme could also purchase and pool removals units from different removal types, vintages or geographic origins, and on the basis of the procured units, sell new credits/financial products that are backed by a blend of different removal units. In addition to reducing quality (and delivery) risks, this pooling function could also have price benefits, allowing buyers to pay an average credit price, supporting the purchase of a portfolio of removal types, without having to pay high prices for the most expensive credit types.

Delivery risk: Uncertainty remains around delivery risk, i.e., the possibility that removal units purchased through offtake agreements or pre-purchase agreements may not be generated as promised, either at all or at the agreed timing and quantity.

- **Delivery guarantee:** The purchasing programme could offer guarantees for pre-purchase and offtake agreements, promising to source replacement CRCF credits in accordance with agreement terms, in the case that they are not delivered. This could be in the form of **insurance**, where buyers pay a fee to the purchasing programme in return for the delivery guarantee, or could be a flat-rate guarantee provided at the cost of the purchasing programme, for example through the creation of a buffer fund.

Policy risk: Buyers also face policy risks due to uncertainty regarding the future policy requirements related to carbon removals. In particular, there is uncertainty regarding whether carbon removals will be permitted to be used towards future compliance obligations. This primarily concerns future EU policy, e.g., whether there will be integration of carbon removals into the EU ETS or development of carbon removals obligations of some form. This also applies to voluntary commitment policies, such as the Science Based Targets Initiative, which is updating its net zero guidance for corporates and the rules around use of permanent carbon removals to meet interim commitments (SBTI 2025). This policy risk creates price risks for buyers, who may pay high prices for removals credits today in the expectation that they will be able to use them for compliance purposes in the future; if this does not turn out to be the case, the future value of these credits will decrease.

- **Policy certainty and signalling:** The most straightforward solution to EU policy uncertainty is to establish long-term, credible policies for carbon removals, and to communicate these. The establishment of a purchasing

programme would signal the EU Commission's commitment to permanent carbon removals, though small relative to decisions about the long-term pathway regarding compliance obligations for carbon removals (e.g. ETS integration, removals obligations, etc.). Credibility can for example be built through rule-based policy making, e.g. the MSR, although this comes at the expense of future flexibility (Sultani et al. 2024). It can be challenging to make credible commitments to future policies in novel, swiftly changing contexts such as CDR technology development.

- **Bridging policies:** Some policy approaches have been proposed that could credibly commit the EU to future compliance requirements for CDR, such as clean-up certificates (Lessman et al. 2024), which would allow ETS emitters to commit to remove carbon in the future rather than return an ETS unit. Depending on the purchasing programme mandate and structure, they could have a role to play in implementing such policies.

In terms of structure, these additional services would be provided by the purchasing programme. This could be conceptualised as a **Technical Assistance Facility**. Technical assistance facilities for funds can go beyond addressing the demand-side uncertainties that we have identified above (e.g. Green Climate Fund 2020). Additional services that could be provided by a technical assistance facility could include:

- **Initial project development**: identifying permanent CDR project opportunities and structuring them into investment projects, especially as proof of concepts that will promote other actors to replicate and scale.

- **Capacity building**: The Technical Assistance Facility could also engage in capacity building. Trainings for both supply-side actors (e.g., project developers, permanent CDR suppliers) and demand-side actors (e.g., Member State, private companies) would support upscaling.

3.4.2. Additional Services

Participants at the workshop expressed clear support for the EU purchasing programme to offer a wide range of additional services to support private demand. Building on the examples of responses to buyer risks identified above, they proposed that the EU purchasing programme implement the following set of additional service:

- **Diversification:** The purchasing programme would purchase a diverse portfolio of removals from different removals technologies, vintages, and providers. This portfolio approach spreads risk, reducing exposure to individual failures. It would also smooth the price for buyers, who could buy into the fund at an average price of the portfolio.

- **Due-diligence:** The purchase programme could perform additional due diligence to identify high impact, priority carbon removals projects. This would encourage private buyers into the purchasing programme, who would be confident that they are purchasing the highest quality and impact carbon removals, without having to carry out the assessments themselves. The purchasing programme could work with the Innovation Fund, drawing on Innovation Fund assessments and assessment approaches, and also allowing for combined funding from public sources (through Innovation Fund) and CRCF unit demand (via purchasing programme), building on Stockholm Exergi example. The purchasing programme should also support market development through transparency, e.g. through public reporting of purchases and prices.
- **Project and buyer support**: The purchasing programme could support market and technology development through additional services. On the project side, the purchasing programme could offer project support, e.g. building on EIB **project development assistance** support under the Innovation Fund. The purchasing programme could also offer **capacity building** to buyers.[51]
- **Guarantees:** The purchasing programme could directly take on buyers' risk by guaranteeing their purchases of CRCF credits. This could take the form of **quality guarantees** (e.g. a commitment to replacing CRCF credits that fail, for whatever reason). They could also offer **delivery guarantees** for pre-purchase and offtake agreements, promising to source replacement CRCF credits in accordance with agreement terms if they are not delivered. This could be in the form of insurance, where buyers pay a fee to the purchasing programme in return for the delivery guarantee, or could be a flat-rate guarantee provided at the cost of the purchasing programme, for example through the creation of a buffer fund. The guarantees would be available to funders of the purchasing programme but could also be extended to buyers outside the programme

These additional services present important synergies with the EU Innovation Fund that should be exploited. For example, purchases taking place through the procurement programme could require that projects first go through the Innovation Fund's evaluation and selection process to be assessed by independent experts. The Innovation Fund's process evaluates and approves projects based on (a) how innovative it is, and (b) how well the business plan is developed. Only projects earning the Strategic Technologies for Europe Platform (STEP) Seal would be eligible to receive an offtake agreement from the procurement programme. Furthermore, a commitment from the procurement programme for an offtake agreement would then also

[51] Buyers would also see other benefits of selling to the purchasing programme, including high degree of trust associated with the purchasing programme's high credit rating, ability to offer pre-funding, and to make large purchases.

strengthen the business case of the project and increase its chances for selection.

The project development mentioned above could be harmonised with the Project Development Assistance currently offered through the Innovation Fund run by the European Investment Bank.

Coherence with already existing mechanisms of the Innovation Fund could make a more attractive offer for buyers, who are provided with more sources of funding and less red tape; as well as for administrators, who have to deal with a simpler and more efficient process.

3.5. Institutional structure

Institutional structure: Refers to the institutional form that the purchasing programme should take. Options include a purchasing platform, financial fund, an executive agency, or an independent institution, each offering increasing degrees of sophistication, capacity, independence, and cost. The institutional structure should mirror the mandate for the purchasing programme, and be sufficient to deliver on the programme's objectives, and manage the necessary tasks and responsibility.

Recommendation: **In the short-term, a familiar, swiftly implementable institutional form is most appropriate. We recommend and EU financial fund,** whose capacities match its role of purchasing carbon removal credits, including decisions on the allocation of funds, procurement of removals units, monitoring and performance evaluation. This could be hosted within an existing EU institution to speed implementation (e.g. Innovation Fund). It should also feature a purchasing platform that incorporates external funding from Member States and private funders. This could build on the "auction-as-a-service" model to coordinate Member State contributions in line with their and the EU's objectives, as well as the EU-coordinated Buyers' Club discussed in chapter 2.

3.5.1. Defining institutional structrure and options

As indicated by the range of institutional structures offered by the policy options investigated in chapter 2, purchasing programmes can take a range of institutional structures. The structure should mirror both the range of functions and objectives, the complexity of the tasks entrusted to it, the overall financial volume it is supposed to handle, and the level of discretion it is expected to apply in fulfilling its mandate (i.e. the degree of political control or oversight). Over time, these structures can evolve from simpler, faster-to-implement

models to more sophisticated institutions capable of providing greater services as the program matures

In this section, we identify a set of institutional structures that could be appropriate for implementing an EU purchasing programme, then evaluate their strengths and weaknesses both in the short and longer term. The objectives and recommended mandate for a purchasing programme imply that even the simplest version of an EU purchasing programme will need to be sufficiently sophisticated to go beyond procuring removals credits to support the development of the removals market through strategic purchases and additional service; on these grounds, we exclude some potential institutional structures from consideration.[52]

We identify four possible institutional forms, listed below. Combinations of these forms would also be possible, such as a financial fund with a purchasing platform. It would also be possible to evolve between these institutions over time, from the simplest/swiftest to establish forms (such as purchasing platform and financial fund into more sophisticated independent institution).

- **Purchasing platform:** The simplest version of the purchasing programme could take the form of a platform primarily focused on coordinating multiple buyers and providing the market infrastructure for purchasing removals units, thus lowering transaction costs. This body would not necessarily have the function, nor the financial means, to procure units itself, but would rather serve to gather demand from different buyers (public or also private). In this way, the purchasing programme would have similarities with the common auctioning platform under the EU ETS, the auction-as-a-service elements of the EU Hydrogen Bank, or the EU Commission's AggregateEU initiative for the EU Energy Platform. The purchasing platform would collect commitments to purchase carbon removals from buyers (e.g. Member States, private actors), coordinate auctions, and match buyers with the carbon removals credits best meeting the buyers' criteria. As with the EU ETS auctioning platform and AggregateEU, the actual service of procuring units could also be provided by a (commissioned) private operator, or, as in the case of the EU Hydrogen Bank, be managed by an existing EU agency such as European Climate, Infrastructure and Environment Executive Agency (CINEA).
- **Financial fund:** In this conception, the primary purpose of the purchasing programme is to manage and distribute funds to removals projects, including decisions on the allocation of funds, procurement of removals units, monitoring and performance evaluation. This type of

[52] For example, we do not consider an institution such as that implied by the "rule-based purchasing mechanism" in section 2.3.6 (i.e., similar in form to the Market Stability Reserve), as it has limited capacity to strategically develop the removals market.

institutional arrangement would conceivably be hosted and administered by an existing (financial) institution, e.g. a government-owned bank (EIB, KfW …), but the fund could also operate as an independent body, with own staff and an own legal personality. Analogies from the existing set of institutions active in the field could be the different funds connected to the EU ETS – the Innovation Fund, the Modernisation Fund or the Just Transition Fund.

- **Integration into or creation of EU executive agency**: In this model, the procurement body would operate as a government agency and thus be part of the overall government administration. Other public institutions – ministries or DG, and/or elected officials – would specify the objectives of the procurement body, provide oversight and monitor the performance of the agency. An agency set up in this way could serve simply as a procurement body whose sole task is to procure a given amount of removal units, but it could also pursue more complex objectives (e.g. scaling up the market for removals, supporting the development of different removals technologies), thus endowing the agency with some discretion on how to best pursue the specified objectives. Examples of such models in action in the carbon removal space come from the Danish NECCS fund and Swedish BECCS subsidy programme (see sections 6.10 and 6.11), both of which are implemented by the country's respective energy agencies.[53] This could also include options where the programme would be integrated into an existing agency, such as the Innovation Fund (implemented by the EU's Climate, Infrastructure and Environment Executive Agency (CINEA).
- **Independent institution:** The most comprehensive and complex institutional structure would be that of an independent institution. In this model, objectives would only be defined in broad and general terms (e.g. meet EU removals) but leave considerable discretion to the institution to choose the best way of achieving those objectives, as well as resolving conflicts and trade-offs between objectives. Such a mandate would require structures for decision-making and oversight, requiring a separate institution with a separate legal personality, own staff etc. Depending on the nature of the mandate, this institution might be more or less shielded from political interference. This type of institution could be modelled on the European Central Bank, there are no other concrete examples of such institutions.

