carbon gap

FROM TARGETS TO TONNES: EXPLORING COMPLIANCE OPTIONS TO DRIVE LASTING DEMAND FOR CARBON REMOVALS IN THE EU

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This report builds on quantitative analysis developed by CONCITO, the results of which are summarised in a separate Modelling Report.

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EXECUTIVE SUMMARY

Achieving the EU's legally binding goals of net-zero greenhouse gas emissions (GHGs) by 2050, and net-negative emissions thereafter, requires a rapid scale-up of carbon dioxide removal (CDR). While deep emissions reductions across all sectors must remain the priority, permanent removals are essential to support mitigation efforts in the short term, balance residual emissions from hard-to-abate sectors and achieve net-negative emissions in the second half of the century.

Today, the absence of a reliable source of demand for CDR is the primary obstacle to scaling permanent removals. The EU is supporting the development of small-scale CDR technology through R&D funding, and a handful of first-of-a-kind (FOAK) mid- to larger-scale projects are in preparation to deliver permanent removals before 2030. Nevertheless, there is an urgent need for policies that bridge that gap from FOAK projects to a full-scale CDR sector able to deliver tonnes in line with the European climate goals. Closing this divide will require creating large-scale and long-lasting demand.

The main proposal currently under consideration for creating a CDR compliance mechanism in the EU is integration into the ETS, the EU's flagship carbon pricing mechanism. However, given the current uncertainty on the progression of the ETS cap and the level of CDR demand that would be actually generated in case of integration, we felt the need to look at complementary policies beyond ETS integration that could generate long-lasting demand for removals up to 2050 and beyond. In this context, we have examined the ability of an EU Removal Compliance System (RCS) to drive significant volumes of high-quality permanent CDR by generating demand amongst market actors.

DEFINING AN RCS

An RCS is a generic term we use to describe a policy intervention that creates demand for CDR. The envisioned RCS would place an annual obligation on firms to remove and permanently store carbon in line with the EU's climate goals. By generating demand in this way, an RCS could deliver the permanent CDR volumes required by the wider EU economy to reach net-zero.

This report presents quantitative and qualitative insights based on modelling by CONCITO to derive key considerations for real-world policies. We present and analyse three policy design options for generating CDR demand up to 2050, each covering different demand sectors and both polluter-pays and ability-to-pay logics. By considering different obligation designs, our primary aim was to **determine the levels of CDR demand generation and the cost of compliance for entities under these different designs and outline their wider policy implications.**

Key findings from the modelling

Modelling by CONCITO builds on existing projections of EU emissions and expected CDR needs: the Commission's 2040 Impact Assessment and the Joint Research Centre. The assessment examines how to allocate these expected CDR volumes under three policy design options:

- **Option 1** – An RCS on CO_2 emissions covered under ETS I and II, approximating a "polluter pays" design.
- **Option 2** – An RCS on non-CO_2 GHGs not covered under ETS I and II, also approximating a polluter pays design, but for non-ETS sectors (excluding land sector emissions.)
- **Option 3** – An RCS on the wider economy, based on turnover, targeting combinations of large, medium, and small firms as defined by EU accounting law.

The key findings from the modelling in terms of potential demand sources for CDR and related considerations are outlined below.

Option 1: RCS on ETS-covered entities (polluter pays)

Due to expected high emissions in their sectors in the 2030s, ETS entities show a significant potential to deliver the necessary CDR volumes over this period through a polluter-pays RCS. Under two possible decarbonisation scenarios, the EU's need for permanent CDR gradually grows in the 2030s but remains low relative to emissions. Because of this trend, we show that **an RCS would need to obligate no more than 21% of ETS emissions before 2040 to meet EU-wide CDR needs.** Given this low share of obligated emissions, the average cost of complying with the RCS for an ETS entity (by purchasing the required amount of CDR) in 2040 is 29-57 EUR per tonne of CO_2 emitted (this is the ratio of the obligation cost to the total emissions of all covered entities). The Modelling Report shows that this amount remains well below the marginal abatement cost expected across the ETS-covered sectors. The gradual introduction of a CDR obligation, starting as a small share of emissions and growing to 100% over time, is thus effective in keeping the costs of the RCS low. The cost of complying with the RCS rises to 122-215 EUR/tCO_2 in 2050 as an increasing proportion of emissions are covered by CDR obligations, again remaining well below expected marginal abatement costs in that year. This cost is additional to any pre-existing carbon price, pointing to a need for further research on how such costs could be absorbed and how ETS and RCS prices might interact.

Option 2: RCS on non-CO2 GHG emitters (polluter pays)

A polluter-pays RCS could also place an obligation on non-CO_2 greenhouse gas (GHG**) emissions, either alone or in combination with ETS sectors.** Some 55 Mt CO_2eq/year of non-CO_2 GHG emissions from non-land sectors (we have excluded land-related emissions from our scope) are expected to persist in 2050 even with ambitious mitigation, with the largest portion originating from Waste Treatment and Energy & Transport. Although lower than the emissions from ETS entities, non-CO_2 emissions become relatively more significant over time as ETS emissions decline. These non-CO_2 emissions could therefore generate considerable demand for CDR under an RCS; a 100% obligation on non-CO_2 emissions in 2050 could meet 26-48% of EU CDR needs.

Option 3: RCS on the wider economy (ability-to-pay)

Expanding the scope of an RCS to large firms across the EU economy beyond the high-emitting sectors could increase the affordability of meeting the CDR obligation. An ability-to-pay RCS could introduce a CDR obligation based on firms' turnover (or another financial metric), not their emissions. An RCS targeting those "large" EU firms (as defined under EU accounting law) would bring in a wider array of firms to pay for CDR, given there are twice as many "large" firms in the EU as firms in ETS I and II combined. The cost of the obligation would reach 0.08-0.22% of turnover in 2050. Basing a compliance system on the ability to pay could ensure long-term demand for CDR even as emissions decline, potentially delivering net-negative emissions in the second half of the century.

- **Overall compliance costs are strongly linked to the composition of the CDR portfolio.** Our study focuses on a cost-optimising portfolio of permanent removals, including biogas CCS, bioenergy with CCS (BECCS), and direct air carbon capture and storage (DACCS). The availability of lower-cost options leads to minimal shares of DACCS being deployed. A policy design requiring a minimum of 25% of CDR delivered through DACCS (as an illustrative example) would diversify the CDR portfolio and limit the role of biomass; it would also increase the cost of complying with the RCS by 27% in 2050. On the other hand, including biochar and enhanced rock weathering (ERW) into the RCS portfolio would decrease costs by 16%.

Recommendations for Developing a Removal Compliance System

Based on the findings outlined above, Carbon Gap has identified key recommendations for designing the RCS as a long-term compliance instrument for CDR that supports the scale-up of carbon removals to achieve the EU's climate and economic goals.

1. **ETS integration (with a sub-mandate) is an important short-term route to generate CDR demand.** Integration of domestic CDR into the ETS, as is currently under consideration by the European Commission, can generate near-term CDR demand by leveraging an established policy framework. If CDRs are integrated, we recommend maintaining the gross cap on emissions to limit mitigation deterrence, while adopting a CDR "sub-mandate" to drive sustained and predictable CDR demand. The sub-mandate would require that a minimum (and growing) share of ETS obligations be fulfilled using CDR units.

2. **Proposals for a separate RCS should be developed to ensure long-term, large-scale demand**. While the RCS should target polluters (per Option 1), a focus on emissions may be inappropriate in the long-term, while ability-to-pay (Option 3) could be politically challenging. Combining elements of Option 1, 2 and 3 could enable an appropriate balance of large-scale demand and longevity. An RCS obligation could be based on multiple criteria simultaneously (e.g. considering both emissions and financial criteria) or sequenced over time. New criteria could be explored – such as an RCS placed on production levels for pre-identified sectors and activities. Obligations should be introduced gradually, with a focus on building a politically resilient tool that can grow towards 2050 and beyond. This phased approach will need strong, long-term consensus building and advocacy to ensure that politicians, firms, and the public understand the need for and function of the policy.

3. **The RCS scope should be broad, balancing the need for CDR at scale with the large costs of CDR units.** Covering a wide array of sectors would allow an RCS to spread the costs widely to include entities covered (directly and indirectly) by ETS I and II, and additional sectors that are high-emitting but not yet covered by carbon pricing. Non-CO_2 GHG emissions are a promising candidate for contributing to a CDR compliance market due to their persistence over time and the fact that most are not yet subject to carbon pricing at the EU level. Demand could be further expanded by looking beyond an emissions-based obligation, which concentrates obligations at one point in the value chain, to a production-based obligation, which would allow multiple actors within the same value chain to contribute to CDR demand and better spread the costs.

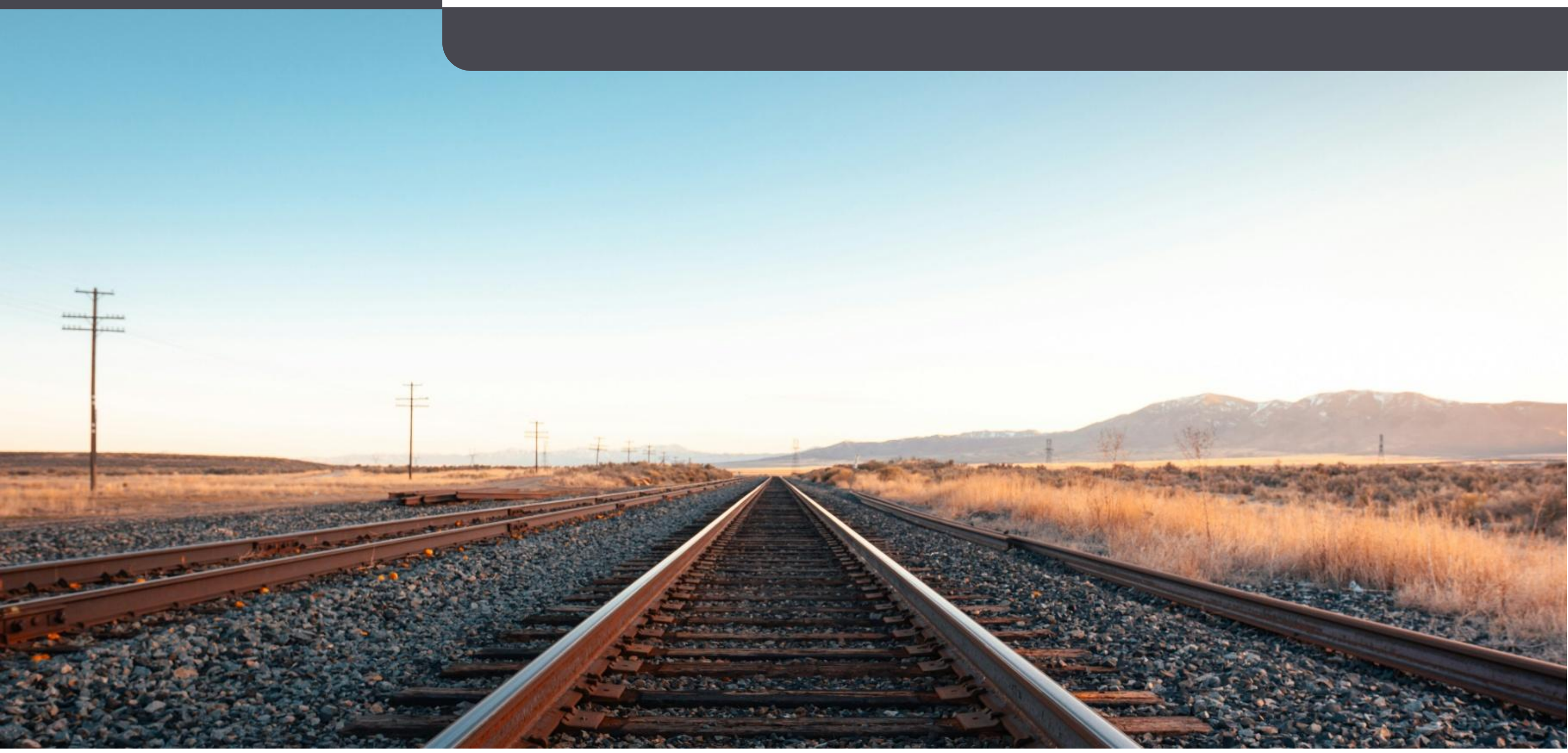
4. **Policymakers should also assess how an RCS would affect EU-firms' ability to compete with non-EU firms.** As an RCS is gradually introduced, it will be important to ensure a level playing field with non-EU entities since EU companies would bear the additional costs of CDR obligations. Further analysis is needed to assess if the impacts on EU firms' competitiveness relative to non-EU firms could be addressed through existing carbon leakage policies, such as the Carbon Border Adjustment Mechanism (CBAM) or a separate policy instrument.

5. **The EU must establish clear, quantifiable targets for permanent removals as a precondition to integration into compliance markets.** These targets are essential to clarify how much permanent CDR the EU needs over time to meet its climate neutrality goals and to inform and create legitimacy for demand-side policies like an RCS.

KEY TAKEAWAYS

To support continuous demand for CDR at scale the EU must seek to build a compliance market, using a sequenced approach.

- **To address near-term demand**, this should involve the integration of CDR to the ETS with a CDR sub-mandate, while adopting guardrails to limit mitigation deterrence and ensure sustainability.
- **To address long-term demand**, the EU should explore options for a Removal Compliance System (RCS). An RCS should be gradually introduced, while making sure that its costs are spread across the economy and competitiveness risks are managed, to build a politically resilient tool that can grow towards 2050 and beyond.



1. INTRODUCTION

Reaching EU climate goals will require significant funding toward carbon removal

The EU needs to remove and permanently store hundreds of millions of tonnes of carbon dioxide from the atmosphere annually by 2050 to reach its climate neutrality goals, according to its own and latest scientific assessments.[1,2,3] Such volumes demand substantial investment into scaling and then operating a European carbon dioxide removal (CDR) sector in order to scale it quickly and systematically over the next decade. In particular, the capacity of permanent CDR methods[4] is currently too low and must be rapidly scaled up to ensure that any remaining fossil emissions can be effectively balanced, in accordance with the like-for-like principle of carbon flows.[5] To date, policy discussions on financing permanent CDR have centred on the role of public entities such as national governments in financing CDR research, development and early deployment. Yet a question remains as to who will pay for the long-term operation of the CDR sector at scale.

Today, CDR suppliers cite difficulties in accessing investment, both from public and private sources. Without a clear market signal that there will be lasting demand for removals, CDR projects cannot be seen as bankable and potential investors do not know how they can achieve a return. Policy interventions are needed to address this investment gap – one such option is the establishment of a "compliance" framework, mandating certain entities to buy CDR over time. This report, which builds on the findings of a modelling carried out in partnership with the Copenhagen-based think tank CONCITO, introduces policy options for a Removal Compliance System (RCS) and evaluates their efficacy in generating lasting demand for CDR.

The context: fragile voluntary demand and lack of clear incentives to buy CDR

At present, voluntary purchases by corporates are a key, but limited source of demand for CDR. Alongside voluntary corporate action, several European demand instruments have been focusing on early-stage R&D funding or incentives, or even First-of-a-Kind (FOAK) project funding. Recent developments show further policy momentum towards CDR deployment support. These include incentives via state aid, infrastructure deployments for carbon transport and storage, and dedicated project deployment funding. Governments, however, face constraints in financing an entire new sector, especially during times of financial pressure on public budgets. Voluntary demand is thus helpful but has proven unreliable as a framework for CDR investment at scale. Voluntary financing of durable CDR activities is made by a very small number of companies globally, because, as the name implies, it is done in the absence of policy drivers or legal requirements. Such transactions rely on a favourable social and political context that encourages high-integrity climate action. Even where companies do make voluntary purchases, those purchases are strongly influenced by organisational preferences and affordability, which shape the type and price of CDRs selected. Market data reflect this fragile demand

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[1] European Commission (2024). Impact Assessment Report: Part 1. Securing our future - Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society.

[2] Neuwahl, F. et al. (2024). Clean Energy Technology Observatory: POTEnCIA CETO 2024 Scenario. Joint Research Centre.

[3] European Scientific Advisory Board on Climate Change (2025). Scaling up carbon dioxide removals – Recommendations for navigating opportunities and risks in the EU.

[4] Throughout this report, we refer to permanent CDR as methods which can store carbon away for centuries to millennia, delivering long-term climate benefits.

[5] While this report focuses on sources of demand for permanent CDR, Carbon Gap recognises and strongly supports the development of parallel incentives for land-based removals, complementing the existing Land Use, Land-Use Change and Forestry (LULUCF) Framework. The like-for-like principle stipulates that long-lasting fossil emissions must be compensated by permanent removals (e.g., through industrial methods such as BECCS and DACCS) and emissions from biological processes enhanced by human activity by temporary biomass-based methods (e.g., enhanced ecosystem management and storage in products) to respect the natural carbon cycles and achieve a state of 'durable net-zero'.

- in 2024, fewer than 1% of companies with science-based targets had bought novel CDR, and most novel CDR startups were yet to make a sale.[6]

Given this fragile voluntary demand, so-called "compliance" systems could provide a north star for CDR policymaking. A CDR compliance system would establish a legally enforceable obligation to buy removals and would provide a more reliable source of revenue for CDR projects. Compliance systems could bring in a wider range of buyers compared with voluntary self-selection. They could also enable standardisation and harmonisation, setting clear rules about what type of credits or projects are eligible.

The EU as a CDR global leader and the need for compliance policies to drive demand

The EU has a unique opportunity to lead globally in CDR by advancing deployment at scale, which is essential to meeting its (proposed) 2040 and legally binding 2050 climate targets. To unlock this potential and reap the economic and climate benefits of CDR, compliance policies need to be put in place to create lasting demand for high-integrity, permanent removals.

One proposal for a CDR compliance mechanism in the EU currently under consideration is the Emissions Trading System (ETS), the EU's flagship carbon pricing mechanism. ETS I sets a cap on the total greenhouse gas (GHG) emissions from power plants, industry, aviation and maritime, and allows companies to buy and sell emission allowances, therefore incentivising cost-effective emissions reductions and driving investment in low-carbon technologies. By law, the European Commission must assess the integration of CDR into the EU ETS I by July 2026 and potentially present a legislative proposal to take this forward – something the Commission now seems likely to pursue.[7] The impacts of integrating CDR into the EU ETS are already being assessed by various stakeholders, including by the European Scientific Advisory Board on Climate Change.[3] **Yet, few have considered alternative or complementary policies, beyond an integration into the ETS, for establishing an adequate market for CDR that meets the EU's climate needs**. This timely report aims to fill this research gap and support the work of EU policymakers as they explore different pathways for CDR compliance policies over the immediate and longer-term horizon.

A UNIQUE ANALYSIS

This report constitutes the first quantitative analysis of the potential role of an RCS as a policy that could establish a long-term market for CDR, harnessing demand from firms, while creating a predictable and growing market signal driving CDR investment and innovation.

Unlike other instruments, such as a dedicated tax used to fund government purchases of carbon removals, an RCS directly obliges firms to procure and retire verified CDR credits. The RCS distributes both financial and administrative responsibility for CDR among an array of entities, reducing the burden on governments.[8] The fact that many firms are already familiar with complying with carbon market rules could facilitate the implementation of an RCS.

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

[7] European Commission (2025). Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality.

[8] Alternatively, a CDR sector of the future could be operated as a public utility, run by the state on behalf of the entities within it, without the need for a commercial case as described in this report. This model could bring a number of advantages – a streamlined system of state purchasing or state operation of CDR supply could perhaps be more cost efficient overall and could be combined with taxes or levies to raise revenue from polluters. Yet this approach also poses potentially enormous start-up and running costs for government to bear, potentially poor value for taxpayers, and in the case of additional taxation, sits outside of EU competencies. In this report, we conceptualise an RCS as a demand-side obligation on individual firms to purchase CDR. We see this system as a politically practicable and fairer approach, building on EU competencies and mirroring successes with the ETS.

To date, this report and the modelling study which underpins it constitute the **first quantitative analysis of an RCS** examining how best to formulate and where best to target CDR obligations. In this way, an RCS could support the nascent carbon removal sector and contribute to Europe's transition towards a climate-neutral economy.

Examining options for a Removal Compliance System

Building on the quantitative analysis carried out in partnership with CONCITO, this report assesses three core policy options for an RCS and outlines related policy considerations. **Our three options focus on different possible sources of demand for CDR relative to the volumes foreseen for EU climate neutrality.** This report does not look into the details of RCS policy design and implementation, though this has been explored by other authors to some degree.[9,10]

As a reference point for EU CDR volumes, we rely on two emissions pathways from EU models. Firstly, we consider the pathway presented by the European Commission in their 2040 climate targets **Impact Assessment (IAS3 scenario),**[1] which reaches climate neutrality by 2050. As an alternative future emissions scenario, we additionally use a recent projection from the **Joint Research Centre (JRC scenario).**[2]

We explore **three possible options for the obligated entities ("demand sources") to generate the CDR volumes needed to meet the EU's climate goals**: (1) those entities emitting CO_2 under EU Emissions Trading Systems (ETS I and II), (2) entities emitting non-CO_2 GHGs (outside of the land-based sectors), and (3) entities across the wider economy. These three policy options can also be distinguished from the distinct rationales of the obligation: Options 1 and 2 adopt a polluter pays approach, whereby the obligation is directly linked to an entity's emissions, while Option 3 follows an ability to pay rationale, whereby the obligation is distributed according to an actor's financial capacity (in this analysis based on turnover). In both cases, the main starting point has been to assess the possible allocation of EU CDR needs from existing scenarios to different entities and sectors across the economy through a dedicated compliance policy.

We consider overall CDR demand creation and associated compliance costs, as well as the sectoral distribution of obligations, affordability, and impact of including different CDR methods in a compliance system. To support this discussion, we explore how the CDR volumes consistent with the Commission scenarios could be met by a **portfolio of CDR methods** (biogas CCS, BECCS, DACCS, enhanced rock weathering (ERW), and biochar) using a simple cost-optimising economic model.

[9] Meyer-Ohlendorf, N. et al. (2025). [EU Climate Framework for 2040: How to Incentivise Carbon Removals?]() Ecologic Institute.
[10] Zetterberg, L. (2025). [An EU Removals Target and Trading System (RTTS) for Carbon Dioxide – Concept paper for discussion.]() IVL.

Box 1: A Removal Compliance System in the broader EU CDR framework

It is important to note that an RCS should be considered as part of a larger CDR policy framework. A demand-side policy like an RCS will not on its own deliver CDR at scale in the EU. Although it will establish a long-term market signal that will strongly shape the CDR sector, it must be complemented by other key policies that encourage technology development, shape markets, and set out dedicated, legally enforceable EU goals. Below we put these policies in context, building on our EU CDR Strategy from spring 2024.

Supply-side policies are a crucial first step to kick-start CDR in Europe. **A purchasing or procurement programme,** as currently being explored by the European Commission,[11] should be designed to foster early demonstration of CDR technologies, putting them on a path to scale up, while at the same time kick-starting large-scale CDR demand. In this way, CDR procurement is a key near-term policy intervention to enable the establishment of compliance markets.[8]

A **dedicated EU CDR target for 2040**, with distinct sub-targets for permanent and land-based removals, is also needed to provide a clear signal for the quantity and type of removals required over time. Without such a target, the EU risks falling behind as it ramps up CDR volumes towards 2050 and beyond. CDR targets would create a strong signal encouraging further investment and market development. A separate EU CDR target would also underpin any RCS, legitimising the need for a compliance system and informing the level at which obligations are set. How the contribution to such CDR targets would be divided between state and corporate entities, what claims those entities could respectively make, how their CDR use would be accounted, and through which legal tools it would be implemented, are key questions that will influence the design of an RCS.

Building on synergies within the broader European carbon management strategy. Further progress and political incentives towards the establishment of a well-functioning carbon transport and storage infrastructure are crucial enablers for most permanent CDR methods modelled within this approach. European efforts towards faster and wider deployment of transport and storage infrastructure must be deployed with use of such infrastructure for CDR in the medium to long term.

An RCS can be considered as a mid- to long-term north star within a phased approach to scaling up CDR in Europe, crucial to sustaining growing volumes of carbon removals over time and reaching net-negative emissions. Realistically, an RCS cannot work in isolation, but will serve as one important piece in the EU's CDR puzzle.

[11] McDonald, H. et al. (2025, July). An EU purchasing programme for permanent carbon removals: Assessment of policy options and recommendations for short-term policy design. Ecologic Institute and Ramboll. European Commission. DG Climate Action.

2. POLICY OPTIONS FOR A REMOVAL COMPLIANCE SYSTEM

The quantitative analysis reviewed three core policy options for an RCS, outlined in this section, with an examination of policy considerations in the subsequent sections. All options are based on the principle of obligating firms to deliver specified CDR quantities on an annual basis from 2030 to 2050. These options differ primarily in terms of (1) the obligated entities, and (2) the rationale for the obligation. Yet, in all options the method of compliance is the same – entities must, on an annual basis, purchase or deliver eligible CDR units at a volume commensurate with the obligation level.

The modelling and the analysis of these options have been carried out to generate insights into the potential policy implications for an RCS. Therefore, the options are more relevant when considered as a continuum rather than as individual design choices for a concrete policy proposal. A full overview of the quantitative results for all the options can be found in the Annexes (Table A2).

Box 2: Who pays for CDR? The relevance and limits of "polluter pays"

The notion of making emitters pay for climate action is well established in international environmental governance as the "polluter pays" principle. In conventional carbon tax or carbon pricing systems (like emissions trading systems), emitters pay for (parts of) their pollution in direct proportion to their emissions in a one-for-one ratio. This model could potentially be instructive for CDR; in an equivalent CDR system, the biggest emitters would buy the most removals.

CDR will be needed to deliver net-zero CO_2 emissions but also to address net negative ambitions corresponding to any (limited) overshoot of carbon budgets. This is reinforcing the fact that large CDR volumes will need to be sustained in the EU over the long term. Yet, as global emissions decline, thanks to continued decarbonisation efforts, a polluter pays approach will rely on a shrinking base of emissions to finance CDR at scale. This trend means that the CDR units will need to be purchased by a reduced number of players, creating a growing burden for the entities that continue to emit.

"Polluter pays" may eventually be an unsustainable way to pay for CDR. We see a need for further research on what a "polluter pays" approach would mean for CDR, as several of our modelled scenarios outline a clear tendency of an increasing burden towards polluters, such that they end up with obligations exceeding 100% of their emissions. Alternative rationales in allocating climate effort have been considered in the literature on carbon budgets. Such rationales include "ability to pay", which we will examine in this report as a potential principle for allocating CDR obligations.

Other research on potential obligation pathways, such as a Carbon Takeback Obligation, are not reflected within this report.

2.1. Option 1: RCS for ETS entities (polluter pays)

Our Option 1 represents an obligation based on a "polluter pays" rationale and considers both ETS I and ETS II entities as a pool of potential obligated entities for a dedicated CDR obligation. Both ETS I and II were included under the scope of Option 1 to assign the responsibility of removing CO_2 from the atmosphere to primary emitters of fossil carbon in the EU, in line with the principle of polluter pays when designing a CDR-focused obligation.

In investigating Option 1, we consider two variants – a "Removal Targets" approach (Option 1a) and a "Share of Emissions" approach (Option 1b):

- **Removal Targets (Option 1a)** – In this design variant, obligated entities must match the EU's total CDR needs (as externally defined and outlined by two scenarios – see Section 3 for details). This design, therefore helps to understand what proportion of ETS emissions must be subject to an RCS to meet EU CDR needs, or what level of burden the EU's CDR needs would place on ETS entities.
- **Share of Emissions (Option 1b)** –This design variant is instead based on placing CDR obligations on a growing share of ETS emissions, thus neglecting externally set absolute volumes of CDR displayed in the Commission's scenarios (endogenous obligation). Subsequently, we model a growing share of emissions under an RCS, from 0% initially to 100% eventually. To calculate the share of emissions under obligation, we draw on trajectories being developed in regulatory and voluntary contexts (see Section 3.1 for more details on these variants).

Ultimately, both options result in an obligation level which can be described as a percentage of the remaining ETS emissions in a given year. However, while the *Removal Targets* option tells us about the wider EU's CDR demand (and how it compares to ETS emissions), the *Share of Emissions* option is expressed as a share of ETS emissions, and thus may result in CDR obligations which exceed or fall short of the EU's goals. These two options help clarify how different obligation trajectories influence the timing and distribution of the CDR burden and prompt us to consider what level of obligation might be appropriate at a given point in time. A stark difference from the two options is the chosen approach to define overall CDR "needs". Whilst Option 1a reflects externally defined CDR volumes (in line with IAS3 or JRC), Option 1b reflects an endogenic approach to defining overall CDR needs. Whilst both can reach 100% of ETS emissions overall, Option 1b will not necessarily answer the question of compatibilities regarding wider European climate neutrality targets.

Our aim with Option 1 is twofold. Firstly, we are testing how much demand for CDR can be generated from ETS sectors, given expected developments in ETS emissions over the coming years (see Figure 1). This question is often implicit in discussions around ETS integration of CDR, but our report aims to make it explicit. The second goal of Option 1 is to consider whether such demand from ETS sectors is adequate. Currently, integrating CDRs into the ETS (I) is the foremost proposal for developing a compliance market for CDRs; limited other sources of demand are currently being examined. Our report considers overall EU CDR needs, asking whether ETS sectors alone can actually meet these needs and whether further demand might be needed – laying the groundwork for Options 2 and 3 to be considered.

Throughout this report, we refer to "ETS sectors" as potentially obligated entities for an RCS. We are referring to sectors covered by the ETS I and II (i.e. Energy supply, Industry, Maritime transport, Aviation, Commercial and Residential buildings, Passenger cars) as key sources of EU emissions and thus potential obligated entities for an RCS – rather than referring to the ETS instrument itself. In Section 5, we consider how a CDR obligation on ETS sectors could be operationalised – whether through the ETS instrument itself (e.g. through Clean Up Certificates or through ETS integration of CDRs), or through a separate and additional obligation on the same sectors (separate RCS). Overall, this report does not cover the specific dynamics of ETS integration (explored by other reports, e.g. CATF and CONCITO's)[12] and focuses solely on the emissions generated by ETS entities and how such emissions could be translated towards compliance for additional removals in light of the urgent need to establish a predictable CDR demand.

Box 3: Option 1 Summary

SECTORS

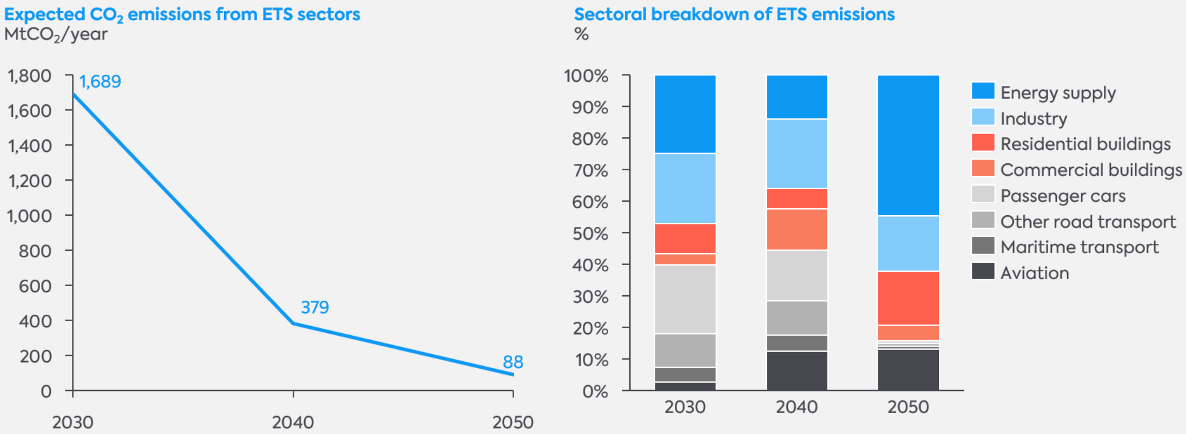
- Energy supply
- Commercial buildings
- Industry
- Residential buildings
- Maritime transport
- Passenger cars
- Aviation

VARIANTS

Option 1a: Removal Targets based on EU Commission models.

Option 1b: Removal Targets defined as a "Share of Emissions"

Figure 1: Estimates of CO_2 emissions in the EU ETS sectors with sectoral breakdown



Expected emissions of sectors covered by the ETS (I & II) in 2030, 2040 and 2050, broken down by subsector, estimated in our model (based on 2040 Impact Assessment, see Section 3.2 for more detail).

[12] Clean Air Task Force and CONCITO (2024). The Balancing Act: Risks and Benefits of Integrating Permanent Carbon Removals into the EU ETS.

2.2. Option 2: RCS for non-CO_2 GHG emitters (polluter pays)

Whereas Option 1 focuses on CO_2 emissions from ETS-covered sectors as a basis for an RCS, there are sources of non-CO_2 GHG emissions across the EU that are not covered by the ETS. While today these sources are small compared with ETS-related emissions (11% of ETS emissions in 2030), their share grows over time (reaching 62% of ETS emissions in 2050), making them a potential new source of emissions on which to place CDR obligations. These emissions are depicted in Figure 2.

In Option 2, we base our analysis on non-CO_2 GHGs like CH_4, N_2O and F-gases which stem from activities like Waste Treatment, Energy & Transport, Heating & Cooling, and Industry,[13] as charted in the 2040 Impact Assessment.[1] Largely, these emissions are not yet covered by ETS I & II. While a tiny share of non-CO_2 emissions from industry are currently covered under ETS I, and non-CO_2 emissions from maritime transport will be covered in the future,[14] the vast majority of non-CO_2 emissions from non-land-related sectors remain outside the scope of the ETS and are currently covered by the Effort Sharing Regulation.[15] Option 2 does not include maritime non-CO_2 emissions due to data limitations, but does include all reported non-CO_2 emissions from the categories of waste treatment, energy, transport, heating, cooling, and industry.

Our proposed Option 2 follows the same rationale as Option 1 – a polluter pays-style obligation on remaining emissions with a focus on non-CO_2 GHG emissions not covered in the existing ETS. We examine the impact of an RCS based on non-CO_2-emitting sectors alone (Option 2a), as well as considering the impact of expanding Option 1 to include these non-CO_2 GHG emissions (Option 2b).

As seen in Figure 2, while the make-up of EU non-CO_2 GHG emissions is expected to change over time, initially covering a range of sources, emissions from Energy & Transport and the Waste Treatment sectors are expected to be more difficult to abate, and many will persist in 2050, even in scenarios where mitigation is incentivised to the same extent as in the ETS. According to a separate analysis from the JRC, these Energy & Transport non-CO_2 GHG emissions are expected to come from sources like landfills, coal mining and abandoned mines, stationary combustion of biofuels and fossil fuels, gas transmission networks, and oil production and refinery.[16]

[13] We exclude agricultural and land-related non-CO_2 emissions from our assessment, as these will be the subject of a subsequent report by Carbon Gap.

[14] Emissions of CH_4 and N_2O from the maritime sector will be included from 2026. European Commission (n.d.). Reducing emissions from the shipping sector.

[15] By 2026, the Commission must assess the inclusion of CH_4 and N_2O from waste incineration in the EU ETS. Our analysis assumes CO_2 from waste incineration is already covered under the ETS. We assume that non-CO_2 emissions from waste incineration, and non-CO_2 emissions from other waste treatment, are not included in the ETS (and are thus included under Option 2). Carbon Market Watch (2025). Waste no time: expanding the EU ETS to cover waste incinerators and landfills.

[16] European Commission (2021). EU reference scenario 2020: Energy, transport and GHG emissions : trends to 2050.