[53]At the EU level, related examples include the European Hydrogen Bank or the EU Energy Platform's AggregateEU mechanism, which aggregates demand and centrally negotiates gas contracts for EU companies, both of which have more limited mandates that are implemented by private contractors, or the collaborative procurement of ammunition by the European Defence Agency.

Table 6: Institutional structure: overview of options

	Purchasing platform	*Financial fund*	*Executive agency*	*Independent institution*
Defining function/mechanism	*Facilitate transactions of removal units*	*Purchase CDR units*	*Foster CDR market to develop supply of CDR units*	*Long-term management of carbon removals in the EU*
Breadth & specificity of objectives	*Very narrow specific objectives*	*Narrow, specific objectives*	*Narrow to broad specific objectives*	*Broad, general objectives*
Amount of discretion	*Low*	*Medium*	*Medium*	*High*
Required financial commitment	*Low*	*Medium-high*	*High*	*High*

3.5.2. Key considerations and opportunities and risks related to institutional structure

The selection of institutional structure depends on the mandate and objectives it should fulfil. Different institutional structures offer different opportunities and risks, making them suitable for different objectives and mandates. This section outlines key considerations for selecting the most appropriate institutional structure for the purchasing programme and discusses the risks and opportunities of each model.

Key considerations and relative risks and opportunities of different models:

- **Administrative complexity** relates to the amount and the complexity of the tasks required to administer an institutional structure of the respective type. This also includes the administrative cost of operating the chosen institutional solution. A purchasing programme is relatively simple to set up and administer. Whereas some effort is required to define the rules or set up the platform, the operation itself is relatively straightforward; in the case of the purchasing platform, part of the operation can also be taken over by private service providers. The financial fund and executive agency are more complex, requiring capacities to take investment decisions, monitor and evaluate performance, potentially also innovation support. The independent institution represents the most complex and costly administrative solution due to its status as an independent institution and broad mandate to make and justify trade-offs between different objectives.
- **Capacities:** Different institutional structures have different degrees of institutional capacity. A low-capacity institution, such as a purchasing

programme, has a narrower scope and objectives and thus will be limited to buying CDR according to a certain cost and portfolio restrictions. High-capacity institutions will be more able to support the development of the permanent CDR market and technologies through strategic permanent CDR purchases and provision of additional services. This would be the case for the other institutional forms, including a financial fund, executive agency, and particularly an independent institution, which would have the broadest scope and longest-term outlook. All institutional forms will be sufficiently sophisticated to achieve static efficiency, that is, identify and attract the cheapest removals on the market. Achieving dynamic efficiency relates to the capacity to drive down costs over time and initiate cost degression. This, however, requires that the procurement body can differentiate between different types of CDR and CDR providers, identify and specifically support those removal types with greater cost reduction potential, and give suppliers an incentive to scale up supply and thereby realise this potential, including by assuring future demand. More complex institutions will also be better able to provide additional services to support permanent CDR upscaling, including risk-sharing.

- **The fiscal burden** to the regulator covers the financial cost of contributions to the mechanism to cover the cost of permanent CDR purchases. The fiscal burden is low for the purchasing platform, which will coordinate purchases by other buyers, with limited financial contributions from the EU, beyond operating costs. The financial fund, executive agency, and independent agency all imply high fiscal burdens, as they imply large commitments from the EU to fund permanent CDR purchases. Short-term costs may be higher with the more sophisticated institutions, as they invest upfront in hopes of reducing long-term costs (e.g. by strategically purchasing more expensive short-term carbon removals to foster market and technology development).

Table 7: Institutional structure: key considerations

	Purchasing programme	*Financial fund*	*Executive agency*	*Independent institution*
Administrative complexity of the tool (and admin costs)	*Low*	*Medium-high*	*Medium-high*	*High*
Capacities	*Low*	*High*	*High*	*Very high*
Fiscal burden/cost to the regulator of support	*Medium-high*	*High*	*Very high*	*Medium-High*

Recommendations: In the short-term, there is a need to provide a rapid and reliable demand trigger. The simplest and most impactful structure for this would therefore be a financial fund. The EU Commission would be in control of such a fund and would thus be able to act quickly and independently. Finally, a financial fund would also have sufficient capacities to strategically target different CDR technologies and providers to develop the market and support a longer-term price decrease. A financial fund could be extended with the addition of a purchasing platform to coordinate additional demand from Member States or even private buyers. Such an approach would reflect the existing European Hydrogen Bank, which facilitates distribution of EU funds through auctions, and acts as auction-as-a-service, facilitating Member State demand.

In the medium to long term, if carbon removal obligations or ETS integration are foreseen, a transition from a financial fund to an executive agency or independent institution would offer advantages. These structures would have even greater capacities to drive the development of a permanent removals market, as well as supporting technologies through strategic purchases and provision of additional services. An additional benefit would be that these more sophisticated governance structures could gain a growing role in not only buying permanent CDR credits but also managing CDR more generally in the EU. Should long-term policy envision the integration of removals in the ETS or establishment of carbon removal obligations, an independent institution would be the most appropriate institutional structure.

3.6. Funding

Funding: In the context of a permanent carbon removal programme, funding refers to the financial resources available to cover the costs of the programme and meet its objectives, including procuring removals, additional incentives or services, and operating costs. Funding can come from a variety of sources, including the EU, Member States, or private sources (which can be sourced voluntarily or mandatorily). From the perspective of designing an effective purchasing programme, these sources differ in terms of security of funding, speed, sufficiency of funds, burden for the public budget, and alignment with the "polluter pays" principle. The preferred funding source will shift over time, as the purchasing programme and EU CDR policy develop.

Recommendation: We recommend the following funding sources: **Years 0-5: EU funding + Member state contributions + private funding:** Funding should ideally come from multiple sources (public and voluntary private) from the start. Public funding should initially be retargeted from existing funding streams, to enable swift establishment of the purchasing programme. To the extent possible, this should be supported by voluntary private contributions; encouraging these private contributions should be a key focus of the purchasing programme in its early years. The EU budget contributions should be augmented by Member State contributions in return for the purchasing programme offering auction-as-a-service, ideally in the form of multi-year commitments to ensure sufficient funding to upscale the purchasing programme. Private funding could also be provided through this channel, though a potentially simpler approach could be to coordinate matching private investment alongside the purchasing programme (e.g., the US DoE's Carbon Removal Challenge). Private funding can also be encouraged through clear signposting of a transition towards a future of mandatory private financing (whether through ETS integration or carbon removal obligations).

Medium- to long term: The long-term funding of the purchasing programme will depend on development of EU CDR policy. A shift towards mandatory private contributions would provide sufficient funding for scale up and align with the "polluter pays" principle; ETS integration or carbon removal obligations would be feasible models for implementing this, though further research is required.

Purchasing carbon removals at the expected scale and cost to develop the market will require significant funding. The source and form of funding will have implications for the purchasing programme design. In this section, we consider potential sources and forms of funding for a purchasing programme, and discuss related issues, including the ability of the programmes to crowd-in private finance, and the potential of funding a purchasing programme through

ETS integration or other compliance policies such as carbon removals obligations.

3.6.1. Defining funding and options

In the context of a permanent carbon removal programme, funding refers to the financial resources available to cover the costs of the programme and meet its objectives, including procuring removals, additional incentives or services, and operating costs. Funding can come from a variety of sources (e.g. EU, Member States, or private), and can take multiple forms (e.g. long-term commitments, short-term funds, or resources under the institutions own control). Below, we identify key potential funding types, which could be standalone or combined. The broader issues associated with ETS integration, removals obligations, and private contributions are discussed in more detail in subsequent sections. Here, we focus specifically on how each of these options could generate funding for a purchasing programme. Different funding sources are appropriate for different institutional structures and are related to the purchase method and mandate. We indicate these links where relevant. As with other elements of the purchasing programme design, the source of funding can and should shift over time as the purchasing programme policy and wider CDR policy develop. Funding can come from EU public budget, Member State contributions, or the private sector:

- **EU public contributions: EU budget allocations**: Funding could be provided by the EU public budgets in the form of repurposing existing funds, annual allocations, or multi-year public budget commitments (or endowments). This would echo the Swedish BECCS and Danish NECCS funding approaches, which are in the form of public budget allocations from the respective governments.
- **Member State contributions: Auction-as-a-service:** The purchasing programme could receive funding linked to the provision of specific services. For example, a Member State or private actor could provide funding on a case-by-case basis to the purchasing programme in return for the purchasing programme carrying out carbon removal purchased on its behalf. This would echo the European Hydrogen Bank, where Member States subsidise rounds of hydrogen purchases. This source of funding would be appropriate for the institutional structure “purchasing platform”.
- **Private contributions – Voluntary:** Funding could come in the form of voluntary contributions from the private sector. These could be voluntary, matching procurement levels made by the procuring authority. They could also be facilitated through the structure of the auction-as-a-service model, with private companies contributing funds in return for the procuring authority to purchase removals on their behalf, similarly to the Frontier model but publicly managed. Voluntary contributions are likely to

be important in early phases to provide support to emerging technologies.

- **Private contributions – Mandatory:** Private sector contributions could also be mandatory. These could take the form of a removal obligation, with private companies obliged to provide funding for permanent removal purchases, echoing the KLIK Foundation model. Removal obligations could take multiple forms, for example linking to current emissions (e.g. ETS obligations, fuel importing requirements, CBAM integration, etc.) or historical emissions. They could come in the form of initial endowments or long-term commitments, or annual or occasional funding. Mandatory contributions will be a very important driver in demand in the medium-long term. *See more detailed discussion in 3.5.3.2.*
- **Private contributions – Sale of allowances:** The purchasing programme could raise its own funds by auctioning allowances into the ETS, effectively another form of private contributions. This could occur in three ways:
    - Funding could come from the **allocation of ETS allowances** to the purchasing programme (or the associated revenue). Allocation of a set % of the ETS allowances is how the Innovation Fund is financed, with these allowances auctioned by the Commission according to pre-agreed rules.
    - **ETS integration** would involve the purchasing programme raising funds by selling permanent carbon removal allowances into the ETS, with ETS participants able to use them to meet their emissions reduction commitments. *See more detailed discussion in 3.5.3.2.*
    - **ETS integration with carbon contracts for difference** would involve ETS installations purchasing the permanent removals directly (at a reference price near the EU ETS unit price), with supplier receiving top up subsidy payments from the purchasing programme in the form of carbon contracts for difference. This would mean less private funding for the purchasing programme than pure ETS integration, though the total funding for the purchasing programme may be higher due to the inclusion of public funding.

3.6.2. Funding sources: key considerations and opportunities and risks

In this section, we assess each of these funding types against criteria. These qualitative assessments are summarised in Table 9. We evaluate each funding type individually to understand their specific advantages and disadvantages. It would also be possible to combine funding types, either in parallel linked to

different procurement policies, or combined to fund the same purchasing programme policy. See section 3.5.3 for a more detailed discussion of combining public and private financing.

It is important to consider that the optimal funding source will shift over time, as the purchasing programme develops and as the wider CDR policy landscape shifts. As discussed below, in the short-term, swiftly implemented options will be most suitable (such as annual allocations from the EU public budget, Member State contributions, and voluntary private contributions), with mandatory private contributions through removals obligations or ETS integration offering some advantages but only implementable over longer time scales.

Table 8: Funding options, opportunity and risk assessment

	EU public budget		Member state	Private contributions			
	Annual allocations	Multi-year commitments	Auction-as-a-service	Voluntary	ETS auction revenue/ allowances	Mandatory (removals obligation)	ETS integration (sale of removals allowances)
Security of funding	Medium	High	Low: uncertain	Very low: uncertain, competition	Medium	High	Medium: depends on relative removals/ ETS prices
Speed	Fast	Medium	Fast	Fast	Medium	Slow	Slow
Sufficiency of funds	Medium	Medium	High	Low - Medium	Medium	High	Medium
Public financial burden	Heavy	Heavy	Heavy	Light	Moderate	Light	Light
“Polluter pays” principle alignment	Low	Low	Low	Medium	Medium	High	High

Security of funding, including long-term funding, is important for the purchasing programme for two reasons. Firstly, it ensures the program can operate efficiently, allowing for strategic planning of purchases across time. This flexibility enables the program to frontload or group purchases (e.g. to enable large purchases from individual actors to support large-scale projects) or delay them (e.g. to gain from expected lower future prices). Secondly, security of (long-term) funding also sends a clear signal to the market that there will be demand for permanent carbon removals into the future, and that this will not be subject to future political changes, which is important for encouraging investment and financing.

Risks/opportunities of different funding options: 'Private contributions: Sale of allowances with CCfDs' and 'Private contributions: Mandatory' score medium for security of funding. An earmarking of ETS allowances (or ETS allowance allocation revenue), similar to the Innovation Fund, would guarantee significant funding for permanent CDR – though for both of these funding levels depends on carbon prices and can strongly diverge from expectations. ETS integration without CCfDs faces the risk that the market ETS price is insufficient to cover the removals allowance costs. EU public budget could provide a high degree of funding certainty, particularly if funding was provided in such a manner that the purchasing programme was able to manage the use of the sum of their funding (rather than annual allotments). Annual EU public budget allocations would provide a moderate degree of security, though these would be at risk of future political reversals. A pay-as-you-go model would provide little funding security, with funding in the short and long-term subject to the decisions of individual Member States. A reliance on voluntary private contributions offers little security, given the uncertainty regarding private voluntary demand and competition for private voluntary contributions (e.g. versus companies making their own purchases, Frontier Carbon, etc.).

Given the desire to address the current lack of sufficient permanent carbon removal demand, **the speed at which funding can be sourced may be an important criterion. Risks/opportunities:** EU budget allocations can be quickly implemented. Member State contributions and voluntary private financing can also both be established relatively quickly, though dependent on Member State and private contributor decision-making. Other public options will be more time-consuming, e.g. to establish multi-year commitments from the EU public budget will be more politically complex, as will the allocation of ETS allowances (or their auction revenue) to a purchasing programme. The establishment of mandatory private contributions (e.g. removals obligation), and the integration of removals into the ETS would both be slow due to their high complexity and changes they would demand of the EU's climate architecture.

Sufficiency of funding to meet objectives is a key determinant of the purchasing programme's impact. Even in the period up to 2030, meeting the EU's permanent carbon removal objectives will involve considerable expense (see section 3.2.2).

Risks/opportunities: It is difficult to assess the relative strengths and weaknesses of different funding sources in terms of sufficiency of funding, as this depends not only on the size of the potential funding pot but also its availability/competition. As one indicator, we consider the size of the total potential public funding. The EU public budget commitments amount to around €190 billion per year,[54] with this budget facing competition from other spending areas. EU Member States have significantly larger budgets, for example, the

[54] Figures 2021-2027 - European Commission

German Federal government alone had revenues of €430 billion in 2024,[55] and therefore collectively Member State budgets could generate sufficient funding for a purchasing programme, though their budgets are also highly competitive. The sufficiency of private sources of voluntary funding for a purchasing programme would be expected to be low-medium, given that to date private purchases sum to approximately €3 billion of which only 4% have been delivered,[56] and that there are many competing private purchase options (e.g. Frontier Carbon, etc.). Current levels of voluntary funding for carbon removals would be insufficient to meet the EU's target of 5 $MtCO_2$-e of industrial removals by 2030. Allocation of ETS allowances scores moderately: the EU ETS had 2023 auction revenues of €43 billion and 2024 revenues of €38bn, however, these are already committed to Member States and other funds including the Innovation Fund (ICAP 2024).[57] There is some flexibility on how the Innovation Fund is spent, with scope to extend to more permanent CDR technologies. This value of auction revenues is expected to grow in the short term, as prices are expected to increase, however, as the cap shrinks, the amount of auction revenue will fall by the late 2030s (Agora Energiewende, 2024). Relatedly, ETS integration offers a moderate degree of funding sufficiency. Private mandatory removals obligations offer a high sufficiency of funds, for example, as one indicator, the largest 107 global oil companies had average annual earnings before interest and tax of €630 billion (2018-2022) (Egli et al. 2024).

Funding sources that minimise the financial burden for EU/Member States and leverage private sources of funding would be preferable from a public perspective.

Risks/opportunities: EU budget allocations and the Member State pay-as-you-go options place a heavy burden on the public budget. Conversely, a mandatory removals obligation places costs on private actors, having therefore a light impact on private budget; the same is true of voluntary private contributions. The use of ETS auction revenue has a moderate financial burden, as this would come at the expense of the current beneficiaries of the majority of ETS auction revenues, who are Member States and EU programmes. If ETS integration replaced free allocation of allowances within the ETS to industry, and therefore does not affect ETS allowance auction revenues, then it will not generate public financial burden.

An analogous criterion is the extent that funding options place costs on the polluters (current or historical) in line with the 'polluter pays' principle. The 'polluter pays' principle is fundamental to EU policy, with the Treaty on the

[55] Federal Ministry of Finance - Overview of federal budgetary and financial data up to and including August 2024

[56] CDR.fyi, accessed 04.12.2024

[57] This comes from auctioning 57% of the cap, with the balance of allowances freely allocated.

Functioning of the Union stating that, “the Union policy on the environment (…) shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.”[58]

Risks/opportunities: Analogous to the scoring for public financial burden, the mandatory private (removals obligation) and ETS integration options score favourably, EU public budget and Member State pay-as-you-go approach score poorly, with the ETS auction revenue option scoring moderately. A voluntary private funding source also scores moderately: while it places financial burden on some voluntary actors who are likely to be polluters, it does not ensure that all polluters pay.

3.6.3. Crowding in private funding

As indicated by the criteria *public financial burden* and ‘*polluter pays’ principle alignment*, **a key focus for any policy option should be minimising public costs for permanent carbon removal and ensuring that those responsible for generating pollution bear the associated costs.** In addition to reducing financial burden and implementing the polluter pays principle, private funding of a purchasing programme, if it is additional (i.e. in excess of what private actors would have otherwise invested), can also increase the total amount of funding for permanent removals, increasing the effective impact of public funding. An important related issue is the ownership of credits, especially in cases where carbon removals projects or companies have received public funding in addition to revenue from selling credits to private buyers. We discuss implications for this policy design issue in section 3.6.

Funding from private sources can be sourced either voluntarily or mandatorily. In this section, we discuss options for both of these avenues and identify key considerations. Throughout, our focus is on issues relevant for the design of a purchasing programme policy. Broader strategic issues, such as the equitable share of cost or the implications of different options for the EU climate architecture are out of scope of this paper; they will be evaluated in subsequent work.

3.6.3.1. Voluntary sourcing of private funding

Existing policies provide some examples of how private financing can be crowded in to voluntarily purchase of carbon removals. In this section, we identify existing models for how voluntary contributions could (partially) fund a purchasing programme and evaluate their potential in the context of providing

[58] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:12012E/TXT

private funding for a permanent CDR purchasing programme. Further information about all policies can be found in Table 1 and section 6 Annexes.

An important consideration is the extent that these models address the motivations for private funders. Microsoft is the largest private buyer of permanent CDR. CDR.fyi (2024) argue that there are two key drivers for Microsoft's purchases: a net zero target[59] (in Microsoft's case, net negative by 2030 and neutralising all historical emissions by 2050, considering scope 1 and 2 emissions) and the interlinked desire to stand out from competitors in terms of ambition and action, with the associated value this generates regarding brand value, talent proposition, social license to operate, etc. The models for voluntary private funding address these motivations of enabling net zero targets and public visibility to differing degrees. Other motivations identified by contributors at the workshop include private buyers facing regulatory compliance requirements, or expecting to in the future; the quasi-compliance motivation associated with meeting public voluntary targets under e.g. under SBTi; a desire to be recognised as contributing to climate mitigation and/or having a catalytic role in technology development; or speculation (e.g. investing in the purchasing programme, which could appreciate in value over time).

Models for voluntary private funding:

Private funding for public purchasing programmes: A potential example for private contributions to a public purchasing programme is given by the Global Energy Efficiency and Renewable Energy Fund (GEEREF 2024). GEEREF is a public-private partnership, initiated by the European Commission in 2006, and launched in 2008 with funding from the European Union, Germany, and Norway, who provided €112 million, which was matched by €100 million from private investors. GEEREF invests in for-profit funds, with a focus on green energy. This example indicates that private investors may be willing to invest in a for-profit fund focused on equity investment; whether such a model would work for a publicly managed CDR purchasing programme is unclear if the emphasis of such a programme is on purchases of units (rather than profit-focused equity investment). The voluntary carbon market provides evidence that there is some voluntary demand for permanent carbon removals. To date, publicly available information on private purchases on the voluntary carbon market indicate that they sum to approximately €3 billion, equating to 12 $MtCO_2$-e of removals, though only 4% of these have been delivered, indicating that this sum is spread over many years of removals (into the future).[60] A significant portion of these purchases have come from a small number of buyers, e.g.

[59] When considering net zero targets, standard setters such as Science-based Targets Initiative and public reporting requirements, such as the Corporate Sustainability Reporting Directive have an important role.

[60] CDR.fyi, accessed 04.12.2024

Microsoft alone has purchased 8.24 $MtCO_2$-e of removals (close to 70%), with a further 1.7 $MtCO_2$-e (or 14% of the market) purchased by the next five largest buyers.[61, 62] Private buyers will need to be engaged by the purchasing programme to support upscaling of voluntary purchases to help meet EU carbon removal targets; the extent to which these private purchases could be funnelled through and therefore provide funding for a purchasing programme is an open question.