Box 4: Option 2 Summary

SECTORS

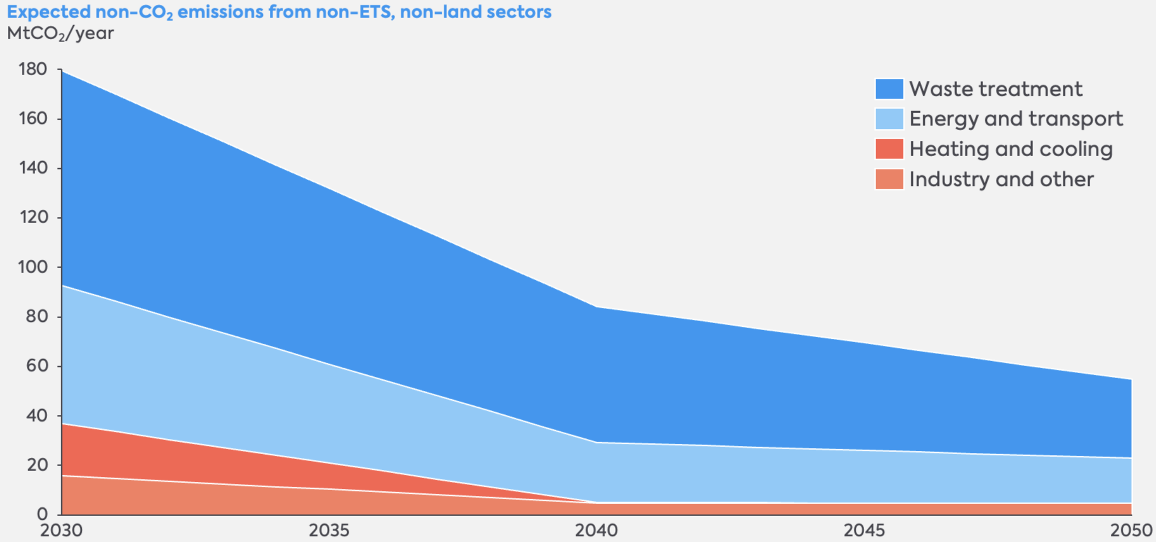
- Waste treatment
- Heating & cooling
- Energy & transport
- Industry & other

VARIANTS

Option 2a: Non-CO_2 GHG emissions only

Option 2b: ETS + non-CO_2 GHG emissions

Figure 2: Total non-CO2 GHG emissions expected over time, by sector



The trajectory of non-CO_2 GHG emissions (CH4, N_2O and F-gases) expected from non-land sectors over time, based on data from the 2040 Impact Assessment, using the "Mitigation" scenario. Data on non-CO_2 emissions throughout this report is expressed in CO_2-equivalents using GWP100).

2.3. Option 3: RCS applied to the whole economy (ability-to-pay)

Option 1 and 2 consider a polluter pays-style obligation. However, as emissions in those sectors are expected to decline, fewer pollution sources will be relied upon to deliver dynamically increasing volumes of CDR. This trajectory may become an unsustainable way of funding the CDR sector over extended timeframes. Option 3 thus frames an obligation around the "ability to pay" logic.

An obligation based on companies' ability to pay for CDR thus merits consideration. Carbon Gap has previously presented thinking on this topic, showing the variations among sectors in profitability per tonne of Scopes 1 and 2 CO_2 emitted by the largest global companies.[17] Considering the Forbes 2000 list of companies globally, we found significant variation among firms in profits per tonne of CO_2 emitted. Nonetheless, the research showed that most companies could afford to neutralise 10% of their current emissions through permanent removals.

The "ability to pay" is not an enshrined principle of EU climate policymaking, though it does appear in the EU Effort Sharing Regulation, where Member States' emissions targets are informed by their GDP per capita.[18] Arguably, the just transition objectives seen within the Green Deal cater to a similar need of reflecting differing capabilities and could be expanded to CDR policy. Embedding affordability considerations into CDR policy could help ensure that obligations are fairly distributed and met. Nonetheless, competitiveness concerns must be thoroughly assessed; ability-to-pay could still lead to

[17] Carbon Gap (2023). Who can pay for carbon removal?
[18] European Commission (n.d.). Effort sharing 2021-2030: targets and flexibilities.

unacceptable levels of CDR burden on EU firms, which drive them to other jurisdictions and impact the EU's economy.

At the same time, a focus on ability to pay could bring in a wider array of firms to pay for CDR and increase the pool of finance. For this Option, we refer to the typology of firms established in Directive 2013/34/EU (the Accounting Directive), which classifies firms (and associated accounting duties) into large, medium, and small based on employees, assets, and turnover. Table shows that, compared with Option 1, which focuses on ETS I and II sectors, a CDR obligation targeting large firms across the economy could bring in twice as many firms; if medium firms are also included, that becomes 12 times as many. **Our proposed Option 3 therefore places a CDR obligation on the wider economy, assigning obligations to entities based on their employee number and turnover, rather than their emissions**. Option 3 covers any firm of a threshold size, covering a broad range of sectors (potentially including EU ETS firms). Additional discussions on the methodological choices to reflect the ability to pay are listed in Section 3 below and the corresponding sections in the separately published modelling report. Table 2 presents an overview of the design options for an RCS examined in this report.

Box 5: Option 3 Summary

SECTORS

- Manufacturing
- Whole & retail trade
- Financial & insurance activities
- Transportation & storage
- Information & communication
- Electricity, gas, steam & air conditioning supply

VARIANTS

Option 3a – Large firms only

Option 3b – Large and medium firms

Option 3c – Large, medium and small firms

Table 1: Estimated number of obligated entities in Option 3 vs 1

	No. of firms	No. of firms compared with ETS I & II
ETS I & II firms (Option 1)	24,141	-
Large firms only (Option 3a)	53,061	2x
Large and medium firms (Option 3b)	298,771	12x
Large, medium and small firms (Option 3c)	1,885,584	78x

Table 2: Overview of RCS design options examined in this report

	Option 1 – ETS Entities		**Option 2 – Non-CO_2 GHG Emitters**		**Option 3 – Whole Economy**
	1a: Removal Targets	1b: Share of Emissions	2a: Non-CO_2	2b: ETS + non-CO_2	3a: Large firms only 3b: Large & medium firms 3c: Large, medium & small firms
Short description	Considers both ETS I and II as a pool of obligated entities for an RCS obligation		Focuses on non-CO_2 greenhouse gases like CH_4, N_2O and F-gases currently not in the ETS		Assigns obligations to EU companies based on their turnover
Rationale	Polluter pays (Emissions-based)		Polluter pays (Emissions-based)		Ability to pay (Turnover-based)
Obligated sectors	ETS I and II entities		Non-CO_2 GHG emitters	ETS entities + non-CO_2 GHG emitters	Whole economy
CDR volumes determined by	EU-wide needs (scenarios IAS3/JRC)	Percentage of emissions obligated	EU-wide needs (scenarios IAS3/JRC)	EU-wide needs (scenarios IAS3/JRC)	EU-wide needs (scenarios IAS3/JRC)

3. ASSESSMENT AND MODELLING METHODOLOGY

For each of the policy options outlined in Section 2, we consider the **impact of CDR obligations on the obligated sectors.** The main research questions are outlined in Table 3.

Table 3: Summary of research questions

	Option 1 and Option 2 (Polluter pays)	Option 3 (Ability to pay)
Research questions	What share of that sector's emissions would be subject to an RCS over time to deliver the CDR quantities required by the EU? How much would this obligation cost per unit of emission in that sector?	Which firms should contribute to deliver the CDR quantities required by the EU? How affordable might this contribution be, and what share of turnover would RCS costs represent?
Cross-cutting questions	What is the impact on RCS costs of altering the CDR portfolio (including biochar and enhanced rock weathering (ERW), or increasing the share of DACCS)? What is the impact of marginal pricing on overall RCS costs?	

In this section, we outline the core assumptions, data sources, quantitative approach, and limitations used to prepare our analysis. Further details on the applied methodology and modelling assumptions can be found in the accompanying Modelling Report.

3.1. Summary of our assessment approach

Our report assesses avenues for creating demand for permanent CDR in the EU, mostly building on pre-existing scenarios that outline future EU emissions and removal volumes needed to deliver EU climate targets. In most climate models, the overall level of CDR deployment is closely linked to the relative cost of CDR methods compared to marginal abatement costs,[19] and CDR deployment levels shift as those relative costs change.

In this report, we instead build upon the CDR volumes predicted in pre-existing model scenarios to investigate **how those total volumes could be delivered through a demand-side mechanism** – namely, which sectors should pay for those volumes and how much they would cost to deliver. Although cost considerations are embedded in this assessment (when considering exactly which CDRs might be deployed to meet CDR demand for mainly externally defined absolute CDR requirements), we do not re-estimate overall CDR deployment quantities based on the model's cost inputs.

3.2. Data on EU emissions and CDR volumes

Emissions and removal scenarios

Our analysis relies on projections about how much the EU will emit over time – specifically, CO_2 emissions from the ETS (Option 1) and non-CO_2 GHG emissions from outside the ETS (Option 2). **We use estimates of future EU emissions and permanent CDR volumes from the European Commission's 2040 Impact Assessment Scenario 3.**[1,20] **We call this scenario "IAS3" throughout this report.** There

[19] The marginal abatement cost is the cost of cutting the last unit of emissions.

[20] The 2040 Impact Assessment foresees a 92% reduction in net emissions in 2040.

are still large uncertainties on future GHG trajectories, and we do not prescribe that those modelled under IAS3 are the only plausible pathway. **Therefore, we also present an alternative scenario for emissions and removal volumes, derived from the POTEnCIA CETO scenario presented by the EU Joint Research Centre, which we refer to as "JRC".**[2] For the JRC scenario, the modelled future emissions and removal amounts are considerably larger than the IAS3.[21]

ETS emissions

In this report, ETS emissions are estimated based on aggregating the emissions of relevant sectors (those covered under ETS I and II) as projected in the IAS3 or JRC scenarios. Our ETS emissions estimate also assumes the expansion of ETS coverage to include the waste-to-energy sector. Only CO_2 emissions are included in our estimate of ETS emissions – non-CO_2 GHG emissions from ETS sectors are excluded due to their minimal share.[22]

Crucially, the 2040 Impact Assessment is agnostic on ETS design; therefore, our ETS emissions estimates do not directly take into account expectations about the ETS cap or linear reduction factor. Uncertainty about actual ETS emissions thus presents a challenge for this (and any) study of Option 1. We have mitigated this uncertainty to some extent by presenting two scenarios, IAS3 and JRC, as well as the inclusion of Option 1b, where CDR demand is endogenously derived. The 2040 Impact Assessment foresees a level of mitigation of ETS emissions that is ambitious, allowing us to present an estimate of how ETS emissions might evolve over time even in the absence of concrete information about future cap design.

Non-CO_2 GHG emissions

In Option 2, we consider non-CO_2 emissions from non-land sectors – namely methane, nitrous oxide and F-gases. Data for non-CO_2 emissions is derived from the S3 scenario of the 2040 Climate Target Impact Assessment (Annex 8, Table 13).[1] We refer to the "Mitigation" scenario used in that report – which assumes the mitigation of non-CO_2 emissions is incentivised to the same extent as in the ETS. Thus, we may underestimate non-CO_2 emissions, if these rates of mitigation are not achieved in reality.

Non-CO_2 emissions include emissions from four main categories: 1) Waste Treatment, 2) Energy & Transport, 3) Heating & Cooling, and 4) Industry & other. Non-CO_2 emissions in the model are expressed in CO_2-equivalents using Global Warming Potentials (GWP) from the IPCC's Fifth Assessment Report (AR5), based on a 100-year time horizon (GWP100). Non-CO_2 GHG emissions in this report refer only to EU territorial emissions and exclude extraterritorial non-CO_2 GHG emissions produced by EU companies - though these are under the scope of the Methane Regulation. We exclude agricultural and land-related non-CO_2 emissions from our assessment; these will be the subject of a subsequent report by Carbon Gap.

[21] Besides more dramatic reductions in GHG emissions in IAS3, there is a higher degree of "circular economy" predicted. This likely translates to a lower overall amount of atmospheric CO_2 captured for sake of storage by 2050, as used in this report. CDR needs are likely negatively correlated to emission reductions via atmospheric CO_2 captured (via BECCS or DACCS) within the circular economy frameworks embedded in IAS3.

[22] As noted above, for simplicity and due to their minimal share, we exclude from Option 1 non-CO_2 emissions from maritime (even though these will be covered under the ETS from 2026), and waste incineration (even though this will be considered for inclusion in 2026). We thus include them under Option 2.

3.3. Quantitative approach for Option 1

In policy Option 1, the RCS imposes a removal obligation on entities covered by both ETS I and ETS II (hereafter collectively referred to as the ETS entities).[8] This obligation aims to leverage the opportunity for polluter pays-aligned demand from emissions-intensive sectors. As mentioned in Section 2.1 and explored further in Section 5.5, this analysis is agnostic as to whether this obligation is enforced separately and additionally to the ETS instrument itself, or as part of the instrument. Further considerations on the appropriateness of imposing additional compliance obligations on ETS II covered entities are excluded for sake of simplicity. Policy acceptance considerations will need to be investigated by further research.

There are two different means of setting **obligation levels** for the covered entities, as introduced in Section 2.1. These approaches have been simulated as follows:

1. **Option 1a: Removal Targets** – The carbon removal amounts directly reflect the required annual permanent removal volumes estimated by IAS3 or JRC in a given year; effectively, we set the ETS obligation to match the externally defined CDR needs. For IAS3, emissions and permanent CDR volumes between modelled years (namely 2030, 2035, 2040, 2045 and 2050) are linearly extrapolated to arrive at a yearly resolution, whereas for the JRC scenario, data for each year is available. This approach thus assumes that the obligated entities should be responsible for delivering EU CDR needs in their entirety.
2. **Option 1b: Share of Emissions** – Alternatively, CDR amounts are calculated as an increasing percentage of the annual emissions of the covered sectors from 2030-2050 (see Annex and Modelling Report). We consider an obligation that ramps up over time, from 0% of remaining annual ETS emissions being subject to a CDR obligation before 2030 to 100% of ETS emissions being obligated by 2050. The trajectory the obligation follows (how quickly it goes from 0% to 100%) is a policy choice that needs careful consideration and further work to be refined. For this report, we draw on precedents from regulatory and voluntary contexts – albeit without further evaluation of the appropriateness of the trajectories proposed:
    a. California Senate Bill 308 (SB308), which proposes a CDR obligation on ETS entities of 8% of emissions in 2035, 35% in 2040, and 100% in 2045;[23]
    b. A linear ramp-up of 5% per year between 2030 and 2050;
    c. A third option, based on the Science Based Targets Initiative (SBTi) draft Net Zero Standard 2.0, is presented in the modelling report.[24]

3.4. Quantitative approach for Option 2

Option 2 focuses only on a "Removal Targets" approach, mirroring Option 1a, meaning that non-CO_2 GHG emitters are required to match total EU CDR needs. As with Option 1a, CDR volumes are distributed to sectors in proportion to their annual emissions. Only the IAS3 scenario is used for this option. For further insights into Option 2, please see the quantitative approach for Option 1a discussed above or refer to the separate modelling report.

[23] Version from 14th March 2023.
[24] Science Based Targets Initiative (2025). SBTi CORPORATE NET-ZERO STANDARD Version 2.0 - Initial Consultation Draft with Narrative. March 2025.

3.5. Quantitative approach for Option 3

Option 3 targets firms based on an ability to pay proxy, rather than specific emissions or activity (as with Option 1). For Option 3, we present three variants – focusing on large firms only (Option 3a), large and medium firms (3b) and large, medium and small firms (3c). For each variant, we identify the number of firms to be obligated (the number of firms of the chosen size category that exist in the EU). We then divide the CDR demand (externally defined by the scenarios IAS3 or JRC) among the obligated firms according to their turnover. For a discussion of further details on the modelling approach, please see the accompanying modelling report. Obligation levels included in this report are directly proportional to the modelled turnover on a sliding scale. In all cases, we present results (obligation level, cost) for large firms only, for simplicity.

Data on the number of firms of each size (large, medium and small), gross operating surplus, and gross turnover are drawn from Eurostat.[25] Firm sizes are identified according to categories used in EU legislation, specifically the Accounting Directive (2013/34/EU), which defines enterprises based on both net turnover, "balance sheet total" and the number of employees. In this analysis, we rely solely on the number of employees as the determining factor for firm size.[26] Notably, we do not make any projections, meaning the financial data is static and not extrapolated to 2050. The cost data therefore does not reflect any evolution in financial statistics over time. For discussions on the use of turnover as a proxy for the "ability to pay", please consult further information within the modelling report.

We note that a range of financial metrics could be further taken into account to assign obligations, particularly metrics that are focused on profitability or financial health. Throughout this report, turnover is used as a simple, readily available indicator. The availability of data, reduced complexity in the calculation of turnover, and precedent in establishing regulatory instruments on this basis have informed the choice (e.g. the EU Corporate Sustainability Reporting Directive (CSRD)). Whilst acknowledging and highlighting the importance of further work to define an ability to pay metric, this report is presented to derive first high-level findings on the implications of an RCS based on different sets of compliance rationales.

3.6. RCS compliance costs and eligible CDR methods

Throughout this report, we refer to the "cost of compliance" under the RCS; this simply means the cost of fulfilling the obligation. Each RCS policy option is associated with a particular demand for permanent removals (in $MtCO_2$) for a given year. For obligated entities to meet the calculated level of demand, they must purchase eligible CDR units. The cost of compliance with the RCS is thus the cost to purchase CDRs up to the volume needed. Box 6 explains how we calculate the cost of CDRs.

The CDR methods eligible in our main analysis are permanent removals with geological storage, specifically biogas CCS, BECCS and DACCS. Additionally, estimations for enhanced rock weathering (ERW) and biochar were included as part of a sensitivity analysis.

The assumptions used in the modelling surrounding the capacity of CDR methods reflect mainly theoretical reviews, considering some technical and sustainable capacity constraints. In real-world applications, further costs are likely to arise, reflecting the FOAK nature of the permanent CDR projects

[25] Eurostat (2025). Enterprise statistics by size class and NACE Rev. 2 activity (from 2021 onwards).

[26] This is due to data gaps for the other defining criteria (assets and turnover). Our approach is consistent with the methodology applied by the JRC's 2022/2023 report on SMEs. Di Bella, L. et al. (2023). Annual Report on European SMEs 2022/2023. Joint Research Centre.

discussed here.[27,28] Such costs, as well as further sustainability constraints such as the competing uses of biomass, need to be taken into account. The assumed quantity restrictions therefore do not necessarily reflect the sustainable potential of technologies but mirror the assumptions behind cited sources.

In reality, CDR prices may be further shaped by market design as well as technology deployment costs. The impact of a possible marginal pricing structure on the cost of compliance under the RCS is examined in Section 4.4 and in the Modelling Report.

[27] Grubb, M. et al. (2021). Induced innovation in energy technologies and systems: a review of evidence and potential implications for CO_2 mitigation. Environmental Research Letters, 16(4).
[28] Rubin, E. S. et al. (2021). Toward improved cost guidelines for advanced low-carbon technologies. 15th International Conference on Greenhouse Gas Control Technologies, GHGT-15.