Partnership: A partnership model occurs when a private company, rather than directly providing funding to a purchasing programme, instead partners with the programme, investing its own funds in a complementary manner. There are a number of examples of this model. In the EU context, the EU Breakthrough Energy Catalyst Partnership brings together EU funds and loans to partner with a private foundation, e.g. for Ørsted's FlagshipONE project, Breakthrough Energy Catalyst took a 15% equity stake, the EIB made a quasi-equity investment, and European Commission provided a grant.[63] The USA DAC Hubs policy features a related combination of blended public and private investment (OCED 2024). A less formal option is offered by the US DOE CDR Purchase Pilot Prize, which included a call for private matching of their USD 35 million public funding (the Voluntary Carbon Dioxide Removal Purchasing Challenge). The US DOE established a leaderboard to raise visibility of responding companies, and the opportunity to have the US DOE certify the quality of removals. In response, both Google and Meta have announced matching $35 million commitments to purchase permanent CDR.[64] These partnership models, which provide control and visibility to private companies while attracting private financing, may be replicable in the EU's permanent CDR context.

Private funding as part of a contract for difference: The H2Global Mechanism, under the EU Hydrogen Bank, offers an example for how private funding can be crowded in by public contracts for difference. The H2Global mechanisms acts as an intermediary. They sell hydrogen to buyers (private funding), whose insufficient private payment is topped up with a contract for difference provided by public funders (public funding) to enable the H2Global mechanism to purchase hydrogen from providers. As discussed in 3.3.3, carbon contracts for difference require a reference price, and there are considerable questions as to whether the voluntary carbon market would be sufficient.

[61] CDR.fyi, accessed 05.12.2024

[62] Note these top five buyers include the private buyers' clubs mentioned, Frontier Carbon and NextGenCDR.

[63] Breakthrough Energy Catalyst Announces €240 Million of Funding Commitments to Accelerate High Impact Climate Solutions in Europe | Breakthrough Energy

[64] DOE is Helping YOU Buy Good Carbon Dioxide Removal Credits | Department of Energy

Therefore, this model may be more feasible when linked to mandatory sourcing of private funding, such as removals obligations or ETS integration.

Private buyers club: The Frontier Carbon Advance Market Commitment mechanism and NextGenCDR offer examples of cooperative private purchasing programmes for CDR. Both were formed by a group of private companies, with the aim of pooling private funding to efficiently purchase CDR and support the development of the CDR market. Both programmes are governed by the founding companies. For example, NextGen CDR's board features representatives of Mitsubishi, South Pole, and SwissRe (NextGen CDR 2023). Both programmes also operate as intermediaries or brokers for smaller buyers, facilitating their trades. These examples indicate that private companies may be willing to invest in cooperative procurement programmes. However, it is unclear whether private investors will be willing to invest large sums in a publicly managed programme (rather than a private programme with high visibility for investors).

3.6.3.2. Mandatory sourcing of private funding

Mandatory sources of private funding offer significant advantages across various criteria, including funding security, funding sufficiency, public financial burden and alignment with the polluter pays principle. Accordingly, in this section, we identify possible options for mandatory sourcing of private financing. These mandatory sources of private financing are unrealistic sources of finance for a purchasing programme in the short-term, due to the significant changes they imply for EU climate policy and the significant establishment times they imply. This implies that they are not appropriate funding sources for the short-term purchasing programme that is the focus of this report. However, given their strengths, in the longer-term (post-2030), they offer attractive options; we introduce key potential mandatory sources of private funding here in limited detail. It is important to note that **many significant considerations regarding whether to implement mandatory sourcing of private financing go beyond the scope of this paper**, these include, for example, the risk of emissions reduction deterrence and definition of residual emissions, ETS market stability impacts, management of removal and emission non-equivalence (e.g. in relation to permanence), equitable distribution of costs, among other issues. **Here, we focus only on implications for purchasing programme design.**

ETS integration: Integrating carbon removals into the ETS offers one way of implementing mandatory sourcing of private funding. ETS integration has been proposed as a way to address carbon removal funding gaps, reduce overall costs of meeting climate targets, and to support management of the ETS (see e.g., ESABCC 2025; Rickels et al. 2022; Sultani et al. 2025). At the same time,

concerns have been raised by environmental NGOs, particularly regarding the risk of mitigation deterrence and non-equivalence, among other concerns.[65]

ETS integration can take multiple forms, the ultimate shape of which will impact the reliability of the ETS as a source of funding. Drawing on the models presented in a related context in Bognar et al (2023), two models could be used to fund a procurement policy: An indirect link model where an intermediary (public or private) purchases removals and then generates funding by selling removals-backed allowances into the ETS (the **ETS integration** funding types assessed in 3.5.1 and 3.5.2), and a no-link model, where revenues from ETS allowance allocation can be used to fund removals (this echoes the **allocation of ETS allowances** funding option assessed in 3.5.1 and 3.5.2).[66] As assessed in section 3.5.2, these two options offer different strengths and weaknesses as sources of funding for a public purchasing programme, with allocation of ETS allowances a potential source of short-medium term funding, and ETS integration unrealistic as a short-term source of funding.

Carbon removal obligation: A carbon removal obligation offers an alternative, regulatory approach to crowding in private financing for permanent carbon removals. If these removal obligations were funnelled through an intermediary in the form of a public purchasing programme, they could offer a source of funding. Like the ETS integration model discussed above, these carbon removal obligation funding models are unattractive sources in the short term, due to the significant policy changes that they represent. However, they are similarly attractive as medium- to long-term sources of financing. Proposed carbon removal obligation models include:

(a) Carbon takeback obligations: Jenkins et al (2021) propose a carbon takeback obligation, which would require fossil fuel extractors or importers to finance permanent carbon removals equivalent to a progressively increasing proportion of their associated emissions.

(b) EU Removals Trading Scheme: Meyer-Ohlendorf (2023) proposes a related EU Removals Trading Scheme within the context of the European Union, with removals obligations falling on larger-scale entities in the EU ETS, in addition to their ETS obligations. This proposal builds upon the Carbon Dioxide Removal Market Development Act Legislative Proposal discussed in the Legislature of California. Related approaches have been

[65] See e.g. https://carbonmarketwatch.org/2024/10/03/no-place-for-carbon-removals-in-emissions-reduction-policies/

[66] Bognar et al. 2025 also consider direct linkage models, which we exclude here, as these would not generate funding for a procurement fund. For example, we do not consider the case where ETS integration could occur through a direct link, where ETS participants can directly purchase removal credits from removal suppliers (whether as fully fungible units, or as deductions that they earn against their own ETS obligation in return for implementing their own removals).

proposed by Bednar et al. (2021), who propose that the ETS is adapted such that emitters surrender allowances for their emissions but also incur an obligation to remove them at a later date. A public purchasing programme could purchase removals and sell these to those with removals obligations, thus funding its operation.

(c) Border Carbon Adjustments: The EU Carbon Border Adjustment Mechanism imposes an effective carbon price on imported goods covered by its scope (high emissions intensity products with a high risk of carbon leakages). If importers were able to reduce their effective carbon price by purchasing permanent carbon removals through a public purchase programme, this could generate funding and additional demand for permanent carbon removals. Other policies could be used in a similar function.

3.7. Other key considerations for purchasing programme design

A number of other design decisions must be considered to ensure the purchasing programme can deliver on its objectives. In this section, we consider three issues: the need for effective public governance aligned with the concept of a just transition; the ownership of carbon removal claims; and legal issues related to public procurement and state aid issues in the EU.

3.7.1. Effective and just public governance

A high-level objective behind the establishment of the purchasing programme is to support the upscaling of carbon removals in a manner that increases social wellbeing. Directly, this can be achieved by increasing mitigation options and the level of climate change mitigation action through additional carbon removals. Ensuring that a purchasing programme for carbon removals delivers on its potential for increasing social wellbeing demands that it is designed and governed in line with the principles of just transition. Nawaz et al. (2024) identify three dimensions of justice related to carbon removal policy:

- **Procedural justice**: Broad stakeholder groups should be substantively involved in the decision-making regarding carbon removal policy, including all affected parties. While such processes can be time-consuming, they can improve resulting policies through the inclusion of multiple sources of expertise, and increase acceptability by aligning policy design with stakeholder objectives.
- **Distributive justice:** Carbon removal policies should be designed to avoid burdening disadvantaged individuals, households, and communities, including those outside the EU. The polluter pays principle

is also relevant here. Additionally, carbon removals policy must be sufficiently ambitious to effectively contribute to climate change mitigation, in order to reduce the costs of climate change that will otherwise be borne by these groups. The external impacts of carbon removal activities must also be considered and managed, including social impacts such as employment, and any potentially negative impacts such as damage to nature.

- **Reparative justice:** Carbon removal policy can be an opportunity to redress legacies of historical emissions. Regions such as the EU have contributed significantly to cumulative global GHG emissions and accordingly have a responsibility to fund mitigation activities, including in the form of carbon removals. Reparative justice calls for ambitious carbon removal policies that consider historical emissions responsibilities as well as present day emissions.

Workshop participants identified that social and environmental considerations were important factors to consider in purchasing programme policy design.

3.7.2. Ownership of carbon removal claims

Carbon removal activities generate outcomes of value for different stakeholders. In this section, we consider potential ownership (and shared ownership) models, their impact on public and private funder incentives, and the system as a whole. CRCF credits are envisioned to be used by entities that have entered into voluntary commitments to achieve a certain emission target, as they can count removal units towards meeting their objectives.[67] They also hold value for countries or jurisdictions with legally binding targets and commitments, such as the EU's Paris Agreement targets and many Member State's Net Zero targets. If ETS integration or carbon removal obligation policies are established, then these would increase the value of carbon removal activities, as obliged private entities would be able to use purchased CRCF credits to comply with their obligations. When these carbon removal activities have been (partially) funded by public support, such as through the purchasing programme, determining who gets to claim the carbon removals that have occurred (and any CRCF credits) is an important design choice.[68] The decision over ownership of removals has important implications: it confers the benefits of either using or selling the removal outcomes, but may also entail a liability in case the removal

[67] Specific rules regarding how CRCF units can be used will be determined by regulations and initiatives beyond the scope of the Purchasing Programme, including the Green Claims Regulation, and delegated acts under the CRCF Regulation.

[68] In the instance where removal activities are implemented without public support, any resulting credits would logically accrue to the removal provider, who would be free to use or sell them.

activity underperforms or fails to deliver as planned, and the removal activity results in fewer removals or delays relative to contractual agreements. Accordingly, this can have significant implications for different actors' incentives to invest in permanent CDR, and the effectiveness of the purchasing programme.

In instances where removal activities have received public support,[69] several ownership models for the resulting removal outcomes are possible: ownership may be transferred entirely to the public funder, remain with the removal provider, or involve a mix of both. Each model has different strengths and weaknesses.[70] We consider only result-based models where removals activities generate CRCF credits; other, lump-sum forms of public subsidy (e.g., subsidized loans or grants to support construction of facilities) are beyond the scope of our consideration (though would most likely fit option (b)). As noted below, the attractiveness of the different approaches depends in large part on EU climate policy and national inventory reporting approaches beyond the scope of the Purchasing Programme. Whatever approach is selected, simplicity and transparency will be essential to ensure practicality and trust.

a) ***Removal outcome is entirely transferred to the (public) funder***

Under this model, a public entity pays the removal provider for the demonstrated removal; the removal provider confers all rights and obligations to the public funder; the removal provider would not be allowed to sell any credits on the voluntary carbon market or elsewhere. The public funder could be the EU, or in the case of a purchasing programme offering auction-as-a-service to Member States, could be a Member State funder. The public funder would be free to use the removal outcome/credit for different purposes, in accordance with rules set beyond the scale of the Purchasing Programme (e.g. UNFCCC inventory reporting rules, relevant EU regulations): either to comply with respective international obligations (under the Paris Agreement), as collateral to issue additional emission allowances in an ETS, or, in case of Member State funding, to comply with ESR obligations/national targets. The public funder could also choose not to use the removal outcome in any accounting framework (national, EU or international), but merely as an accounting unit to determine the remuneration (result-based finance).