Box 6: The RCS "cost of compliance"– Modelling CDR costs under an RCS

Calculating cost based on CDR demand

Our calculation of the cost of CDRs is based on an average-cost assessment of CDR deployment costs over time. This assessment draws on assumptions about:

- The capacity of permanent CDR technologies over time,
- Time-dependent cost ranges for CDR methods, which reduce over time.

These inputs draw from both peer-reviewed literature and real-world data, as further discussed within the modelling report.

A cost-optimising model for CDR methods

Each policy option creates a CDR demand volume for a given year, and the model then finds the cheapest mix of carbon removal technologies needed to meet the removal demand resulting from the given policy option. Our model is therefore cost-optimising in making choices about which CDR method gets deployed at a given point in time. A dynamic cost-optimisation over the chosen – or extended – time horizons has not been part of the modelling. Furthermore, the model does not cost-optimise the balance between CDR and abatement (this balance has already been considered within the IAS3 and JRC scenarios, and CDR deployment volumes are therefore not re-estimated in this work). More insights on dynamic cost-optimisations could prove helpful. The report highlights such aspects for example by setting quotas for certain methods (e.g. 25% DACCS) and depicting the findings thereof.

Relativising CDR costs

For each option, we present a metric that helps to understand the cost of CDR in relative terms. For Option 3, we present the annual cost per firm, i.e. the cost of compliance as a percentage of firms' turnover. For Options 1 and 2, cost per firm is more challenging, due to a lack of data about emissions per firm. Instead, for these options we present the cost of compliance relative to the total emissions. Namely, we divide the cost of the RCS in a given year by the total emissions in that year. This calculation provides a cost in EUR/tCO_2 *emitted* (or EUR/tCO_2eq for Option 2). The resulting numbers can be compared with other known metrics such as the marginal abatement cost, though they are based on fundamentally different approaches. Crucially, this **does not represent the cost per tonne of CDR,** but highlights the relativised costs of an RCS, irrespective of emissions reduction costs already installed. See Annex I for more detail on this.

RCS costs and ETS costs

The RCS cost of compliance presented for all options **does not take into account any pre-existing carbon prices** (namely ETS prices). In Section 5.5, we consider how the RCS and ETS costs might interact.

See the Modelling Report for more detail on the model of CDR costs.

4. RESULTS AND ANALYSIS

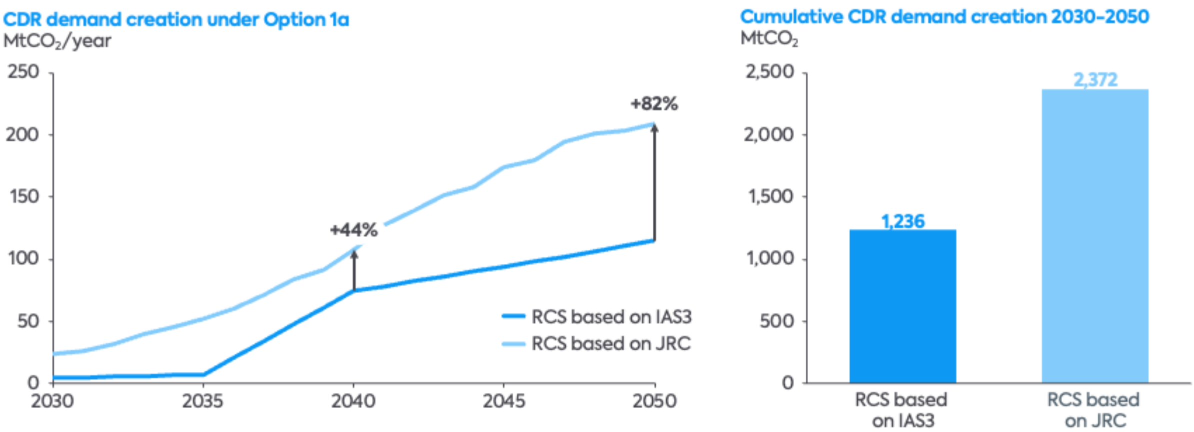
In this section, we focus on the impacts of creating a CDR obligation (RCS) on different sectors. We present findings from the modelling carried out by our project partner CONCITO (full results and methodology can be found in the accompanying Modelling Report). Taking each of the policy design options from Section 2 in turn, we examine the potential demand creation and cost of compliance, as well as presenting cross-cutting considerations (like pricing dynamics and eligible CDR methods). In Section 5, we then turn to some wider considerations for the implementation of these options.

4.1. Assessing an RCS placed on ETS entities (Option 1)

Modelling results: Allocating CDR demand under Option 1a (ETS entities based on Removal Targets approach)

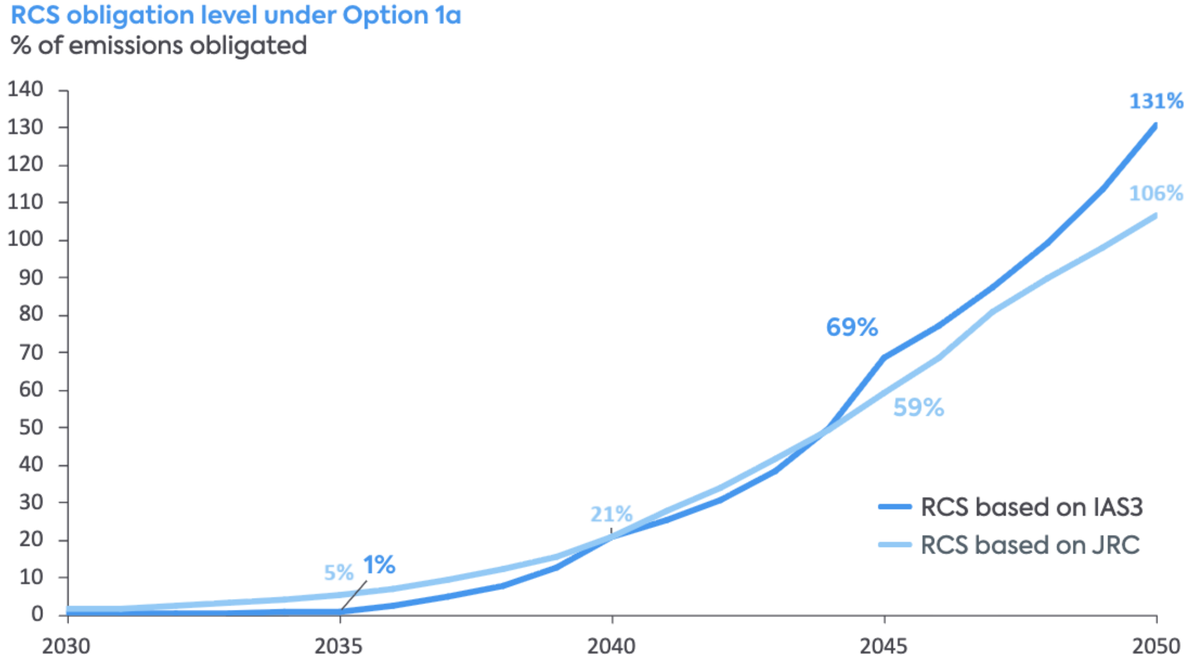
Figures 3 and 4 provide insights into the burden that the EU's permanent CDR demand would place on the ETS entities if a CDR obligation were to be designed according to policy Option 1a (namely, mandating ETS sectors to deliver the wider EU's total CDR needs). Two scenarios are presented for Option 1a – our main scenario (IAS3) and a sensitivity scenario (JRC) – to illustrate that different expectations exist about how ETS emissions and EU permanent CDR needs will evolve over time. We see that these two scenarios offer diverging expectations about the volume of permanent CDR needed by the EU (Figure 3), but reasonably similar expectations about the ratio between the remaining ETS emissions and EU CDR need over time (Figure 4).

Figure 3: CDR demand in the 2040s and by 2050 in the JRC scenario is roughly double that in the IAS3 scenario (Option 1a - Removal Targets)



The figure shows the annual permanent CDR demand generated from the Option 1a ("Removal Targets"). Option 1a is designed to match the estimated annual permanent CDR needs of the EU, hence Figure 3 also directly reflects these estimates under two scenarios – S3 of the 2040 Impact Assessment (IAS3), and the JRC's POTEnCIA CETO 2024 scenario (JRC).

Figure 4: EU permanent CDR needs are low relative to ETS emissions throughout the 2030s, not exceeding 21% of ETS emissions until 2040 (Option 1a - Removal Targets)



The figure shows the percentage of ETS emissions that would be subject to obligations in a given year under Option 1a ("Removal Targets"). Options are designed to deliver the CDR volumes shown in Figure 3 under two scenarios – IAS3 (the main scenario) and JRC (the sensitivity scenario). The percentages reflect the ratio between expected emissions from ETS entities and expected EU permanent CDR needs under the two scenarios.

In Figure 3, we see that CDR demand in the 2040s and by 2050 in the JRC scenario is roughly double that in the IAS3 scenario (209 versus 115 $MtCO_2$/year) – concurrently ETS emissions in JRC are also double those in IAS3. This pattern confirms a strong correlation between ETS emissions and permanent CDR needs during this period.[29] Figures 3 and 4 therefore reveal the interdependence of the rates of emissions reductions in the ETS and the level of permanent CDR demand needed in the EU in the modelling for the two scenarios. As ETS emissions in the JRC scenario are higher than those in IAS3, so too is the volume of permanent CDR demanded.

Figure 4 tells us the obligation level that an Option 1a RCS would place on ETS emissions to deliver the EU permanent CDR needs. The obligation level grows gradually, from 1% or less in 2030 to 20% or 21% in 2040 (depending on the scenario). By 2050, 131% of emissions are obligated under IAS3, and 103% in JRC, meaning more CDR must be purchased than is emitted by the covered emitters. Thus, we see that each tonne of ETS emissions would need to be subject to an obligation of more than one tonne of CDR in 2050, in order to cover the wider EU's CDR needs. The increasing slope of the curve towards 2050 outlines this tendency to grow beyond 2050. Whether this "increased ratio" model is appropriate, or whether demand should be sourced elsewhere, is a policy choice.

It is perhaps unrealistic to assume that a Removal Compliance System would be designed in a way that forces ETS entities to deliver a quantity of CDR in line with wider EU CDR needs rather than simply balancing their own emissions. Hence, we also outline Option 1b – a ramp-up of CDR obligations from 0% to 100%, drawing on precedents set out elsewhere in the policy landscape, but potentially

[29] Interestingly, a different relationship is evident in the 2030s, as JRC ETS emissions are only marginally higher than IAS3 ETS emissions during that decade, yet JRC CDR volumes are several times higher than IAS3 CDR volumes. This discrepancy suggests other key factors, such as compensation for (limited) overshoot, that could be driving permanent CDR demand in the 2030s.

undermining total CDR needs inherent within pathways compatible with climate neutrality or net-negative ambitions.

Modelling results: Allocating CDR demand under Option 1b (ETS entities based on a Share of Emissions approach)

Option 1b represents a CDR obligation focused on ramping up the share of ETS emissions obligated under an RCS, rather than being designed to meet the CDR needs of the wider EU. While this design does not guarantee a specific CDR outcome, it promotes greater certainty for entities about their compliance obligations over time while creating an incentive to cut emissions. This obligation reaches (and caps out at) 100% of ETS emissions in 2050 – achieving in effect a climate neutral ETS (though of course then not delivering further CDRs to address other sources of residual emissions). This approach has some precedent. A bill introduced to the California Senate, Senate Bill 308 (SB308), proposed an obligation for firms participating in the California ETS to purchase CDR, in addition to their obligations under the ETS (see Box 7 for more). We also see an end goal of 100% neutralisation of residual emissions reflected in the Science Based Targets Initiative's Corporate Net Zero Standard.[30]

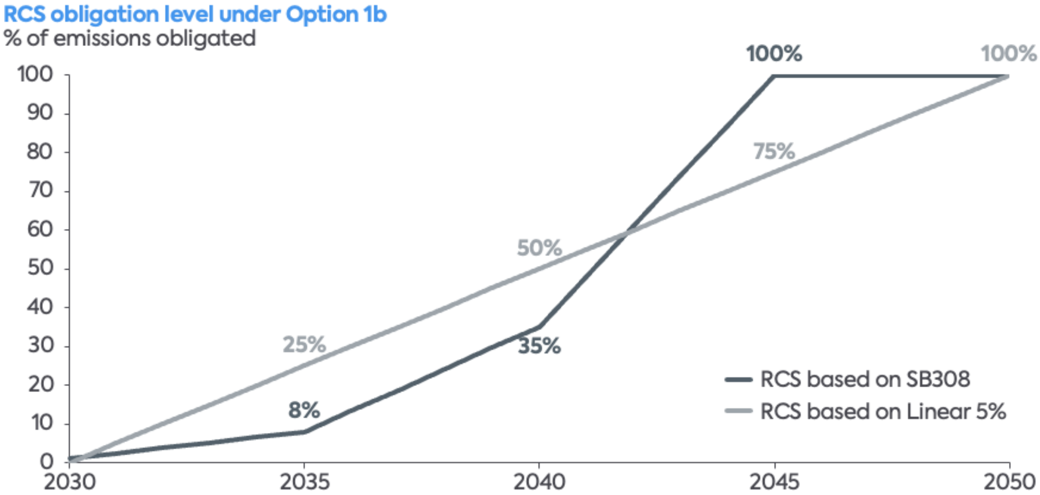
Box 7: California SB308

California bill SB308, known in a former version as the Carbon Dioxide Removal Market Development Act, was a proposal which would have established a negative emissions obligation on private entities. The "emitting entities" subject to the CDR obligation were proposed to be participants in California's emissions trading system, namely any firm reporting emissions above 25 ktCO_2 eq/year.
Qualifying emitters would have been obliged to purchase certified negative emissions credits equal to a specified percentage of their greenhouse gas (GHG) emissions (in CO_2eq) for each year. The pathway started at 1% of emissions in 2030, 8% in 2035, 35% in 2040, to reach 100% in 2045 (according to an amended version of the bill presented on 14th March 2023). Purchased CDR credits would have been reflected in state-level GHG calculations.
While this bill would have been the first of its kind in enforcing a dedicated compliance system for CDR, it builds on a precedent for using the "polluter pays principle" to guide climate action at state level.

[30] Science Based Targets Initiative (2024). SBTi Corporate Net-zero Standard Criteria v1.2. Please note that a recent academic discourse has been questioning the SBTi approach for neglecting net-negative CO_2 emissions pathways featured in IPCC literature. See Reisinger et al. (2024) for further discussions on SBTi.

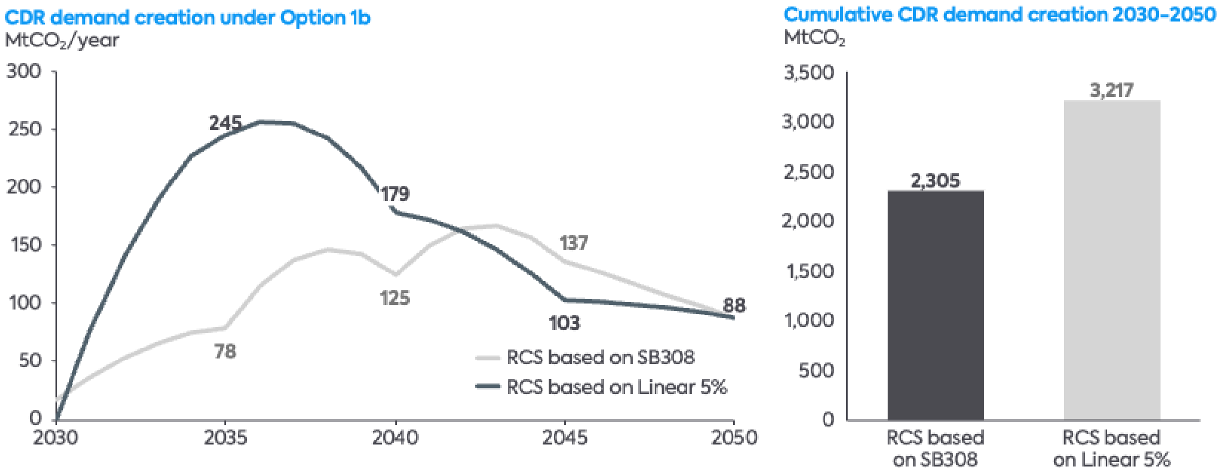
Figures 5 and 6 show possible variants of Option 1b – a pathway based on SB308 (see Box 7 for background) and a pathway based on a linear ramp up of 5% annually from 2030 to 2050. We see an unsteady demand curve for CDR, as the growing obligation percentage contends with emissions reductions in the covered sectors. The unsteady growth and decline in annual CDR demand in the SB308 and Linear 5% pathways may present problems for prospective CDR developers appraising the market opportunity over time.

Figure 5: Different RCS obligation trajectories are available for the "Share of Emissions" policy design (Option 1b - Share of Emissions)



The figure shows the percentage of covered emissions that would be subject to obligations in a given year under Option 1b ("Share of Emissions"), considering two possible trajectories – one from the SB308 proposal and a theorised linear ramp-up of 5% per year from 2030 to 2050. Both are based on data from the IAS3 scenario. These obligation trajectories result in the volumes shown in Figure 6.

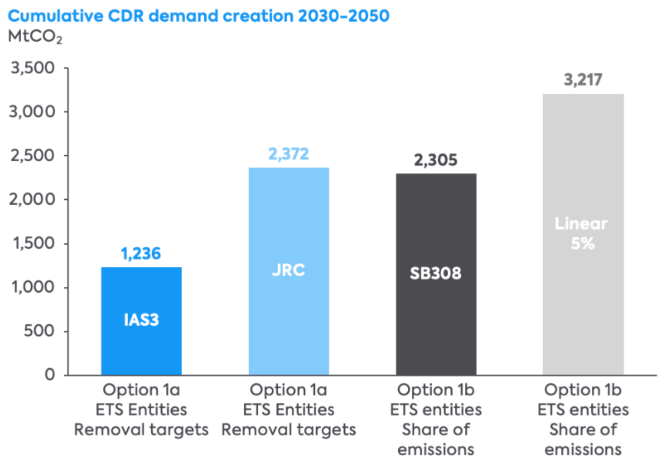
Figure 6: Both pathways generate an unsteady demand curve for CDR as the growing obligation percentage contends with emissions reductions in the covered sectors (Option 1b - Share of Emissions)



The figure shows the annual permanent CDR demand generated from the Option 1b trajectories shown in Figure 5. Under Option 1b ("Share of Emissions"), total demand volumes are determined by applying the percentage in each trajectory to the covered entities' emissions in a given year. Both are based on data from the IAS3 scenario.