Strengths/weaknesses: This approach could provide clear incentives to public funders (including Member States) to fund carbon removals to meet their

[69] In the instance where removal activities are implemented without public support, any resulting credits would logically accrue to the removal provider, who would be free to use or sell them in accordance with rules established beyond the scope of the purchasing programme, e.g. in the Green Claims Regulation.

[70] Following the CRCF, we only consider the case of EU-based carbon removals; we do not consider international trade in carbon removals.

targets.[71] However, this may be challenging to implement, given that current EU accounting favours emissions/removals activities being credited where they occur, meaning adjustments would be required to recognise project-based removals credits in national inventories.

b) ***Ownership of the removal outcome remains with the removal provider***

Here, a public entity would support the removal activity by providing subsidies (either lump-sum or tied to tonnes of removals achieved) but would not claim ownership of the removal outcome. The removal provider would be free to use the removal outcome to meet their own targets or obligations (whether a voluntary target or under a compliance system), or to sell it in the form of a credit to a third party (in which case the third party would be able to use the credit to meet their own targets or obligations, in line with rules set beyond the scope of the EU purchasing programme e.g. Green Claims.

Strengths/weaknesses: Incentives for the public funder (e.g. EU or Member States) are limited, as they would not be able to claim removals against their targets. Positively, this model avoids the risk of "double claiming", as ownership remains with the removal provider (or the buyer of the credits). Suppliers would benefit from subsidy as well as the sale of removals claims on voluntary private market. However, there is a risk that this model would create inefficiencies as the public support may lower the market price of CRCF credits (by increasing supply), which if used to meet emissions reduction targets in other sectors, would effectively be subsidizing emissions reduction deterrence. While this poses a risk, it could be justified in the case of the early-stage purchasing programme policy, if it effectively supports technology and market development and crowds in private funders that would not otherwise engage, and considering the relatively small scales envisioned in early years. If so, care would need to be taken to avoid setting poor standards in the longer term.

c) Removal outcome is partly transferred to the (public) funder

Under this third option, the funding entity can use the removal outcome for compliance with respective legal obligations (e.g. national targets) – but the removal provider can still generate credits to be sold and used in a context where there is no formal obligation (such as a voluntary market, e.g. to meet company-level voluntary targets or commitments). This would be considered a case of "double claiming", since the same removal activity is effectively claimed twice, once by the funder and once by the removal provider. Yet it would not necessarily be double counting, as long as the carbon removals are only claimed once in a

[71] This would in part depend on developments in UNFCCC national inventory reporting approaches, which at present would limit the recognition of removals to the host (not funder) country; the use of CRCF credits to meet national inventory targets would also require some policy development, due to the mismatch between project-based CRCF credits and annual inventory reporting approaches. These developments would be beyond the scope of the purchasing programme to decide.

formal compliance mechanism. On the voluntary carbon market, close attention needs to be paid to ensure that these removals would be considered additional (i.e., would not occur without the incentive generated by the voluntary carbon market payment). Spalding-Fecher at al. (2021) propose methodologies for **proportionally attributing the mitigation claims across multiple funders** in the related context of blended finance from voluntary carbon markets and climate finance.

Strengths/weaknesses: This model creates incentives for the public funder (Member States and EU), as they could claim removals against their compliance targets (depending on inventory reporting rules and EU climate policy decisions, as discussed above) . It also creates some incentive for private buyers (outside of the Purchasing Programme), who can claim the removals against voluntary targets.[72] Such a model would increase the amount of carbon removals generated through public subsidies, as the sale of credits into voluntary carbon markets would effectively crowd-in private financing. Proportional attribution of carbon removal claims in accordance with the ratio of public funding to private voluntary carbon markets would avoid the creation of inefficiencies due to public funding reducing the price of CRCF credits. A related model has been applied in the Swedish BECCS policy, where funding comes from Swedish, EU, and voluntary carbon market sources. In the medium term, should policy shift to compliance markets and away from voluntary private contributions, such a model would pose risks of double counting. Such a model could also pose implementation challenges if CRCF credits are purchased, as these will be linked to a particular unit of removals that will be recorded in CRCF registry.

3.7.3. Procurement and state aid rules in the EU

The EU purchasing programme will need to be compliant with EU rules on public procurement and state aid. The CDR purchasing programme will be grounded within the existing framework defined by the public procurement directives 2014/24/EU, as well as revisions to this framework expected in the next few years. The purchasing programme will need to be compliant with the rules and guidance stipulated in these directives. The Net Zero Industry Act offers additional possibilities to support climate-friendly public procurement.

There are relevant binding rules in the Public Procurement Directive that constrain the design of the purchasing programme for carbon removals. One important consideration is that Article 22 of the 2018 Procurement Law (implementing Directive 2014/24/EU) stipulates that only 4-year terms are

[72] This could reduce incentives for private buyers to invest directly into the purchasing programme, unless this proportionate claim could also be distributed between public/private funders of the purchasing programme.

allowed for procurement. For offtake agreements, these terms may need to be extended to 10 years or more. These could be justified by the long-term need for CDR to achieve net zero and the immediate need to catalyse market development (Open Air Collective, 2025).

Clear, practical guidance should be provided for the agencies responsible for implementing the purchasing programme, ensuring that contracts are not awarded solely based on the lowest cost. The procurement directives enable the use of the alternative Most Economically Advantageous Tender (MEAT) framework, which encourages the use of multi-criteria selection in public procurement. It encourages contracting authorities to consider non-price elements—such as quality, environmental impact, innovation, and social benefit—in evaluating bids. This framework should be used to provide target support for CDR. The EU could set weighted criteria to help procurers buy credits in a way that supports the development of the technology. For example, Open Air Collective (2025) suggest (for Luxembourg, but also applicable to the EU) weighing the criteria as follows: 50% for lowest price per tonne offered, 25% for permanence, 17% project maturity / reliability to achieve its intended outcomes, and 8% on alignment with climate plans.

Differentiated support for different technologies should be possible. Given the substantial cost differences between technologies, including these all under one funding call (for all options apart from equity investment), lower-cost technologies may disproportionately benefit, while early-stage, high-potential technologies may be overlooked. To provide this targeted support during the initial technology-building phase, it may be preferable to run separate calls for separate technology groupings (e.g., for each CRCF technology). However, there are potential legal feasibility issues with running separate procedures, particularly if this funding comes from the Member State level, which requires approval under State Aid rules. According to Article 107 of the Treaty on the Functioning of the European Union (European Union, 2012), the proposed funding mechanism must show that it ensures that the funding is not allocated in a way that distorts competition in the single market, and that the funding complies with the Guidelines on State Aid for climate environmental protection and energy (CEEAG).

The Swedish reverse auction scheme for BECCS was approved under State Aid rules, showing that separate calls for separate technologies is possible. The Commission assessed the scheme under the State Aid rules and approved it after finding that:

- The scheme is necessary and appropriate to incentivise CDR in Sweden and hence contribute to national and EU climate targets.
- The scheme has an incentive effect, as winners from the scheme would not carry out the removals without the public support (that is, the removals are additional).

- The scheme has limited impact on competition and trade within the EU.

It is quite likely that these findings would be similar for other schemes targeting different technologies and using different purchasing mechanisms.

Nevertheless, to speed up the approval processes for separate procedures to be approved, additional legislation may be necessary. For example, auctions for separate technologies were already carried out in the EU for renewable energy. In this case, the Renewable Energy Directive (RED) reduced the scrutiny under EU state aid rules by providing Member States provisions to design their auctions according to national objectives (see box below). Most of the provisions outlined in the RED are also relevant for CDR. To enact this, supplementary legislation may be required to make it easier for separate calls to be accepted.

Renewable Energy Directive (EU) 2018/2001 of the European Parliament and of the Council

"Member States may limit tendering procedures to specific technologies where opening support schemes to all producers of electricity from renewable sources would lead to a suboptimal result, in view of:

(a)the long-term potential of a particular technology;

(b)the need to achieve diversification;

(c)grid integration costs;

(d)network constraints and grid stability;

(e)for biomass, the need to avoid distortions of raw materials markets."

4. Longer-term evolution of purchasing programme

This report has examined the potential role and design of a purchasing programme for permanent carbon removals within the EU. A central conclusion is that **the design of an EU purchasing programme will need to evolve progressively over time, shaped particularly by two factors: (1) CDR technology and market development, and (2) the broader trajectory of EU climate and carbon removal policy.** These two dimensions will influence the programme's evolving objectives, and in turn the mandate and mechanisms for its effective implementation. Chapter 3 outlined a proposed purchasing programme design for the initial phase (2025-2030). This concluding section considers how this policy should develop beyond this period, and how ongoing technological, market, and policy developments will influence its future design.

CDR technology and market development is uncertain; how it progresses has implications for how the purchasing programme design should evolve. In our short-term purchasing programme policy design, we recommended prioritising policy designs that will deliver particularly technology development. This demands policies that can be swiftly implemented, with a focus on purchase methods that support relatively early-stage technologies, e.g. through a diverse CDR portfolio, the use of offtakes, and provision of additional services to also foster external demand, alongside coordinated supply-side support policies. It is important, especially in early phases, that the purchasing programme prioritise testing and demonstration of efficacy and safety, focussed not on cost or quantities, but supporting innovation. As technologies and markets mature, the purchasing programme should adapt, with the focus shifting over time to cost-effectiveness. This cost-effectiveness must also carefully consider the societal net-benefits of different technologies, including e.g., resource and energy use, biodiversity impacts, and competitiveness aspects. The purchasing programme must be designed to ensure that as technologies and markets develop, our understanding of the impacts and effectiveness of different CDR technologies, helping us to adapt the purchasing programme (and related policy) to best meet our objectives.

The medium- and long-term development of an EU purchasing programme will be most significantly influenced by broader developments in EU carbon removal and climate policy. Key issues at the EU level, which are beyond the scope of this paper, include:

- **ETS integration**: Will carbon removals be integrated in the EU ETS? In what way, e.g., through an intermediary institution or direct purchase of CRCF credits and under what conditions (e.g., with quantitative limits or requirements)? How will the ETS be adapted (e.g., changes to MSR, cap adjustment etc.)?

- **Removals obligations**: Will a compliance mechanism be implemented to ensure demand for permanent carbon removals, what form would this take, and how should it be governed?
- **Future vision of carbon removals sectors**: What scale of permanent carbon removals is anticipated? What will be the role of public ownership? How will "hard-to-emit" emissions be defined? What will be the balance between nature-based and other removals?
- **Non-EU developments** will also be important, including Member State ambition regarding carbon removals, as well as the development of private sector commitments to emissions reductions and carbon removals (and relevant frameworks, including the Science-based Targets Initiative's Net Zero guidance, among others), as well as international action on carbon removals.