On the other hand, Figure 7 shows us that the SB308 and Linear 5% deliver significant CDR demand – far outstripping cumulative IAS3 volumes and broadly matching JRC volumes over the 2030 to 2050 period. This trend suggests that the SB308 and Linear 5% pathways could be very demanding for obligated entities – delivering more CDR cumulatively than is needed by the EU at large[31]. Another important issue is that the obligations based on ETS emissions tend to generate higher volumes of CDR in the decade 2030-2040 and much lower volumes from 2045 onwards, which is at odds with the expected growing EU CDR needs over time and the current limited supply of permanent CDR.

Figure 7: Cumulative CDR demand from 2030-2050 under SB308 and Linear 5% pathways exceeds cumulative IAS3 volumes – suggesting a more gradual obligation trajectory could still meet EU needs



The figure shows the cumulative CDR volumes delivered under each design variant of Option 1 over the period 2030-2050.

Modelling results: Assessing RCS compliance costs under Option 1 (ETS entities)

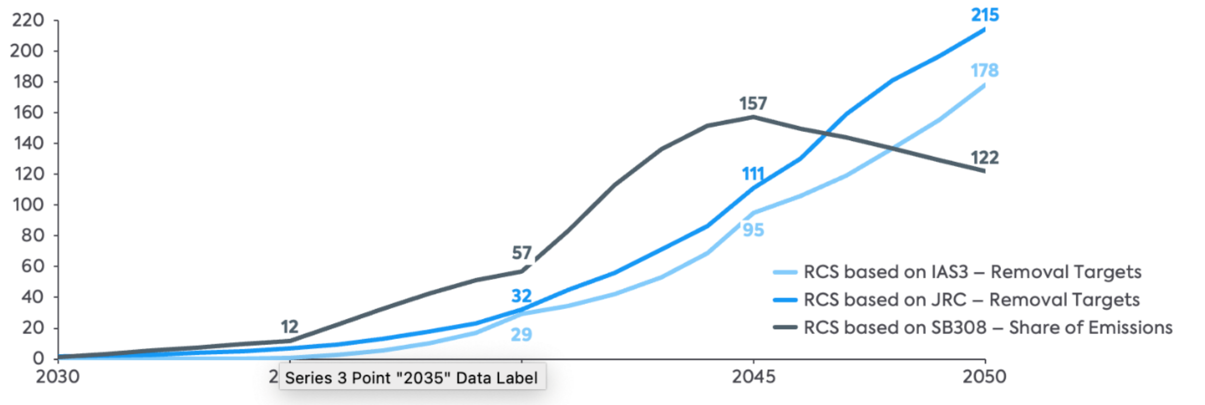
Figure 8 summarises the additional cost of RCS compliance[32] per tonne of emissions under the different versions of Option 1 – the "1a. Removal Targets" approach (in IAS3 and JRC scenarios) and the "1b. Share of Emissions" approach (using the SB308 pathway). We see that the Share of Emissions approach based on SB308 is more costly per tonne of emissions until the late 2040s, because this option, per design, delivers more units of CDR as a share of emissions compared with the IAS3 and JRC Removal Targets scenarios. Towards 2050, the trend flips; the Removal Targets approach drives CDR volumes higher than ETS emissions, increasing costs, while the Share of Emissions approach stabilises at 100% of ETS emissions and costs begin to decline (due to declining emissions as well as cost reductions in CDR methods). Table 4 reveals this reversing trend. As well as demonstrating how costly an RCS might be, the data in Figure 8 and Table 4 further reinforce the finding that towards 2050, permanent CDR needs outstrip ETS emissions and become more and more burdensome for ETS sectors to carry alone.

[31] These cumulative volumes for Option 1b would be even higher if based on the JRC emissions scenario, which is not presented here.

[32] Recall that the cost of compliance is the ratio between the cost of complying with the RCS and the total emissions obligated and does not include any pre-existing carbon prices (see Box 6 for more).

Figure 8: The Share of Emissions approach delivers higher CDR volumes and thus is more costly per tonne of emissions until the late 2040s compared to Removal Targets, though the trend flips towards 2050

Cost of RCS compliance relative to total emissions under Option 1a and 1b
EUR/tCO_2 emitted



The figure shows the costs of complying with the RCS under Option 1, considering three of the design variants shown above; Option 1a ("Removal Targets", IAS3 and JRC scenarios), and Option 1b ("Share of Emissions", SB308 scenario). In each case, the volumes of CDR generated in the figures above are used to determine an overall cost, divided by the associated emissions to calculate a cost per tCO_2 emitted.

Table 4: Summary of RCS compliance costs under Option 1 variants

	Compliance cost 2035 (EUR/tCO_2 emitted)	Compliance cost 2040 (EUR/tCO_2 emitted)	Compliance cost 2050 (EUR/tCO_2 emitted)
Option 1a: Removal Targets (IAS3)	0.69	29	178
Option 1a: Removal Targets (JRC)	7.10	32	215
Option 1b: Share of Emissions (SB308)	12	57	122

Summary of compliance costs in 2035, 2040 and 2050 for different versions of Option 1a and Option 1b.

Policy analysis: ETS entities are a promising demand pool for CDR, with higher impact in the 2030s

ETS entities are a candidate for CDR obligations that could support the financing of CDR. In 2050, ETS I and II sectors are expected to represent 89% of EU territorial CO_2 emissions (according to our analysis). In line with the polluter pays approach, these sectors should play some role in financing permanent CDR. We have shown that the ETS is a promising demand sector for CDR, due to the relative abundance of ETS emissions compared to EU permanent CDRs needs in the 2030s. This trend indicates that in the 2030s only a low share of ETS emissions must be subject to obligations to meet overall EU CDR needs – the share is no more than 21% in 2040 (Figure 4).

Under Option 1, the model shows that the cost of RCS compliance remains low, below 60 EUR per tonne of CO_2 emitted, before 2040. In 2040, costs range from 29-57 EUR/tCO_2 across all options; in 2050, they span from 122-215 EUR/tCO_2 (Figure 8). These numbers are substantially lower than expected marginal abatement costs within the ETS (the reasons for this are explored in the Modelling Report). There is a lack of data related to the financial performance of ETS firms, especially for future emitters under the ETS, therefore, it has not been possible to estimate the cost of compliance of the proposed policy options in terms of affordability.

By 2050, ETS entities are less able to fulfil the entire EU CDR needs alone. A 100% obligation on ETS emissions in 2050 meets 77-94% of EU CDR needs. This CDR "demand gap" is not drastic, but highlights the need for a range of sources of demand to ensure a resilient market for CDR. When the wider EU's need for permanent CDR exceeds 100% of ETS emissions, it places a growing cost on emissions from those sectors. Fulfilling those needs would require ETS entities to deliver more than one unit of CDR for every tonne of CO_2 they emit, which could be politically challenging to establish. Moreover, if CDR needs grow, for example if the EU underperforms on emissions reduction, the burden could be exacerbated further. This section thus reveals the opportunity and limitations associated with ETS entities as a primary demand sector for permanent carbon removals.

4.2. Expanding the RCS obligation to non-CO2 GHG emissions (Option 2)

Modelling results: Allocating CDR demand under Option 2 (non-CO_2 GHG emitters)

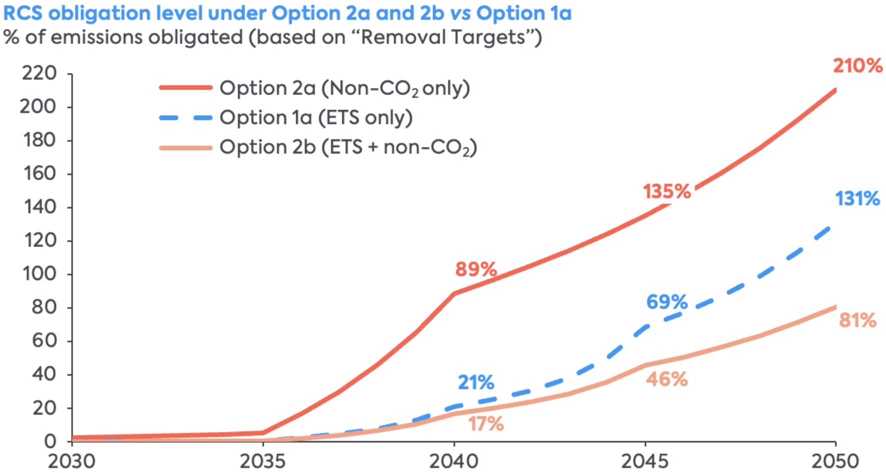
Under Option 2, we focus on non-CO_2 GHG emissions from sectors not currently covered by EU-level carbon pricing. These emissions present a promising candidate for CDR obligations. Non-CO_2 emissions are small relative to ETS emissions at first (only 11% of ETS emissions in 2030) but become relatively more significant over time (62% of ETS emissions in 2050) because ETS emissions decline much faster than non-CO_2 GHGs. Obligating non-CO_2 emissions under an RCS therefore becomes a more useful policy lever over time and critical towards 2050.

We present two versions of Option 2 here: **Option 2a,** which focuses on **non-CO_2 GHG emissions only,** and **Option 2b**, which covers **ETS emissions *and* non-CO_2 GHG emissions** under the same obligation (essentially an **expansion of Option 1a**). Both options are based on delivering IAS3 volumes ("Removal Targets").[33]

Figure 9 shows the obligation level that would need to be placed on the non-CO_2 emitters in order to deliver the IAS3 volumes of permanent CDR over time compared to Option 1a. We show Option 2a (non-CO_2 emissions only) and Option 2b (ETS emissions and non-CO_2 emissions). Per model design, the obligation level (percentage of emissions obligated) is in all cases higher in Option 2a compared with Option 1a; a greater share of the non-CO_2 emissions must be obligated in a given year to deliver the same CDR volume because there are fewer non-CO_2 GHG emissions than ETS emissions. Conversely, the obligation level in Option 2b is lower at all times than Option 1a, because the same CDR quantity is divided amongst a larger pool of obligated entities.

[33] The design of Option 2 mirrors Option 1a (ETS entities); we present a "Removal Targets" approach, which means setting CDR demand under Option 2 to match EU CDR needs (we focus on the IAS3 scenario here). Under this "Removal Targets" design, total demand would mirror that shown for Option 1a in Figure 3 (IAS3), but since the obligation is placed on a different pool of obligated entities, the obligations are spread out differently.

Figure 9: Extending an RCS obligation to non-CO2 emissions could expand the CDR demand base over time and allow a lower obligation level for each tCO2 emitted



The figure shows the percentage of emissions that would be subject to obligations in a given year under Option 2, to deliver the CDR volumes in Figure 3. This includes two design variants: Option 2a (non-CO_2 GHG emissions only) and Option 2b (ETS emissions and non-CO_2 GHG emissions) are compared to the obligation trajectory under Option 1a (shown in Figure 3). We refer to this trajectory as "Removal Targets", meaning obligated entities match the CDR volumes needed by the wider EU (based on IAS3).

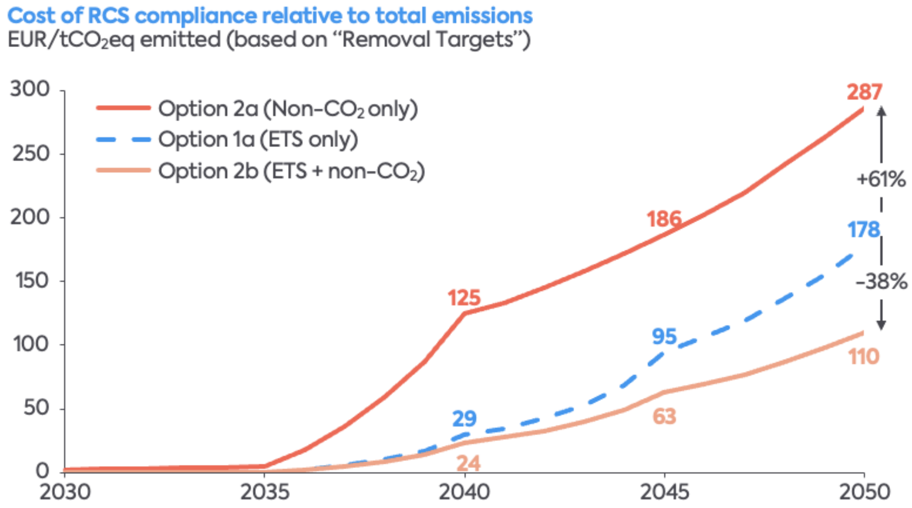
While we have shown pathways consistent with the externally modelled CDR needs, we can also apply a "Share of Emissions" approach to Option 2 (as we did with Option 1). Considering the "SB308" and "Linear 5%" trajectories shown under Option 1 and applying these to non-CO_2 emissions (alone) could generate 29 or 42 $MtCO_2eq$ of CDR demand in 2040 (where 35% and 50% of emissions are covered by the RCS in each variant respectively) and 55 $MtCO_2eq$ of CDR demand in 2050 (where 100% of emissions are covered in both variants). At first, this design would see non-CO_2 emitters deliver a fraction of the CDR demand that would otherwise be delivered by ETS entities; however, by 2050 non-CO_2 emitters would deliver 62% of the demand from ETS sectors. We do not present these data as charts for simplicity.

Modelling results: Assessing RCS compliance costs under Option 2 (non-CO_2 GHG emitters)

An obligation on non-CO_2 GHG emissions (Option 2a) to deliver EU CDR needs ("Removal Targets") would place a higher cost of compliance on obligated entities compared with Option 1a (ETS entities), as the obligation level is higher in a given year (due to the smaller pool of obligated entities). To deliver these volumes, compliance costs in the non-CO_2-only option are seven times higher in 2035, four times higher in 2040, and 60% higher in 2050 per tonne of CO_2eq emitted. It must be noted that these non-CO_2 GHG emitters are not paying the ETS price, potentially enhancing the relative affordability of RCS obligations.

On the other hand, Option 2b (obligation on ETS and non-CO_2 GHG emissions) involves more emissions subject to an obligation compared with Option 1a, meaning the larger volume of obligated emissions could deliver the same CDR volume at a lower cost per tCO_2eq emitted. **In Figure 10, we see that adding non-CO_2 GHG emissions to the pool of obligated emissions, alongside ETS emissions, would reduce costs per tCO_2eq emitted by 38% in 2050 compared with an obligation only covering ETS emissions (Option 1a).** In considering this approach to expanding Option 1a, Figure 11 shows that by 2050, the non-CO_2 sector would grow in significance, outlining the trend of faster ETS emissions reductions described elsewhere. Given the objective of this report, expanding the scope of obligated entities beyond ETS could make for important, longer-term signals of CDR demand. Table 5 below provides a summary of RCS compliance costs under Option 2 variants.

Figure 10: Adding non-CO2 GHGs to the pool of obligated emissions, alongside ETS emissions, would reduce costs per tCO2eq emitted by 38% in 2050 compared with only covering ETS emissions



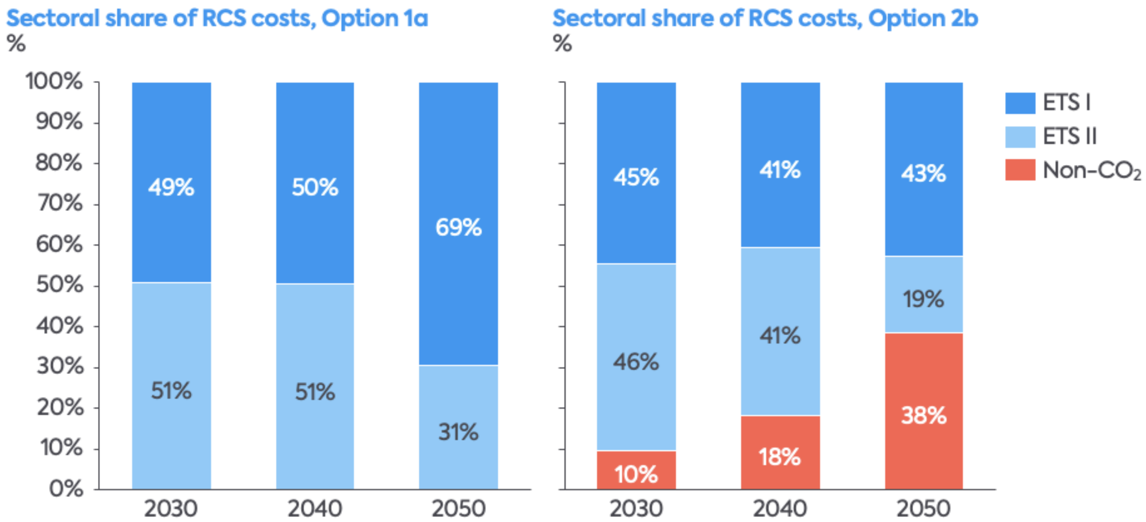
The figure shows the costs of complying with the RCS under Option 2, under a design covering only non-CO_2 emitters (Option 2a) and non-CO_2 emitters combined with ETS entities (Option 2b), which are compared with Option 1a (shown in Figure 8). Cost is expressed in EUR/tCO_2eq based on a "Removal Targets" design (IAS3 scenario).

Table 5: Summary of RCS compliance costs under Option 2 variants

	Compliance cost 2035 (EUR/tCO_2)	Compliance cost 2040 (EUR/tCO_2)	Compliance cost 2050 (EUR/tCO_2)
Option 2a: Non-CO_2 only (IAS3)	5.10	125	287
Option 2b: ETS + non-CO_2 (IAS3)	0.60	24	110
Option 1a: ETS only (IAS3)	0.69	29	178

Summary of compliance costs in 2035, 2040 and 2050 for different versions of Option 2 compared with Option 1a.

Figure 11: The share of RCS costs borne by non-CO2 GHG emissions increases over time, until almost reaching the level of ETS I by 2050



Breakdown of total costs of the RCS by sector, when non-CO_2 GHG emissions are included alongside ETS emissions. The calculations of ETS emissions are based on a "Removal Targets" scenario delivering IAS3 permanent CDR volumes.

Policy analysis: Non-CO_2 GHG emissions can generate sizeable demand and can work alongside ETS entities to create a more affordable RCS

As presented above, the impact of including non-CO_2 GHG emissions in an RCS can be significant. Acting alone (Option 2a), non-CO_2 emitters would find it more expensive than ETS entities (Option 1a) to deliver fixed quantities of CDR (Figure 10). But an RCS targeting both sectors (Option 2b) would reduce the cost of the RCS by 38% in 2050 compared with an RCS on ETS entities alone, making it more affordable for each entity to meet the EU's CDR needs overall. Non-CO_2 GHG emissions also become relatively more significant over time, as ETS emissions decline. A 100% obligation on non-CO_2 emissions in 2050 could meet 26-48% of EU CDR needs.

An obligation on non-CO_2 GHG emissions under Option 2 could be implemented through expanding the scope of current EU carbon pricing (ETS I & II) to include new emissions sources, or through a separate obligation targeting those sources, such as an RCS. Importantly, either option would place a carbon price on those emissions where one does not yet exist, while helping to generate demand for CDR.[34] Among other things, a separate RCS on non-CO_2 GHG emissions could implicitly target certain emissions (mostly methane) from domestic oil and gas operations that currently fall outside the scope of the ETS in the EU. These emissions are mostly released from venting, routine flaring and fugitive leaks across upstream sites, pipeline transmission (compressors, valves), distribution networks, and LNG terminals.

However, imposing RCS obligations on non-CO_2 GHG emitters raises measurement challenges and administrative issues. Some sources, such as landfills or wastewater treatment plants, are difficult to monitor with high accuracy, and emissions are often diffuse. Questions of ownership and accountability can also arise, for instance with fugitive emissions from gas pipelines or continued emissions from decommissioned coal mines. The interplay with other EU policies (such as the Methane Regulation) would also need to be scrutinised. These complexities can make it harder to assign responsibility and enforce compliance. Further analysis is thus needed to assess the practical feasibility of including these emissions.

4.3. Assessing an ability-to-pay RCS on the wider economy (Option 3)

Sections 4.1 and 4.2 showed us that significant demand for CDR can be generated from polluters in proportion to their emissions. The expansion of covered entities in Option 2b hints at promising routes for political acceptability if the burden of a CDR obligation is distributed across the entirety of ETS and non-CO_2 emissions sectors. Yet a growing CDR obligation on emissions (either to cover 100% of emissions to achieve climate neutrality in certain sectors, or simply to keep pace with estimated EU CDR needs) places a rising cost on each tonne of emissions. **Crucially, according to the models we considered for our analysis, by the late 2040s the CDR needs eventually outstrip total emissions** (see Figure 3). In this context, a polluter pays obligation is likely to become an unsustainable way to fund the removals sector. We thus turn to Option 3 – an obligation placed on firms across the economy that are above a modelled threshold "ability to pay" proxy for CDR.

Modelling results: Allocating CDR demand under Option 3 (wider economy)

Like Options 1a and 2, we follow a "Removal Targets" design, ensuring the obligated entities deliver total, externally derived, EU CDR needs. We present three variants of Option 3 – based on the inclusion

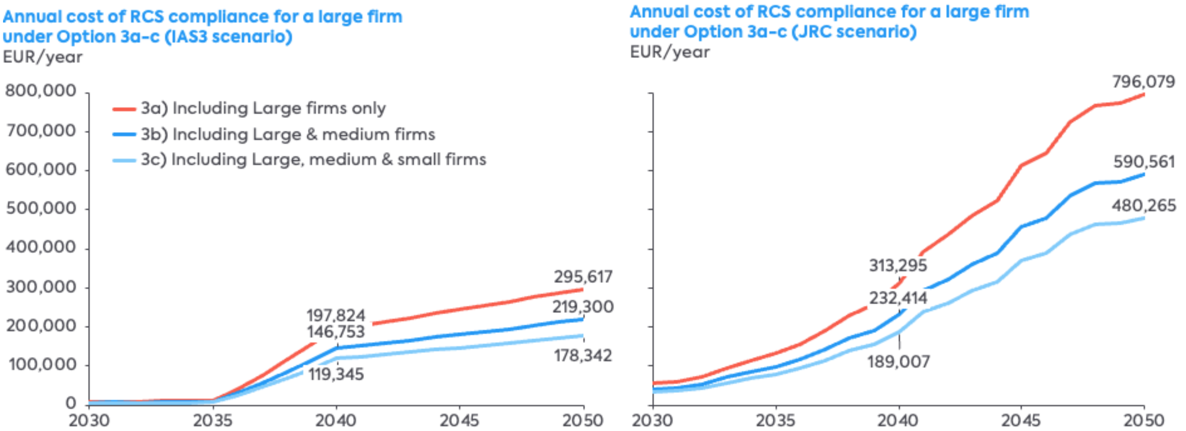
[34] While policies exist to address non-CO_2 emissions, for example the Effort Sharing Regulation, Methane Regulation, F-Gas Regulation, and Industrial Emissions Directive, these do not directly place a price on those emissions.

of **only large firms** (Option 3a), **large and medium firms** (3b), and **large, medium, and small firms** (3c). In all figures, we present the results from the **perspective of an average large firm**; for example, we consider the obligation level and the cost for an average *large* firm and examine how these change when *medium* and *small* firms are also included. Further analysis on the impact of an RCS on SMEs is crucial to better understand the RCS impact on respective firms. Further work in this regard is needed.

Modelling results: Assessing RCS compliance costs under Option 3 (wider economy)

Figures 12 and 13 present the annual cost of compliance for an average large firm associated with Option 3, under IAS3 and JRC scenarios. As in Option 2b, we see substantial cost savings associated with expanding the obligation to more firms. For example, the obligated total turnover increases by 33% and 63% for 3b and 3c respectively compared with 3a – making Option 3b 26% cheaper than 3b, and Option 3c 40% cheaper than 3a, by annual compliance cost. In 2050, compliance costs for a large firm range between 178,000 and 796,000 EUR/year under the three versions and two scenarios.

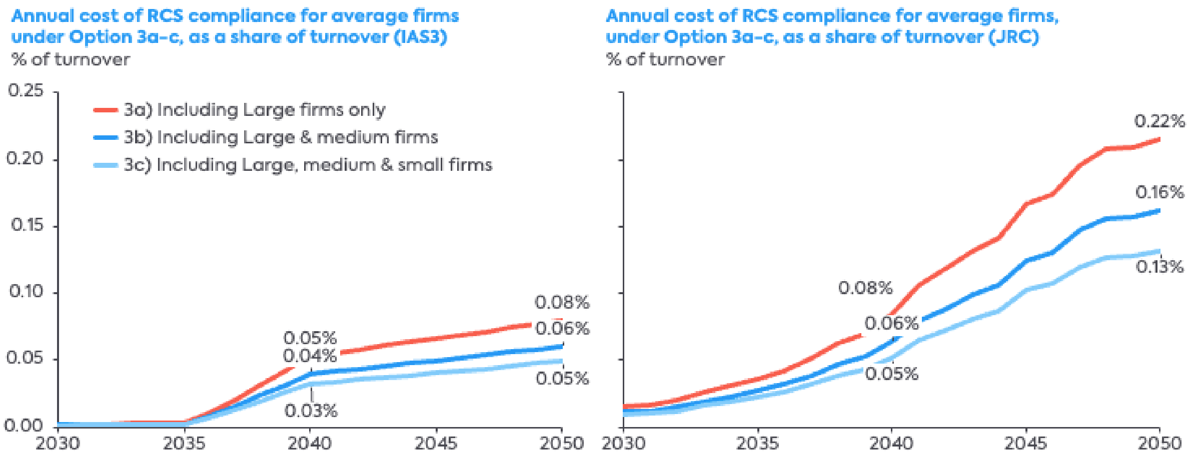
Figure 12: Expanding the obligation to more firms delivers substantial savings in annual compliance costs for participating firms



- **In a "Large firms only" design, the cost to an average large firm is about 200,000-310,000 EUR/year in 2040 and about 300,000-800,000 EUR/year in 2050, depending on the scenario**
- ***The cost of an RCS covering "Large & medium firms" (3b) is 26% lower than "Large firms only" (3a), while that of one on "Large, medium and small firms" (3c) is 40% lower than on "Large firms only" (3a)***

The figure shows the annual cost of complying with the RCS under Option 3, expressed in EUR/year, considering three design variants. A design covering large firms only (Option 3a) is compared with designs covering large and medium firms (Option 3b) and large, medium and small firms (Option 3c). Data is shown for both the IAS3 and JRC scenarios on the left and right panel respectively, following a "Removal Targets" approach.

Figure 13: Option 3 allows EU CDR needs to be met at well under 0.5% of turnover, even where only large firms are covered



› *In a "Large firms only" design, the cost to an average large firm is 0.05-0.08% of turnover in 2040 and 0.08-0.22% of turnover in 2050, depending on the scenario*

The figure shows the annual cost of complying with the RCS under Option 3, expressed as a percentage of turnover, considering three design variants. A design covering large firms only (Option 3a) is compared with designs covering large and medium firms (Option 3b) and large, medium and small firms (Option 3c). Data is shown for both the IAS3 and JRC scenarios on the left and right panel respectively, following a "Removal Targets" approach.

Figure 13 reveals the affordability of the Option 3 RCS, presenting annual compliance costs as a percentage of turnover. When only large firms are obligated (Option 3a), compliance costs are in the range 0.054-0.085% of turnover in 2040 and 0.080-0.22% in 2050 across the two scenarios. We see that in all cases, the JRC scenario places higher obligations and higher costs on firms, because of its higher expected permanent CDR demand. Under Option 1 and 2, CDR obligations are expressed in proportion to emissions (which are also higher in JRC), so the differences between the two scenarios is somewhat mitigated. In Option 3, there is no link to emissions, meaning the higher JRC CDR demand drives significant increases in RCS costs. This comparison between the IAS3 and JRC scenarios reinforces that variations in the actual levels of permanent CDR needed by the EU strongly shape the cost and thus affordability of an RCS. There is a growing body of work looking into the definition of "hard to abate" or "residual" emissions that are deemed a good match for CDR. Future work should incorporate relevant findings and seek to define the cost impact of increased or decreased reduction efforts in a more explicit manner.[35]

Policy analysis: EU CDR needs could be met at a low cost to EU firms, but an ability-to-pay obligation could face some political barriers

An obligation levied across the most high-performing firms in the economy could allow EU CDR needs to be delivered in an affordable manner. **Considering a wider array of firms as potential obligated entities for an RCS would bring down average costs per firm, meanwhile delivering the same total CDR volume**. Option 3 is able to capture roughly twice as many large firms in the EU as in the ETS I and II (Table). Option 3 also seeks to target the firms most able to absorb the costs, as indicated by turnover, increasing the political feasibility of such a proposal. Even targeting large firms alone (Option 3a) can meet CDR needs from 2030 to 2050 at a cost of well under 0.5% of turnover annually, and well under 0.1% in the IAS3 scenario (Figure 13). This finding means that the more politically and administratively complex task of bringing in medium and small firms may not be necessary to enable large-scale finance for CDR. Speculating on the potential strengths of this approach, its independence from emissions could create longevity of CDR demand and could be more compatible with the objective of reaching net-negative emissions in the long term, including by covering new sectors or firms that emerge in future.

However, there are also significant drawbacks. Introducing an ability-to-pay obligation in EU policy has limited precedent[36] and verges towards dedicated taxation. Depending on design, implementing Option 3 could impact the competitiveness of EU firms (see Section 5.1). Since the obligation is levied based on turnover, it cannot be avoided by cutting emissions; this effect would be difficult to manage through conventional carbon border adjustment measures. While in Options 1 and 2, the introduction of CDR obligations creates a new or additional incentive to cut emissions where there was not one previously, an ability-to-pay-style obligation creates a new regulatory burden with no additional

[35] See e.g. Friedmann et al. (2020), Buck et al. (2023) or Dufour-Decieux et al. (2025).

[36] Though an ability-to-pay element appears, for example, in the Effort Sharing Regulation, it is not codified as a principle of EU environmental lawmaking in the same way as "polluter pays", which features in the Treaty of the Functioning of the European Union.

incentive. The obligation may also generate perverse incentives for companies operating close to the obligation threshold, which may change behaviour to avoid CDR obligations.

Communicating to a broad audience the role of permanent removals in EU climate neutrality would be a precondition for securing political support and would be difficult without a separate target for permanent CDR enshrined in law.

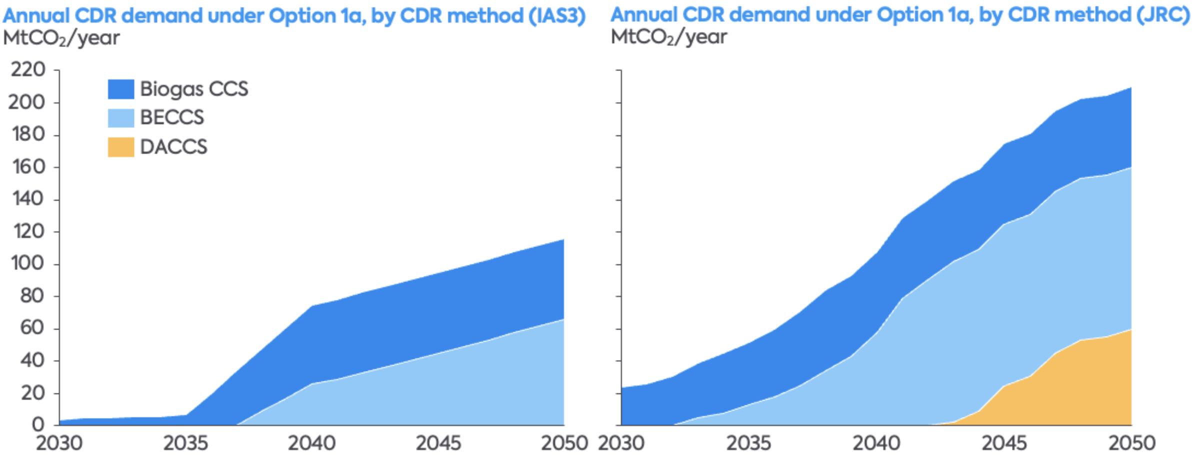
Alternatively, an RCS could bring together both the ability to pay and polluter pays rationales, for example by targeting only firms meeting a threshold level of turnover whilst linking the specific obligation level to firms' individual emissions. A lack of data has made this option challenging to examine, and any policy proposal would need to be premised on a clear emissions reporting structure. The recently enforced European emissions reporting regulations, such as the Corporate Sustainability Reporting Directive and the accompanying European Sustainability Reporting Standards, present promising precursors for such a policy design. A key question to resolve, however, is the scope of emissions covered, including whether a CDR obligation should or could have extraterritorial reach.

4.4. Impacts of a wider CDR portfolio

Sections 4.1, 4.2 and 4.3 present three possible formulations for RCS design, considering possible sources of demand. Here, we present some analysis as to how the eligible CDR methods under an RCS can shape the cost of compliance as well as raising wider questions about the purpose of an RCS.

Throughout Section 4, we have presented data on the cost of complying with the RCS by purchasing durable removals. In this section, eligible methods have so far included only biogas CCS, BECCS, or DACCS. These methods are brought online mostly according to (1) cost and (2) availability constraints (see the Modelling Report for more data on how these two dimensions are taken into account). **As illustrated in Figure 14, this cost-optimisation leads to a CDR supply dominated by biogas CCS and BECCS, with a minimal role for DACCS (especially in the 2030s and early 2040s), which is beaten on price by the other available methods**. Yet this overrepresentation of biomass-based CDR methods poses sustainability risks such as land-use competition with food production, deforestation, biodiversity loss, and water stress, especially at scale.[37] While our model does include some constraints on the availability of biomass, our assumptions are not as conservative as those used in the Commission's 2040 Impact Assessment – see the Modelling Report for more detail.

Figure 14: Cost-optimisation leads to a CDR supply dominated by biogas CCS and BECCS, with a minimal role for DACCS (especially in the 2030s and early 2040s)



In the IAS3 scenario, no DACCS is deployed between 2030 and 2050

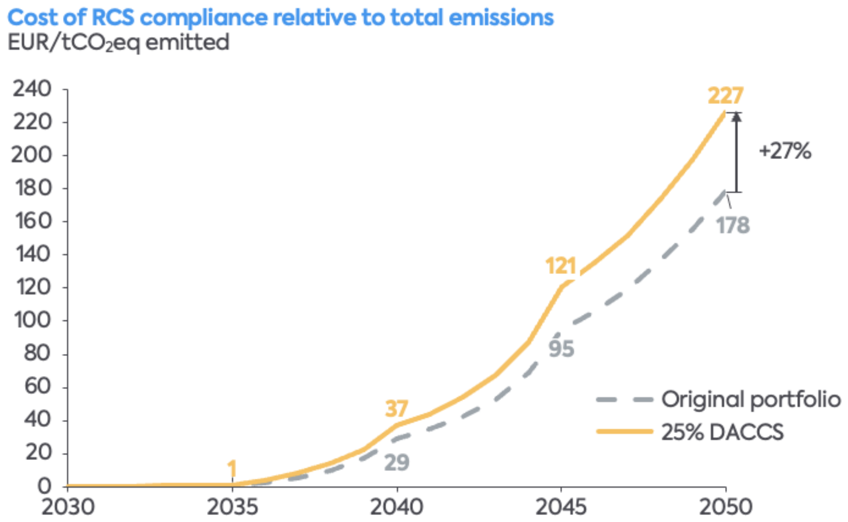
[37] See e.g. the Land Gap Reports, accessible via the dedicated homepage

- *In the JRC scenario, a small share of DACCS is brought online in the mid-2040s (29% of total deployment in 2050)*
- *Biogas CCS and BECCS dominate supply in the early phases*

We present the breakdown of CDRs (types and quantities) that would be deployed to meet the overall demand in that year to meet EU removal needs (Option 1a) – drawing on a cost-optimising model of CDR deployment. Data is presented for the IAS3 and JRC scenarios respectively.