Each of these points will have decisive impact on the role and structure of an EU purchasing programme in the medium and long term. As decisions are made, they will also impact the short-term design of the purchasing programme, which should be adapted to support an appropriate transition towards the longer-term policy. For example, if ETS integration or removals obligations are foreseen, with their implication of clear future demand, it may be more appropriate to focus the purchasing programme's short-term purchases on immediate deliveries of CRCF credits, where a lack of demand would remain. Such political decisions will also generate a need or opportunity for new policy interventions, which have not been considered in this paper. For example, "clean-up certificates" or other transitionary tools towards ETS integration or removals obligations could be appropriate to smooth the transition from the proposed purchasing programme to a compliance policy.[73]

The effectiveness and efficiency of the EU purchasing programme will also depend on other concurrent policy interventions. Supply-side support options will be important to further support technology development and market upscaling, with options discussed in Witteveen et al. (2025). Progress related to research funding or carbon removals infrastructure (e.g. storage and transport), among other issues, will also be essential. Open questions, such as the scale of public funding available for purchasing carbon removals, will also influence the design and success of the purchasing policy.

[73] See e.g. Lessman et al (2024) and Sultani et al. (2024) for discussion of clean-up certificates and options for sequencing permanent CDR into the EU ETS.

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6. Annex 1: Examples of existing procurement policies or related policies

6.1. H2 Global

Scope (and objectives):

H2Global has a broad scope: it aims to support the development of markets for clean hydrogen (and other low-emission fuels) while mobilizing public and private capital towards them. It supports his objective through research and outreach but primarily aims to achieve this through its market-based instrument, the H2Global mechanism, which is implemented through a subsidiary company, Hintco. The H2Global mechanism "accelerates clean hydrogen market creation through a pioneering double-auction mechanism combined with an intermediary—Hintco—that enters contracts with sellers and buyers that often struggle to connect independently at an early stage of market development. This intermediary then buys products—which are typically more expensive than their carbon-intensive counterparts—to sell them through an auction at a lower price to end consumers supporting demand build up. The price difference is covered by public funding though conceivably it could also be covered by climate funds, private capital, or a combination thereof." Hintco's main function is to implement a competitive bidding process for the purchase and sale of clean hydrogen and other low-emission fuels.

Institutional structure:

The H2Global Foundation is an independent foundation. The foundation is governed by a Board of Trustees and a two-person Executive Board. The Board of Trustees is elected by the donors (made up of companies along the renewable energy value chain). It has a high degree of autonomy and independence. It wholly owns the subsidiary "Hintco" – the implementing entity of the H2Global mechanism.

Funding:

H2global foundation is funded by the German government, the Bezos Earth Fund, and 71 corporate donors from the hydrogen value chain. Hintco is owned by H2global. The funding for its tenders (and the contracts for difference) come in the form of pay-as-you-go funding. This is generally public, though this could differ depending on the tender and funding bodies priorities. Current/in preparation tenders are funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) and Dutch Ministry of Economic Affairs and Climate.

Purchase method:

The H2global mechanism, run by Hintco, acts as an intermediary, making purchases (and sales) using a model related to carbon contracts for difference. They make multi-year (up to ten-year) hydrogen purchase agreements with sellers of hydrogen, which provide sellers with fixed prices and quantities of sales, and the necessary security to make investments. Sellers are selected through pilot auctions (tenders). These tenders can be divided up into lots e.g. the 2024-33 €900million BMWK-funded tender features three lots, focused on three products: Ammonia, Methanol, eSAF.

Figure 6: Hintco for H2global contract for difference market development model (Hintco 2024)[74]

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H2global mechanism also sells hydrogen, e.g. through auctions to buyers who have short-term (one-year) offtake agreements with buyers of hydrogen.

Due to nascent state of market, there is currently a gap between sale price and buyer price. This is bridged (i.e. contract for difference) using external funding (e.g. from German government, although other jurisdictions or private funders can also provide funding.

The purchase method supports market development by providing long-term secure demand to hydrogen developers, generating transparent price willingness-to-pay and willingness-to-sell price information.

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6.2. 45Q Tax Credit

Scope (and objectives):

The 45Q tax credit is offered by the US Internal Revenue Service for the sequestration of carbon oxides. The tax credit is performance-based (meaning payment is paid per tonne of removal achieved) and is offered to projects that capture carbon oxides from eligible industry and facilities, power plants, or directly from the atmosphere. As such, we can consider its scope as somewhat narrow: it aims to foster the development of carbon removals, but in a rather targeted manner and in specific domains. Currently, it only covers DACCS, but still makes a big impact since the 45Q provides a guarantee of up to USD 180 for every tonne of CO2 captured from future plants. The guarantee is provided even if the private buyers pull out.

Institutional structure:

The tax credit can be considered as a budget item/is rule-based. It is administered by the US Internal Revenue Service (IRS), the federal department responsible for collecting federal taxes and implementing the tax code. It is an agency of the Department of the Treasury and led by a Commissioner appointed by the US President. As such, elements of the tax code and the IRS' mandate can be influenced by the ruling party and president of the United States.

Funding:

The funding for the 45Q tax credit comes via the US federal budget and is instrumentalized as foregone tax revenue. The credit came into existence in 2008, was initially expanded in the 2018 Bipartisan Budget Act, and strengthened once more in the 2022 Inflation Reduction Act. Estimates from the Department of the Treasury expect the expenditures resulting from the 45Q tax credit at $2.4 billion from 2022-26, and $30.3 billion from 2022-32. As it is a tax credit, we can infer that at present the funding is effectively unlimited.

Purchase method:

Flat rate price (per tonne tax credit), ranging from $60-180/metric ton depending on the project (see below). To claim the tax credit, the secure storage of captured or reused carbon must be proved through processes (MRV/LCA) established by the US department of Treasury, IRS, the US Environmental Protection Agency, and the Department of Energy.

Figure 7: 45Q tax credits (Carbon Capture Coalition, 2023)

	For dedicated secure geologic storage of CO_2 in **saline or other geologic formations**	For **carbon reuse projects** to convert carbon into useful products (e.g., fuels, chemicals, products)	For secure geologic storage of CO_2 in **oil and gas fields**
INDUSTRY & POWER	$85/metric ton	$60/ metric ton	$60/ metric ton
DIRECT AIR CAPTURE	$180/ metric ton	$130/ metric ton	$130/ metric ton

Source: Carbon Capture Coalition, 2023

Reference: Carbon Capture Coalition (2023). Primer: 45Q Tax Credit for Carbon Capture Projects.

U.S. Department of Energy (2022). 12.01 Carbon Management: Brad Crabtree's remarks at 12.01 Carbon Management on December 1, 2022.

6.3. Global Climate Partnership Fund

Scope (and objectives):

The GCPF if a financing instrument with a relatively narrow scope which aims to facilitate investments in climate projects. This is achieved by providing local financial institutions with credit lines that can in turn be used to offer loans to projects in renewable energy, energy efficiency, and greenhouse gas reductions.

Institutional structure:

“The Global Climate Partnership Fund is an investment company under Luxembourg law. It was established by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and KfW Entwicklungsbank in 2009.” A six-person board, appointed by

shareholders, is responsible for decision making and defining the strategic orientation of the GCPF.

The Technical Assistance Facility is established in parallel to the GCPF and aims to support the growth of existing investees of the fund and to facilitate new investments. “Activities which could be funded through the TA Facility include Business development support; Technical appraisals of potential initiatives; support financial institutions in developing their sustainable energy financing portfolio, including the design of dedicated products; improve the social and environmental management systems (SEMS) of GCPF partner institutions; Market research as well as feasibility studies to enable the start-up and planning phases of potential direct investments. (NDC Partnership 2024).

The investment manager is “responsAbility Investments AG,” and runs the key business activities and manages the Technical Assistance Facility.

Funding:

GCPF operates a blended funding model, aiming to leverage public funds through private investments. Private investments can come from financial institutions like banks, microfinance institutions, pension funds, or insurance companies; or they can come from “climate-focused companies”. Public funds come through governments and development finance institutions.

Purchase method: The Fund is primarily a green lender, providing early stage or catalytic debt financing for companies addressing climate change in the developing world.

Reference: NDC Partnership (2024) Global climate partnership fund (webpage). https://ndcpartnership.org/knowledge-portal/climate-funds-explorer/global-climate-partnership-fund-gcpf, accessed 05.12.2024

6.4. Global Energy Efficiency and Renewable Energy Fund

Scope (and objectives):

The Global Energy Efficiency and Renewable Energy Fund (GEEREF) is a “fund-of-funds” that invests in private equity funds specialized in renewable energy and energy efficiency. It has a focus on emerging markets across Asia, Africa, Latin America, as well as non-EU Eastern Europe. In terms of its investment focus, it targets funds developing small to medium-sized projects in renewable energy (including hydropower, solar, wind, biomass, and geothermal) and energy efficiency (including waste heat recovery, energy

management in buildings, co-generation of heat and power, energy storage and smart grids).

Institutional structure:

GEEREF is a public-private partnership, initiated by the European Commission in 2006, and launched in 2008 with funding from the European Union, Germany, and Norway. GEEREF is managed by a Board of Directors, with investment decisions being made by its Investment Committee. It receives important advisory support from the European Investment Bank and the European Investment Fund.

Funding:

GEEREF received initial funding in 2008 from the EU, Germany, and Norway of EUR 112 million. By 2015, it finalized its fundraising from private sector investors to bring the total value of the fund to EUR 222 million.

Purchase method:

GEEREF invests in private equity funds (i.e. equity investment). These funds then invest directly into private sector projects. As of May 2019, the fund is fully invested in 15 funds across its target areas.

Reference: GEEREF (2024). What GEEREF is (webpage). https://geeref.com/about/what-geeref-is.html, accessed 05.12.2024

6.5. KliK Foundation

Scope (and objectives): The KLiK Foundation has a relatively narrow scope and is tasked with fulfilling the legal requirements of oil companies to offset the CO2 emissions generated by the use of their fuels.

Institutional structure:

The KliK Foundation (The Foundation for Climate Protection and Carbon Offset) is a private organization, initially founded in 2012 by the Swiss Petroleum Association (now Avenergy Suisse). The Foundation operates independently and is supervised by the Swiss Federal Foundation Supervisory Authority and audited by KPMG. The Foundation has a six-person board of trustees made up of representatives of the fuel importers and retailers. The president of the Board is also the president of Avenergy Suisse. There are approximately 20 staff members working for the Foundation.