Deliberately incorporating a higher percentage of DACCS in the RCS portfolio can help mitigate these sustainability risks, though it would increase overall costs, as illustrated in Figure 15. Instead of a cost-optimising portfolio, Figure 15 shows a policy design where the CDR portfolio is managed more deliberately (we examine such a policy design in Section 5.2), and is "forced" to include a minimum of 25% DACCS. This amendment increases the cost of compliance by 27% in 2050 compared with determining the portfolio through cost-optimisation. Crucially, baking in demand for DACCS is necessary to create an incentive to invest in DACCS innovation and scale-up. Without any long-term demand signal for more expensive methods like DACCS, there is a risk that near-term investment in and scaling of these methods will not take place. Thus, even if carbon prices eventually reach a level that could support DACCS, DACCS supply may simply not be available to meet needs.

Figure 15: Incorporating a 25% share of DACCS into the portfolio increases costs by 27% in 2050 compared with the original cost-optimising portfolio



- ***Incorporating a 25% share of DACCS into the portfolio increases costs by 27% in 2050 compared with the original cost-optimising portfolio***

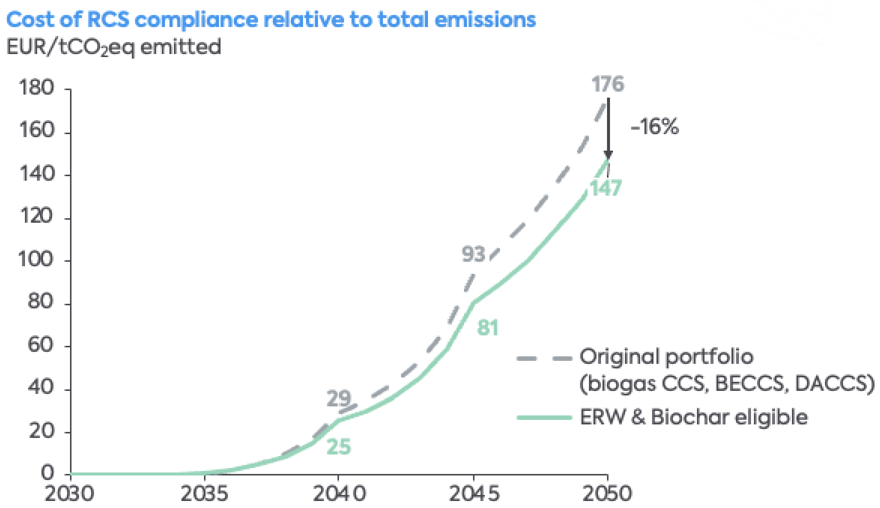
The figure shows the costs of the main cost-optimising CDR portfolio ("Original") presented throughout this report, compared with the costs of a portfolio which is "forced" to adopt at least 25% DACCS. Costs are presented for Option 1a (Removal Targets). As before, the volumes of CDR from Figure 14 are used to determine an overall cost and divided by the associated emissions to calculate a cost per tCO_2 emitted.

In Figure 15 we show the impacts of a portfolio with an increased share of DACCS. By contrast, looking beyond CDR methods that rely on geological CO_2 storage could potentially reduce the cost of compliance.

Figure 16 shows how the introduction of enhanced rock weathering (ERW) and biochar as eligible CDR methods could impact the overall cost of compliance during the assessed time period from 2030-2050. We see that in 2050, compliance costs under the RCS are reduced by 16% compared with the portfolio based on geological storage alone.

Broadening the portfolio of eligible CDRs under the RCS could have impacts on sustainability, as well as cost. In any RCS, unsustainable levels of biomass demand must be avoided. In light of the lack of an EU-level carbon pricing regime in the land sector, increased biomass use for Bio-CCS could lead to land use change and, depending on the biomass feedstocks, negatively impact the already challenged carbon removals in the LULUCF sector. Without targeted restrictions on the quantity of carbon removals using biomass, the deployment of Bio-CCS could far exceed the levels assumed in the European Commission's impact assessment for the 2040 climate target, which are capped by constraints on the availability of sustainable biomass. Such constraints are assumed to make up for some of the differences in modelled deployments of the share of the respective technologies seen within the IAS3 scenarios and the removal methods deployed in this report. Requirements for the sourcing of sustainable biomass, further specified under European Renewable Energy Directives (REDIII), present important, readily available regulations that consider biomass constraints. Inclusions of such aspects within permanent CDR methodologies under preparation within the EU CRCF show that such considerations are being taken into account. An expanded set of options merits consideration if it could deliver significant climate impact in a more affordable way. Yet care is required: the choice of eligible CDR methods must reflect the intended climate impact, including pathways towards an achievement of the like-for-like principle, and consequentially, the state of the evidence regarding the permanence of such methods. A lower cost of CDR options relative to the marginal cost of abating emissions could potentially also interact with and shape abatement levels, especially in policy designs where the choice between abatement and CDR is available.

Figure 16: Allowing ERW and biochar as eligible methods under an RCS reduces costs by 16% in 2050, compared with a portfolio only allowing biogas CCS, BECCS and DACCS



The figure shows the costs of the main CDR portfolio ("Original") presented throughout this report, in which only biogas CCS, BECCS and DACCS are eligible, compared with the costs of a portfolio in which ERW and biochar are also eligible. Costs are presented for Option 1a. As before, the volumes of CDR from Figure *14 are used to determine an overall cost and divided by the associated emissions to calculate a cost per tCO_2 emitted.*

An expanded set of options merits consideration if it could deliver significant climate impact in a more affordable way. Yet care is required - the choice of eligible CDR methods must reflect the intended climate impact, including pathways towards an achievement of the like-for-like principle, and consequentially, the state of the evidence regarding the permanence of such methods. A lower cost of CDR options relative to the marginal cost of abating emissions could potentially also interact with and shape abatement levels, especially in policy designs where the choice between abatement and CDR is available.

Marginal cost pricing and market power

Throughout the report, our analysis of the cost of RCS compliance is based on the average cost of CDR technology over time instead of an approach based on marginal pricing. In the Modelling Report, we present a comparison between our average-cost approach and a marginal pricing approach (see Figures 6 and 12 of the Modelling Report). The comparison shows that marginal pricing could materially impact the cost and the affordability of compliance under an RCS, increasing compliance costs by 40-60% in 2050 in Option 1 (depending on the scenario considered), for example.

5. WIDER CONSIDERATIONS FOR RCS POLICY DESIGN

Section 4 presented quantitative analysis of our three policy options, looking primarily at CDR demand and costs resulting from an RCS. This section addresses the broader, concrete design questions that policymakers must confront when translating theory into action. Any obligation system must grapple with practicalities such as cost-effectiveness, institutional readiness, political feasibility, and fairness across sectors and states, which we explore in Sections 5.1 to 5.4. In Section 5.5, we take a closer look at the format for an RCS, considering if and how it might interact with the EU ETS.

5.1 Political considerations

Competitiveness

CDR obligations on sectors will generate competitiveness considerations by impacting how those sectors compete in the international market and how they interact with consumers. Under the polluter-pays designs (Option 1 and 2), the most emitting entities will be most impacted, but will have the option to cut emissions to drive down the level of CDR they must deliver. Meanwhile, the ability-to-pay design (Option 3) is perhaps more challenging for competitiveness, as it levies an obligation across the EU economy that cannot be avoided through emissions cuts. Any RCS should thus need to be accompanied by policies that address competitiveness, such as carbon leakage measures, which could also enhance incentives to purchase CDR for firms operating outside the EU. Further analysis is needed to develop such proposals.

Distributional impacts

The costs of an RCS could be felt more strongly by some entities than others. For Member States, the effect of an RCS would depend on their economic and industrial make-up. On one hand, high-emitting countries could shoulder a greater share of CDR obligations under the polluter-pays options. On the other hand, the impact of an RCS for Member States will depend on their CDR capacity, whether as a result of geophysical assets or simply greater innovation capacity, leading some states to supply CDR to others. This potential exchange could lead to price-maker and price-taker dynamics between those Member States that are net-suppliers versus those that are net-buyers of CDR within the RCS market. This dynamic could be problematic for political acceptability and effective implementation over time. A broader distribution of CDR methods and geographies could be promoted through supply-side policies. In the context of the RCS, a well-distributed supply could be promoted through the involvement of an intermediary body – see Section 5.4 for more detail.

Besides distributional impacts on Member State levels mentioned above, there will be further impacts concerning the specific sectors targeted. The inclusion of ETS II entities within Option 1 and 2, as well as further expansions of RCS coverage will likely face political barriers. Better understanding these barriers and the resulting political trade-offs goes beyond the scope of this report but will be important aspects to clarify prior to an RCS implementation.

5.2 Economic considerations

Cost-effective mitigation

Cost-effectiveness has been highlighted as a key consideration for the design of CDR-related policies.[3] It is often noted that CDR policies should promote a cost-effective mix between abatement and removals and take into account the relative prices of each. As highlighted in Section 3, our study is focused on how CDR demand could be allocated, assuming a certain level of CDR deployment; we build upon the CDR volumes foreseen in pre-established scenarios rather than re-estimating CDR quantities. Our proposals for an RCS mandate that obligated entities undertake some level of CDR, namely Option 1a (Removal Targets) and Option 3, even if it is not entirely cost-effective relative to abatement.

Mandating that companies undertake a certain level of CDR serves the goal of establishing a predictable and growing market for CDR. While such mandates under an RCS may not directly support cost-effectiveness, they provide a business model for CDR that could ultimately facilitate deployment and bring costs down. Indeed, the European Scientific Advisory Board on Climate Change has highlighted the importance of "dynamic cost-effectiveness" in CDR policymaking, i.e. considering how cost-effectiveness evolves over time as a result of multiple policies. Market design alone is thus not single-handedly responsible for determining cost-effectiveness and is complemented by other policies, such as policies that support technological demonstration and learning. An RCS could thus contribute to dynamic cost-effectiveness by providing a long-term demand signal which would help support near-term deployment and investment planning.

Another consideration for cost-effectiveness is the role of trading within the market. Under RCS Options 1 and 2, entities may wish to trade both obligations and purchased CDRs due to different expectations about how much they might emit, just like under the ETS. Trading may be further driven by differing expectations about the future cost of CDR. While CDR costs are typically expected to come down over time (due to factors like scale-up and process improvement), CDR units may also be cheaper in earlier years due to the cheapest projects being realised first. Therefore, we could observe some form of banking, with entities purchasing CDR units early on to anticipate future needs.

It has been suggested that a more "integrated" market, in which CDR suppliers trade directly with buyers, could enhance cost-effectiveness through improved price discovery.[38]

CDR methods and costs

The cost of complying with the RCS is shaped by (among other things) which CDRs are eligible and in what manner they are allowed to enter the market. As presented in Section 4.4, a cost-optimising approach to the CDR portfolio encourages the cheapest methods to come online first, which leads to a large representation of biomass-based CDRs (biogas CCS and BECCS in this case).[12] As we have seen, a more regulated portfolio (rather than a cost-optimising one) with higher shares of DACCS, for example, (encouraging diversification away from biomass-based methods alone) makes compliance materially more expensive. Yet, forcing DACCS demand to steadily scale up over time would ensure that this technology will be ready to deliver at the necessary scale later in the century (e.g. beyond 2050) when scenario modelling predicts that the EU could require considerable volumes of DACCS removals.[39,40]

A diverse portfolio of removal methods appears to be key to decarbonising in a cost-effective manner.[39,40] Greater portfolio diversity and reduced compliance costs could be achieved by allowing the use of further methods like ERW and biochar. The market design can shape the CDR portfolio that arises through a range of mechanisms (see Section 5.4).

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[38] La Hoz Theuer, S. et al. (2021). Emissions Trading Systems and Net Zero: Trading Removals. International Carbon Action Partnership.

[39] Carbon Gap (2025). Divide to Deliver: Why 2040 separate targets for carbon removal are feasible and necessary to reach EU net zero

[40] Markkanen et al. (2024) Sustainable negative emissions in Europe: evaluating scenarios to meet carbon neutrality by 2050.

5.3 Climate and CDR impact considerations

CDR availability for obligated entities

An RCS as a policy intervention is primarily focused on creating demand for CDR. Doing so does not guarantee that supply will scale up to keep pace with such demand, although it could help by enhancing the investment case for CDR projects. The EU will need to create mechanisms to ensure any obligations do not exceed available supply, as this is (broadly) not within the control of the obligated entities. Further considerations on the scope, availability, and timing of certifications (e.g. ex-ante vs. ex-post verification requirements) of removals achieved, are important in this regard and must be further investigated. This point increases the prominence of an intermediary body to balance the impact and responsibility attributed to obligated entities.

Modelled CDR quantities vs real-world possibilities

The modelling presented in this report relies on projected CDR volumes prepared by the European Commission and the Joint Research Centre. These models do not (and are not designed to) predict or specify the future, and the estimated CDR volumes are responsive to assumptions about rates of emissions reduction, technology development, and resource availability. Our use of these datasets does not constitute an endorsement of their forecasts – in fact, there are some significant issues embedded. CDR scales up rapidly in the models, reaching 7-52 Mt annually in 2035 and 75-107 Mt in 2040. These volumes stand in stark contrast with the approximately 0.9 Mt of purchased CDR that has been delivered *cumulatively* to date.[41]

Given the EU expects to achieve 50 Mt of annual CO_2 injection capacity by 2030,[42] the respective share of storage capacity implicitly allocated to permanent CDR could be greater than optimal. In light of stated EU priorities for reduction-related activities over removals, the modelling results present conflicting messages. Large volumes may indicate that the models excessively focus on CDR methods like BECCS and DACCS, where instead a portfolio of CDR solutions (including for example ERW and biochar) could be used, easing the pressure on available geological CO_2 storage capacity reserved for CDR methods pre-2050. Notably, there are promising signs of increasing storage availabilities in Europe, but in light of shared needs for transport and storage infrastructure for both conventional CCS from (fossil) point source capture and removals, the available infrastructure is likely to remain insufficient compared to the numbers modelled here.[43]

In our Option 1b, CDR volumes are endogenously defined (i.e. as a percentage of emissions, rather than linking to independent and externally modelled volumes). We have used primarily California's Senate Bill 308 as a reference trajectory, showing an 8% coverage of emissions in 2035, 35% in 2040 and 100% in 2050. Section 4.1 shows that this approach delivers large volumes of CDR demand, likely at high cost. A suitable trajectory for the EU requires careful consideration, adopting a gradual phase-in via an appropriate S-curve and building demand for CDR in a way that is politically resilient and thus scalable long-term, especially in the challenging economic climate currently faced. Whilst the trajectory from the Californian example provides an initial reference point, our usage of identical values is for the sake of simplicity, rather than a normative statement on the appropriateness of the values. Further work should look into the exact nature, size, and speed of the CDR scale up envisioned over time and align policy accordingly.

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[41] Cdr.fyi (2025). Homepage.

[42] Regulation (EU) 2024/1735 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724 (also known as Net Zero Industry Act)

[43] Przadka, A.et al. (2024) Annual knowledge sharing report of the Innovation Fund – De-risking innovative low-carbon technologies, CINEA, *Publications Office of the European Union*

CDR demand beyond 2050

When predicting the long-term EU needs for CDR, it is key to consider the different roles removals should play in climate action. **The IPCC[44] clearly identifies achieving net-negative emissions as one of the three core uses of CDR, noting its potential if deployed at levels exceeding residual emissions**. Additionally, the European Climate Law (ECL)[45] explicitly stipulates that the EU must reach a balance of emissions and removals by 2050 and "should aim to achieve net negative emissions thereafter." Therefore, any compliance policy for carbon removals should ensure that CDR is deployed not only to balance residual emissions but also serve as a tool for climate repair by actively reducing atmospheric CO_2 concentrations beyond net-zero. Further work is needed to better understand the CDR volumes needed to achieve net-negative emissions beyond net-zero and the actors responsible for delivering those volumes.

To date, there are very few studies estimating the specific quantities of CDR needed by the EU beyond 2050 up to the end of the century. One recent study[46] models CDR integration into the ETS from 2020 to 2070 without assuming net-negative emission targets post-2050, therefore treating removals only as a mechanism to neutralise residual emissions. In this scenario, CDR volumes stabilise after 2050, as removals are only deployed to offset hard-to-abate emissions, with no ambition to go further. Such an approach presents barriers to the achievement of the long-term temperature targets of the Paris agreement and to generating net-negative emissions in the second half of the century.

On the other hand, one group of researchers recently modelled EU scenarios up to 2060 in which CDR plays an explicit role in achieving net-negative emissions,[47] aligning with the IPCC approach. In their analysis, CDR volumes continue to increase between 2050 and 2060, reflecting the ambition to use removals not only to balance residuals but also to actively reduce atmospheric CO_2 and repair the climate.

This need to generate higher demand for CDR after 2050 has implications for our RCS design options if extrapolated into the future. Namely, for Option 1b, which calculates removal obligations as the share of declining yearly emissions, the corresponding RCS will need to explicitly utilise percentage trajectories which reach > 100% after 2050. The other policy options, which distribute Removal Targets based on the yearly emissions (Options 1a and 2) or financial metrics (Option 3), must ensure that these targets are based on scenarios which ascribe a net-negative phase for the EU post-2050. Yet, the exact level of ambition and which strategy is appropriate is an open question which comes with ethical considerations. Such an approach would require obligated entities to assume responsibility for neutralising historical emissions, raising questions of fairness and the EU's role in global climate repair.[48]

Use cases and claims

In this report, we have conceptualised the RCS as an obligation for firms to buy CDR, implying that the obligated firms could also reflect those purchased units in their own corporate inventories. This design broadly suggests a "compensation" use case for CDR. The current paradigm in the CDR market (and

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[44] Riahi, K. *et al.* (2022) Mitigation pathways compatible with long-term goals. In *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the IPCC* (eds. Shukla, P. R. *et al.*) (Cambridge Univ. Press).

[45] European Union. (2021) *Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality (European Climate Law).* *Off. J. Eur. Union* L243, 1–17.

[46] Sultani, D. et al. (2024). Sequencing Carbon Dioxide Removal into the EU ETS. CESifo Working Paper No. 11173.

[47] Markkanen, J., et al. (2024) Sustainable negative emissions in Europe: evaluating scenarios to meet carbon neutrality by 2050. *Environ. Res. Lett.* **19**, 114050.

[48] Fyson, C. L. et al. (2020) Fair-share carbon dioxide removal increases major emitter responsibility. *Nat. Clim. Change* 10, 836–841.

the VCM more broadly) is strongly focused on tonne-for-tonne claims, meaning an RCS designed in this way could perhaps be seen as a natural evolution of the existing VCM.