The Swiss Federal Office for the Environment establishes rules for emissions reduction activities (equivalent to e.g. Gold Standard certification methodology). This sets the minimum requirements for activities to qualify as emissions reductions actions, and in turn the rules for quantification of impact. KliK is then charged with finding and paying for these activities (e.g. develop projects, pay market price, commercial development). Swiss regulators set emissions factors when they don't agree with those defined in voluntary carbon markets

Funding: Funding for the programme comes from a charge added to sales of petrol and diesel of up to 5 centimes per litre. Legally, the surcharge is on the fuel companies (i.e. importers of fuel); they transfer their obligation to the KliK and KliK then funds mitigation actions as offsets on behalf of the fuel companies. This money raised from the surcharge is passed to the KliK Foundation, who have full control over use of the procedures. KliK uses the funds to support the adoption of climate-friendly technologies (e.g. switching to a heat pump) among companies and individuals. The resulting reduction in GHG emissions are then quantified by myclimate (a separate, non-profit climate protection organization) as subsidies, and passed to the KliK Foundation as certificates (emissions allowances), which are then transferred to the Swiss federal government, who count them towards Switzerland's climate targets.

Purchase method: Procurement is typically done on a project-by-project basis, with KliK purchasing the resulting emissions reductions as offtakes. The foundation does not put out calls for tenders but rather develops projects or encourages the development of projects themselves.

The pricing is a fixed price per tonne, which differs per project and mitigation type. Prices range from approximately €80-200 per tonne depending on the mitigation type. KliK operates what can be considered a demand monopoly – they pay the price required to move the needle (and thus ensure the project takes place), but do not pay more as this would be discriminatory. There is a concern that the board is biased with how they select projects, for example by buying biofuel credits. Additionally, Switzerland has pushed for KliK to pursue international projects in line with article 6.2 agreements.

References: KLIK (2024) KLIK Foundation website. https://www.klik.ch/en/home, accessed 09.12.2024

6.6. Frontier Climate

Scope (and objectives):

Frontier is an "advance market commitment" that supports the development of carbon removal technologies by guaranteeing future demand. The goal is to

purchase at least $1 billion of carbon removals by 2030.Thus, we can say that it has a somewhat broad scope, as it aims to foster the development of the removals market. It does not, however, aim to manage the carbon removal market overall.

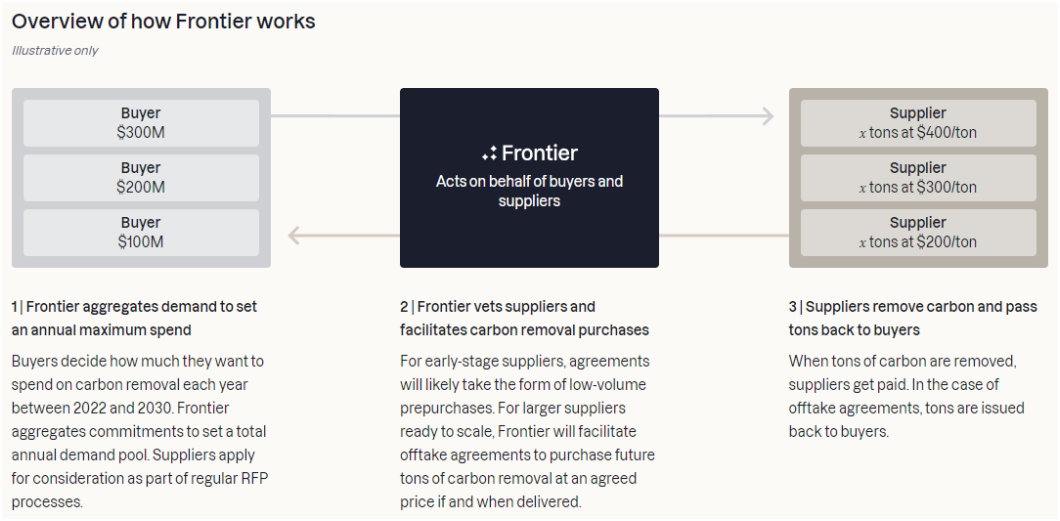
Institutional structure:

Frontier is a public benefit LLC that is wholly owned by Stripe Inc. The additional founding members are Alphabet, Shopify, McKinsey, and Meta. It is managed by a team of technical and commercial experts on behalf of buyers. The founders serve on a Founder Advisory Board, and further advisory expertise is gathered from a group of nine industry experts.

Funding:

Funding for Frontier comes via a pay-as-you-go approach. Buyers can participate in two main ways. Firstly, they can join Frontier as a member, requiring a $10 million commitment to purchase removals through Frontier until 2030. Alternately, buyers can purchase the Frontier portfolio, with no purchase minimum. This can involve purchasing the full frontier portfolio, or just from one of Frontier's offtake companies. Payment is made upfront for delivery between 2025-27.

Figure 9: Overview of Frontier Climate fund (Frontier Climate, 2024)



© Frontier Climate

Purchase method:

Procurement at Frontier is typically done on a project-by-project basis, often through bilateral negotiations with suppliers they agree on offtake agreements for future permanent CDR, in some cases pre-purchases are also made.

Reference: Frontier Climate (2024). Landing page (webpage). https://frontierclimate.com/ accessed 29.11.2024.

6.7. NextGen CDR

Scope (and objectives):

NextGen operates as an advanced market commitment, and states that they aim to "build a market for credible, scalable carbon removal by supporting projects that remove atmospheric CO2 emissions at scale." Thus, the scope is rather broad and hopes to foster the development of a removals market. Upon its announcement in April 2023, it had made an advance purchase of 200,000 tons of removals from three projects (DACS, biomass removal and storage, and biochar), with an intention to reach one million tons by 2025.

Institutional structure:

NextGen is run by South Pole and Mitsubishi. The founding members are Boston Consulting Group, LGT, Mitsui O.S.K. Lines, Swiss Re, and UBS.

Funding:

NextGen operates with a pay-as-you-go approach but appears to so far have a limited number of buyers besides the aforementioned companies (at least not publicly disclosed). Purchases seem to be made with offtake agreements with removals providers, with a target average price of $200 per tonne. Part of NextGen's offering is a "diversified portfolio" which comes with reduced risk compared to purchasing directly from projects.

Purchase method: Purchases are made through (short-term) offtake agreements with removals providers, with a target average price of $200 per tonne

Reference: NextGen CDR (2024) NextGen Impact Report - Unlocking the market for durable carbon removals. https://www.nextgencdr.com/wp-content/uploads/2024/01/NextGen_ImpactReport2023_Final.pdf, accessed 05.12.2024

6.8. European Hydrogen Bank

Scope (and objectives):

The aim of the EHB is to "create investment security and business opportunities for European and global renewable hydrogen production." More specifically, it aims "to unlock private investments in hydrogen value chains, both within the

EU and globally, by connecting renewable energy supply to EU demand and addressing the initial investment challenges." It operates with 4 key "pillars": scaling up the domestic (EEA) hydrogen production market, the EHB auctions (see below), an international pillar to attract imports of renewable hydrogen into the EU market and ensuring transparency and coordination of information supporting the market and infrastructure development.

Institutional structure:

The EHB is not a physical institution, but rather a financing instrument run by the European Commission.

Funding:

The funding for the EHB comes via the EU's Innovation Fund. The Innovation fund is an EU funding program aiming to support the commercialization and deployment of clean energy technologies. The financing for the Innovation Fund, in turn, comes from revenues from auctioning allowances in the EU ETS. In addition, the EHB also offers an auction-as-a-service model, bringing in additional funding from MS.

Purchase method:

Purchases operate through an auction system via the EU's Innovation Fund. "The successful bidders under the IF24 Auction will receive a fixed premium in €/kg of renewable hydrogen produced, over a maximum of ten years of operation. The Innovation Fund support will bridge the gap between production costs and the price that off-takers' are ready to pay for renewable hydrogen." (EC, 2024) This can be considered a carbon contract for difference.

Reference: European Commission (n.d.). European Hydrogen Bank (webpage). https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/european-hydrogen-bank_en accessed 05.12.2024

European Commission (2024). Second renewable hydrogen auction: European Commission publishes Terms and Conditions (webpage). https://climate.ec.europa.eu/news-your-voice/news/second-renewable-hydrogen-auction-european-commission-publishes-terms-and-conditions-2024-09-27_en accessed 05.12.2024

6.9. EU Innovation Fund

Scope (and objectives):

The EU Innovation Fund is a funding programme that aims to support the deployment of net-zero and innovative technologies. These include: “innovative low-carbon technologies and processes in energy-intensive industries, including products that can substitute carbon-intensive ones; carbon capture and utilisation – CCU; construction and operation of carbon capture and storage (CCS) facilities; innovative renewable energy generation; and energy storage”

Figure 10: Innovation Fund overview (EU Commission 2024)

© EU Commission:

Institutional structure:

The fund is a budget item managed by the European Commission. CINEA is responsible for the bulk of the implementation. The EIB provides and manages project development assistance, i.e. financial and technical advisory. The EIB is also in charge of monetising the Innovation Fund allowances from the EU ETS and managing the Innovation Fund revenues. The EIB reports regularly to the Commission.

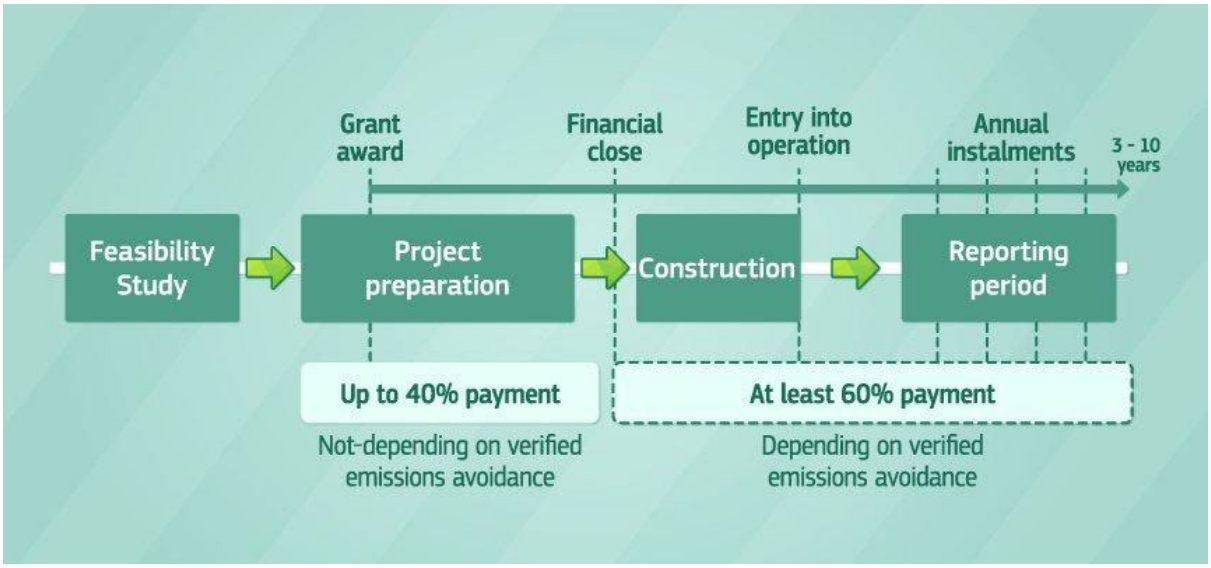
Funding:

This funding comes from revenues from the EU ETS. Unspent funds from NER300 (precursor to the Innovation Fund) were also transferred. “The Innovation Fund’s total funding depends on the carbon price, and it may amount to about **€40 billion** from 2020 to 2030, calculated by using a carbon price of €75/tCO_2. In practice, the Innovation Fund allowances from the EU ETS are being auctioned based on the agreed schedule and the revenues perceived are later used to provide support to innovative projects.“

Purchase method:

The fund makes regular grants (covering 60% of costs) and competitive bidding (100% of costs). Rather than purchasing units, the innovation fund funds projects (with no transfer of mitigation claims).

Figure 11: Overview of Innovation Fund grant procedure (EU Commission 2024)



© EU Commission:

Reference: EU Commission (2024) Innovation Fund (website). https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/competitive-bidding_en

6.10. Swedish BECCS

Description:

€3.1bn subsidy from Swedish government for BECCS, targeting biogenic CO2 from biomass. The subsidies are delivered through a reverse auction (cheapest offer wins the contract). Suppliers must demonstrate that they can safely remove, transport and store the biogenic CO2.

The first auction targets 600Kt removals with storage set to begin in 2026, with the target of achieving 2 $MtCO_2$-e annually by 2030. It is unclear how much will be paid for tonne, but likely under 143 USD (Höglund, 2024). CO2 capture cost estimated 48-135 USD/tCO2, however actual costs are likely well over 200 USD due to high costs for transport and storage (Höglund, 2024).

Scope (and objectives):

Between narrow and broad scope (moderate). Procure units but also to foster the development of the removals market. Competitive aspect to the subsidy. Objective is to crowd in private investment – buyers (e.g., Microsoft) can purchase permanent CDR for much cheaper than total cost due to the subsidy. The government creates predictable demand for the duration of the subsidy.

The objective of the subsidy is to achieve 30 Mt of CO_2 stored after the 15-year period and reduce emissions in Sweden. Corporate offset buyers must acknowledge that their purchases contribute to the achievement of Sweden's national climate targets (Höglund, 2024).

Institutional structure:

The Swedish government commissioned the Swedish Energy Agency to design and organize the auctions. Suppliers make bids through the TendSign procurement platform.

Funding:

Annual contribution from MS (Sweden). Funding comes from the Swedish government (taxpayer), who has allocated approx. €3.1b over the next 15 years (i.e. an initial endowment/annual contributions).

Purchase method:

Reverse auction: The purchase is carried out by selecting the tenders with the lowest tonne cost until all of the requested tonnes have been exhausted. In other words, suppliers are selected based on the shape of the marginal abatement cost curve, selecting the cheapest offers until all of the tonnes have been procured.

Pros and cons of approach in the Swedish context assessed in detail here: https://enveurope.springeropen.com/articles/10.1186/s12302-024-00971-0

6.11. Danish NECCS

Denmark has three different subsidy funds for CCS. All funds offer funding for the capture and storage of fossil and biogenic CO2, covering both CCS (emissions reductions) and permanent carbon removals (Danish Energy Agency, 2024). The NECCS fund is specifically targeted towards generating negative emissions units.

Description: NECCS fund is for capture and storage of biogenic and atmospheric CO2 to achieve negative emissions. Biogenic sources include CO_2 captured from biogas upgrading, biomass-based power and heat generation,

the biogenic portion of CO_2 from waste incineration plants, and carbon captured directly from the atmosphere (DACCS). The fund has been completed, with contracts awarded to three biogas CCS projects (DEA, 2024).

- 28.7b DKK (€3.85b) Negative Emissions Carbon Capture Storage (NECCS) fund.
- Included funding for Scotland based carbon removers, for CCS from organic sources including decomposition, fermentation and combustion.
- Remover providers are allowed to sell voluntary carbon credits to corporates, provided that the NDC attributes stay in Denmark. Excess revenues are then deducted from the received subsidy. Credits are verified by puro.earth and marketed as “permanent carbon removals”

Scope and objectives: The objectives are to both procure removal units on behalf of the government and to foster the development of a market for removals. The government projects that this fund alone will sequester 2.3 Mt of CO_2 annually from 2030 onward, equivalent to approximately 5% of Denmark's total emissions.

Institutional structure: The Danish Energy Agency manages the subsidy schemes and publishes the calls for tenders in the EU’s Tenders Electronic Daily (TED) procurement platform. The Danish Energy Agency evaluates the offers received for all subsidy schemes and selects the winning tender to award the contracts.

Funding: The funding for each scheme is provided by the Danish government, coming from the state budget.

Purchase method: Purchases in all funds are made through competitive tendering (project-based), where suppliers, if they have been prequalified by the DEA, can submit offers and participate in the negotiation phase. The DEA can negotiate various aspects of the tender documents and make potentially significant changes.

However, the rate paid can also depend on carbon prices (tax, ETS, carbon credit revenues). For example, the CCS fund subsidy rate subtracts savings made from the compliance carbon price as well as income from carbon credits.

6.12. US DoE CDR Purchase Pilot Price

Scope (and objectives):

The purchase pilot prize is a $35 million fund for purchasing CDR (DACCS, BECCS, ERW). It allows companies to compete for the opportunity to deliver

carbon dioxide removal units directly to DOE. The scope of the program is therefore relatively narrow, as it simply procures removal units on behalf of the government. Carbon removal units can be purchased by any individual or entity that is interested in responsibly managing their past and/or future carbon dioxide emissions. This scheme already includes buy in from Meta and Google[75].

Institutional structure:

The prize exists as a fund administered by an executive agency, the Office of Fossil Energy and Carbon Management at the US Department of Energy. As such, the managing institution has a limited mandate of implementing the prize.

Funding:

Funding is in the form of a contribution from the US budget (is provided from the Bipartisan Infrastructure Law Section 41005b).

Purchase method: Competitive project-based tendering with multiple winners of cash prizes. See table 2.5 for an overview of prizes.

Table 9: Summary of the US CDR purchase pilot prize (US Department of Energy, 2024)

Phase	Number of Winners	Prize amount per winner	Total cash prize pool
1	Up to 25	$50,000	$1,250,000
2	Up to 10	$375,000	$3,750,000
3	Up to 10	Up to $3,000,000 (CDR awards)	$30,000,000

Reference: U.S. Department of Energy (2024). Funding Notice: Carbon Dioxide Removal Purchase Pilot Prize (webpage). https://www.energy.gov/fecm/funding-notice-carbon-dioxide-removal-purchase-pilot-prize accessed 07.12.2024

[75] Google matched the government's investment of 35 million (see: US DOE calls on private sector to purchase carbon removal credits, Google steps up with $35-mln pledge match « Carbon Pulse)

6.13. US Regional DAC Hubs

Scope (and objectives):

$3.5 billion of public funding to develop four regional hubs (network of removers, transport, and storage) for direct air capture. Each must demonstrate the potential to capture at least 1 million metric tons of CO2 annually, to be stored in geologic formations or converted to new products. Managed by Department of Energy. Projects are tendered and selected based on multiple criteria. We can say that it has a relatively narrow scope, focused on technology development and fostering the supply of removals.

Institutional structure:

The DAC hubs are administered by the US Department of Energy's Office of Clean Energy Demonstrations (OCED), which received over $25 billion through the Bipartisan Infrastructure Law and Inflation Reduction Act.

Funding:

Contribution from US budget (the funding comes from the Bipartisan Infrastructure Law and is worth $3.5 billion). The first two selected projects (demonstrations in Texas and Louisiana), also receive support and investment from the private sector.[76] The latest notice of intent for funding states that projects require at least 50% non-federal cost share.[77]

Purchase method: The program makes up-front grants to support the establishment of the hubs. It announces notices of its intent to fund the technologies, along with the topic areas it is focused in.

References: OCED (2024) Factsheet Regional Direct Air Capture (DAC) Hubs Program – Project Cypress. US Department of Energy. Factsheet_DAC_ProjectCypress_8.8.24_0.pdf

[76] https://www.energy.gov/articles/biden-harris-administration-announces-12-billion-nations-first-direct-air-capture

[77] https://www.energy.gov/oced/articles/oced-issues-notice-intent-18-billion-fund-transformational-direct-air-capture

6.14. Canada: Carbon Capture, Utilization, and Storage (CCUS) Investment Tax Credit

Scope (and objectives):

The CCUS ITC is a budget item (refundable tax credit) applied in Canada for qualified CCUS projects from 2022-2040. It has a rather narrow scope, as it fosters the development of carbon removals in a targeted manner. To receive the tax credit, the project can operate in any of the following domains:

- "Capturing CO_2 that would otherwise be released into the atmosphere
- Capturing CO_2 directly from the ambient air
- Transporting captured carbon
- Storing or using captured carbon"

Projects must also intend to operate for at least the duration of the CCUS project review period (20 years).

Institutional structure:

The tax credit can be considered as a budget item/is rule-based. The CCUS ITC is administered by the Canada Revenue Agency (CRA), the government body responsible for administering taxes. The operation of the CRA is overseen by the commissioner of revenue, and it reports to the Canadian Parliament through the minister of national revenue.

Funding:

The funding for the CCUS ITC comes via the Canadian federal budget and is instrumentalized as foregone tax revenue. The CCUS ITC was first announced in the 2021 budget and has been updated annually in subsequent federal budgets.

Purchase method:

The tax credit is applied to qualifying expenditures on CCUS projects at varied rates depending on the type of project and the time frame. The rates are cut in half after 2030.

Figure 12: Regular credit rates for qualified CCUS expenditures incurred from January 1, 2022, to December 31, 2040 (EY, 2024)

Type of expenditure	Incurred from 2022 to 2030	Incurred from 2031 to 2040
Qualified carbon capture expenditures incurred to capture carbon **directly** from ambient air	60%	30%
Qualified carbon capture expenditures incurred to capture carbon **other than directly** from ambient air	50%	25%
Qualified carbon transportation, storage, or use expenditures	37.5%	18.75%

References: EY (2024). Canada enacts and updates investment tax credit for carbon capture, utilization and storage (webpage). https://www.ey.com/en_gl/technical/tax-alerts/canada-enacts-and-updates-investment-tax-credit-for-carbon-capture-utilization-and-storage accessed 05.12.2024

7. Annex 2: interviewees

Name	Organisation	Focus	Date
Mischa Classen	(formerly) KliK foundation	Independent foundation model policy option for CDR credit procurement	11 Nov 24
Paolo Piffaretti	ClimeFi	Carbon removal procurement strategies, buyer incentives	19 Nov 24
Christoph Beuttler, Valter Selén	Carbon Gap	Public procurement. Carbon Gap's new policy brief	19 Nov 24
Megan Kemp	NextGen CDR / South pole	Buyers' club model of CDR credit procurement	20 Nov 24
Cimerley Groß and Julius Lang	Novocarbo	Public incentives for biochar	22 Nov 24
Peter Freudenstein	Climeworks	Public incentives for DAC	2 Dec 24
Amy Sims	Boston Consulting Group	USA CDR upscaling expert, USA examples	2 Dec 24
Martin Schröder, Felix Stark, Matthias Börner	KfW	Buyers and potential implementers of a purchasing programme for CDR.	24 Feb 25
Martin Schröder, Felix Stark, Matthias Börner	KfW	Buyers and potential implementers of a purchasing programme for CDR.	14 Mar 25
Francesca Battersby, Valter Selén, Matteo Guidi	Carbon Gap	Draft policy options for purchasing programme	10 Apr 25

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