Yet the RCS could alternatively be designed to promote a "contribution" use case instead. Throughout the report, we have highlighted that EU CDR demand will eventually exceed the emissions of key sectors (ETS emissions, non-CO_2 GHG emissions), suggesting that tonne-for-tonne compensation may have an expiry date. To address this possibility, we have explored scenarios where CDR obligation levels exceed 100% of the emissions of obligated entities (where those obligated sectors are contributing to the wider EU's CDR need, not just their own) or where companies finance CDR based on their ability-to-pay, and not their emissions. Over time, companies may need to get familiar with "contributing" to CDR, rather than "compensating".

An RCS in which obligated entities retain ownership of CDR units (and can use them for compensation) could be more palatable to those entities, leaving them with an asset at the end. A contribution model, which does not offer ownership or accounting claims, arguably comes closer to a dedicated CDR tax. Compensation may thus be a more promising route in the near term. Nonetheless, EU policymakers, when implementing any RCS, must clarify the interactions between the RCS, EU claims and reporting rules for corporates, and voluntary net-zero initiatives. Guidance on double claiming or co-claiming (claims on the same CDR units at corporate and national level) must also be provided.

Separately, the use case for CDRs under an RCS can, and should, inform which CDRs are allowed to participate and how those CDRs should be measured. Compensation claims require a high standard of measurement precision and storage certainty (to demonstrate that they fully address the associated emissions) and thus may favour CDR methods like BECCS and DACCS. Yet an RCS could be more "method agnostic" if it were not driven by compensation claims. Carbon Gap sees the potential for an RCS which, if designed in the right way, could provide a home for a wider array of CDR methods, especially those that are less measurable or less permanent, thus generating demand for those methods outside of a compensation construct. Without demand, those CDR methods will struggle to scale, yet proposals to integrate them into the ETS face legitimate criticisms that could enhance the case for a separate system.

5.4 Administrative and institutional considerations

Managing the CDR portfolio

There are different ways of determining the CDR portfolio to be used for the RCS. For example, the RCS may set out eligibility criteria, only allowing CDR units meeting certain conditions to be used. Or there may be rules-based supply controls, limiting how many CDRs of different types enter. On the other hand, a regulator or intermediary body may be more actively involved in issuing certain types and amounts of CDRs into the market at different points in time. As argued in Section 5.2, the sustainability of an RCS will be impacted by which CDRs are used and in what ratio. Without rules to manage the CDR portfolio, the RCS will likely generate a "least cost" portfolio, which encourages a heavy reliance on biomass-based CDRs (as shown in Figure 14 and highlighted elsewhere in discussions on ETS integration).[12,49,50] There is a need for a clear framework that draws on one or more of these levers (eligibility criteria, supply controls, intermediary body) to manage the CDR portfolio and ensure overall sustainability.

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[49] UK ETS Authority (2024). Integrating Greenhouse Gas Removals in the UK Emissions Trading Scheme A joint consultation of the UK Government, the Scottish Government, the Welsh Government and the Department of Agriculture, Environment and Rural Affairs for Northern Ireland.

[50] Sultani, D. et al. (2024). Sequencing Carbon Dioxide Removal into the EU ETS. CESifo Working Paper No. 11173.

Intermediary body

Across these considerations, a critical enabling element could be the establishment of an intermediary body at the EU level, such as a Carbon Clearing House. The European Scientific Advisory Board on Climate Change (2025) suggested that such a body could manage the "conditions, volumes and timing by which different removal methods are integrated" into the ETS,[3] and such functions may also be applicable with an RCS. Such an intermediary could also go beyond managing how CDRs enter the market and be involved in procuring CDRs that match key criteria (CDR method, country of origin) by entering into offtake contracts with eligible suppliers and then selling these into the RCS at a minimum price; this function could help facilitate the scale-up of supply. Through a more proactive governance of the RCS, an intermediary could manage risks of sustainability impacts or other CDR integrity issues and, in turn, help foster trust and scale in emerging removal markets. Such a body would undoubtedly have administrative costs (depending on its design, remit and reach), and its level of independence and political accountability is a key question.[3] The body would need a clear mandate and guardrails to ensure transparency to market participants. Table 6 below summarises our key policy considerations for the implementation of a Removal Compliance System (RCS), divided by category: political, economic, climate and CDR, administrative and institutional.

Table 6: Summary of key considerations for the implementation of an RCS

POLITICAL Considerations that influence the political feasibility of implementing an RCS in the EU	**ECONOMIC** Considerations regarding the economics of CDR and decarbonisation through an RCS
Competitiveness Obligations on sectors will impact how those sectors compete in the international market and how they interact with consumers. **Distributional impacts** An RCS could impact Member States or sectors differently. For example, States' economic and industrial make-up and CDR potential would determine whether they would be net-suppliers or net-buyers within the RCS. The distribution of RCS obligations relative to supply could lead to price-taker dynamics, which should be managed through policy design.	**Cost-effective mitigation** Cost-effective decarbonisation is enabled when entities have a choice to abate emissions or use CDR. In mandating the use of CDR, the RCS does not directly promote cost-effectiveness but may contribute to dynamic cost-effectiveness by strengthening the investment case for CDR. **CDR methods and costs** The choice of eligible CDR methods will strongly shape the cost of compliance under the RCS. A portfolio approach is needed; however, it is critical to consider the overall effectiveness and suitability of different methods.
CLIMATE AND CDR Considerations regarding the impact of an RCS on achieving CDR goals	**ADMINISTRATIVE & INSTITUTIONAL** Considerations for setting up and operating an RCS
CDR availability Mechanisms will be needed to ensure that any obligations do not exceed the available supply of CDR, as this is largely outside the control of obligated entities. **Modelled CDR quantities vs real-world possibilities** The EU must ensure its expectations about CDR needs over time are aligned with reasonable expectations of future CDR capacities. **CDR demand beyond 2050** RCS design should be guided by long-term CDR needs, which means considering who will be responsible for CDR in the post-2050 phase. **Use cases and claims** Given that the proposed RCS places an obligation on firms, policymakers might have to allow obligated firms to make associated claims about their CDR purchases through a "compensation" use case to create further incentives. Alternatively, the RCS could focus on a "contribution" use case where firms cannot claim associated removals tonne-for-tonne. In this way, the RCS could become a home for less permanent CDR methods without interfering with like-for-like provisions.	**Managing the CDR portfolio** Without rules to manage the CDR portfolio, the RCS will likely generate a "least cost" portfolio, which encourages a heavy reliance on biomass-based CDRs. There is a need for a clear framework to manage the CDR portfolio to ensure overall sustainability, for example, through eligibility criteria, supply controls, or more active involvement of the regulator. **Intermediary body** Across these considerations, a critical enabling element could be the establishment of an intermediary institution at the EU level, such as a Carbon Clearing House.

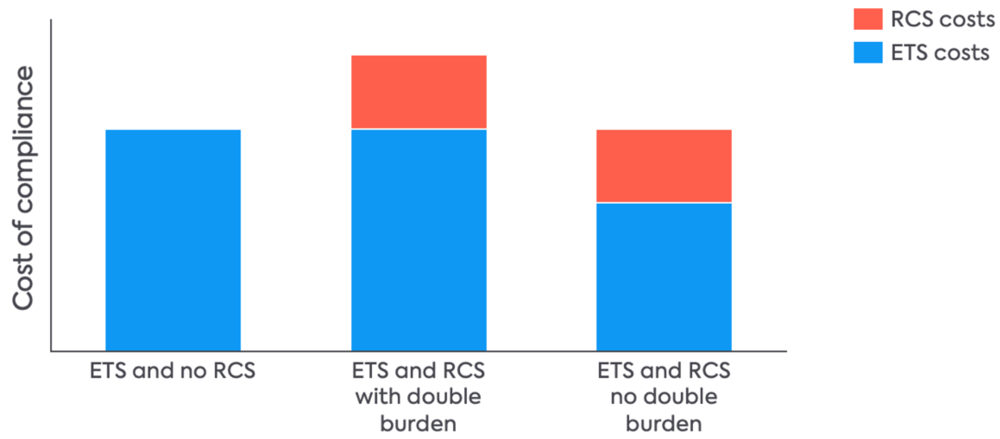
5.5 Interactions between RCS and ETS: RCS as a double burden?

An RCS on ETS sectors could be operationalised either through the ETS itself (see Box 8) or as a brand-new instrument, implemented in parallel to the existing ETS; we focus on the latter option in this sub-section.

An RCS implemented in parallel to the ETS – based on the same emissions, but with separate and additional compliance requirements – raises the question of whether a "double burden" will occur, whereby the two obligations lead to two costs for the covered entities. Covered entities must both purchase ETS allowances (EUAs) as before, as well as acquire CDRs to meet the RCS obligation. This additional obligation could increase incentives for reducing emissions (each unit of GHG emission now faces the additional cost of the RCS) but also overall compliance costs for those who do not cut emissions.[51]

A "double burden" implicitly assumes ETS allowance prices remain unchanged by the existence of an RCS, meaning ETS and RCS prices are added together to form the total compliance cost (middle scenario of Figure 17). Yet ETS I and II are dynamic, market-based systems responsive to changes in demand, and whether an RCS actually increases total compliance costs in practice, or simply reallocates costs, remains uncertain. The RCS could influence this demand; for example, because emitting becomes more expensive due to the RCS costs, it would make EUAs less attractive. **These scenarios imply that the RCS may not create a true "double burden", but instead could reallocate part of the ETS price towards RCS compliance** (as in the last scenario of Figure 17). The potential interactions between ETS and RCS costs are schematically illustrated in Figure 17.

Figure 17: Schematic diagram showing possible interactions between ETS and RCS costs



This chart is illustrative only – further analysis is required to understand real-world outcomes.

Ultimately, whether the RCS constitutes a true double burden on ETS-covered sectors remains uncertain, as arguments rest on theoretical analyses of how the two systems might interact. In practice, the interaction between ETS and RCS could also be influenced by a range of additional factors, such as the Market Stability Reserve (MSR), price intervention mechanisms like Articles 29a and 30h in the ETS Directive, and potential political interventions. Further research is needed to understand the interactions between CDR obligations and existing carbon prices, and how these interactions could influence the cost and acceptability of an RCS.

In Box 8, we outline a proposal for ETS integration of CDRs with the inclusion of a dedicated "sub-mandate" for CDR purchases. In this case, the sub-mandate arguably does not constitute a double

[51] In addition, any parallel system will add administrative burdens, independent of the direct cost of compliance. While these administrative costs are real, they are not the focus here. Instead, the focus is on the financial costs of buying EUAs and CDRs.

burden (in the sense of placing additional obligations on the same emissions), as total compliance obligations (by tonnes) remain the same. Nonetheless, a mandate to fulfil a certain proportion of ETS obligations with CDR could increase overall costs – though this depends heavily on the approach to CDR integration and future ETS design, such as the linear reduction factor and design of the future ETS cap.

In Table 7 below, we present a summary of the main strengths, considerations, and recommendations for the RCS policy options assessed in this report.

Box 8: Integrating CDR into the EU ETS

This report has shown that ETS emissions expected between now and 2050 create ample scope for CDR demand, which we have conceptualised as a growing percentage of ETS emissions being subject to CDR obligations over time. We have highlighted that demand from ETS sectors (per Option 1) could be harnessed through the ETS instrument itself (with design changes), or through a separate and additional mechanism.

Different approaches are available to establish CDR demand through the ETS instrument. Proposals such as Clean-up Certificates[52] outline how CDR obligations could be bundled with ETS obligations. Such proposals merit further consideration but could require significant amendments to the current policy framework. On the other hand, proposals to integrate CDRs into emissions trading are already being concretely advanced, notably by UK policymakers.[49] **ETS integration therefore presents a near-term window of opportunity to generate demand for CDR without undergoing the administrative burden of setting up a new compliance obligation.**

ETS integration creates the potential for CDR demand, by making CDRs an eligible form of compliance unit that can be surrendered under the ETS. However, this set-up does not guarantee the levels of demand needed to meet EU climate targets (outlined in this report as scenarios IAS3 and JRC) because conventional allowances may still be preferred. **Carbon Gap thus calls for ETS integration (with a maintained gross cap) combined with a CDR sub-mandate to grow and sustain CDR demand coming from the ETS**. The sub-mandate is a requirement to fulfil an increasing share of ETS obligations with permanent CDR, meaning CDR is not an additional obligation but part of the ETS obligation. In all cases, the gross cap on emissions must be maintained to ensure CDR integration does not drive mitigation deterrence.

A key issue for ETS integration is the gap between expected CDR costs and current allowance prices. This gap could be addressed through reductions to the ETS cap (which drive up the price of allowances over time); supply or demand controls that drive up the price of CDR allowances specifically (such as a CDR sub-mandate); contracts for difference that address the gap between ETS prices and costs, or other supply-side policies to demonstrate technologies and bring down costs.

ETS integration combined with a sub-mandate represents a promising first step for an RCS. Nonetheless, as highlighted throughout this report, we envisage **a demand gap emerging as ETS emissions decline.** Meeting EU CDR needs in the longer term would either require increased burden on ETS sectors (via a many-to-one ratio between CDR obligations and emissions) or new sources of demand. **A separate RCS, based on either new sectors or new principles (e.g. ability to pay), should thus be a long-term goal of CDR policymaking**. This separate system would allow policies to adapt to the evolving European economic and climate reality and effectively match the EU's CDR needs.

[52] Lessman et al. (2024) Emissions Trading with Clean-Up Certificates: Deterring Mitigation or Increasing Ambition? CESifo Working Paper No. 11167

Table 7: Summary of strengths, considerations, and recommendations for RCS policy options

	Option 1: ETS Entities (Polluter Pays)	Option 2: Non-CO_2 GHG Emitters (Polluter Pays)	Option 3: Wider Economy (Ability to Pay)
Key strengths	• ETS entities drive 89% of residual CO_2 emissions in the EU in 2050. • ETS entities are familiar with emissions monitoring and compliance. • A growing obligation on ETS entities (e.g. the SB308 pathway – 1% in 2030, 35% in 2040) would deliver substantial CDR volumes in the 2030s – more CDR than is needed in the EU over that period.	• Potentially more politically opportune than a separate obligation on ETS entities, avoids potentially double-burdening those sectors. • Significant emissions persist in 2050 even with mitigation (~55 Mt CO_2eq/year). • Establishes mitigation incentives for emissions not yet priced in the ETS. • If presented as an extension to Option 1 (per Option 2b), it could reduce compliance costs on each unit emission by 38%.	• Brings in thousands more firms to pay for CDR, reducing costs to each (there are twice as many "large" firms in the EU as firms in ETS I and II). • Independence from emissions creates longevity and could facilitate net-negative. • Compliance costs remain well below 0.5% of turnover in 2050. • Large firms alone (Option 3a) can cover the costs of EU CDR affordably (well below 0.5% of turnover), without the need to obligate medium and small firms.
Further considerations	• Demand towards 2050 declines, meaning complementary mechanisms are needed to sustain CDR demand. • Any "double burden" and high costs for entities could undermine political feasibility. • Potential interactions with ETS prices could arise, which could be desirable (increase affordability) or undesirable (impact overall mitigation).	• Measurement, monitoring and verification of some non-CO_2 GHG sources will be the key challenge. • Interaction with Methane Regulation must be evaluated.	• Not polluter pays-aligned. Limited precedent in EU policymaking. • Does not create an incentive to cut emissions. • Creates competitiveness impacts which cannot be managed through emissions cuts. • Verges towards dedicated taxation.
Recommendations	• Integrate CDR into the EU ETS., using a sub-mandate to ensure predictable demand. • Undertake further analysis on the interactions between CDR obligations and ETS prices. • Seek to bring non-CO_2 GHG emissions under carbon pricing as soon as possible, with CDR as an eligible instrument. • Explore options for a long-term compliance system to complement CDR demand in the ETS, drawing on elements of all three options to ensure longevity, affordability, and political resilience, while ensuring that competitiveness impacts are managed.		

6. CONCLUSIONS

As the EU seeks to meet its climate neutrality objectives, the need for a dedicated and reliable demand signal for CDR is increasingly clear. This report has explored the potential for a Removal Compliance System (RCS) as a possible compliance policy to drive demand for permanent CDR within the European Union. In this section, we summarise the main results of our analysis and further elaborate on the key policy considerations.

6.1 Cross-cutting conclusions

Key message: A CDR compliance system is critically needed to drive long-term demand for permanent CDR but requires careful design to maximise political feasibility.

This report aims to evaluate if and how CDR volumes could be allocated to demand sectors across the economy as part of a CDR "compliance market". We focus on a large-scale, centralised, EU-level instrument, though we also recognise the value of smaller-scale demand levers. Our assumption is that such a compliance market would establish a bankable price signal, reliable revenues, and contribute to the business model for CDR in the EU. We design our RCS around firms, recognising that private firms are responsible for most territorial emissions, many demonstrate high ability to pay, and a CDR obligation on those firms could thus be a fair route to allocating CDR costs.

In this research, we explore three RCS design options covering different policy rationales and sectors. In doing so, we reveal a series of opportunities and challenges for policy design in creating a long-term CDR market, with a few cross-cutting insights:

Very high EU CDR volumes foreseen in authoritative scenarios call for a swift build-out of supporting infrastructure. According to CDR.fyi, around 0.9 Mt of total CDR ever purchased has been delivered, as of summer 2025. Yet across our two scenarios, CDR volumes in 2035 represent a scale-up of 8-60 times that amount (7-52 Mt), and by 2040, just 15 years from now, the volumes foreseen are 80-120 times current deployments (75-107 Mt). The JRC scenario foresees more CDR (BioCCS and DACCS) in 2035 than is expected to be available as operational injection capacity for any CO_2 source in the EU (50 Mt/year in 2030, based on the Net Zero Industry Act target). These volumes, as calculated by the Commission, highlight a discrepancy between expected CDR needs and wider policy goals which must be further interrogated. This also underscores the need for the EU to swiftly build out supporting infrastructure, without which any delivery of permanent CDR, especially for geological methods, will fail.

Balancing competitiveness impacts with economic opportunities remains an open question. An RCS is very likely to produce impacts on EU firms' competitiveness compared with non-EU firms (for those covered by the framework). Limiting the compliance costs allocated to individual firms should therefore be a key goal when designing such a policy. Policymakers will need to maintain a level playing field for European firms, ensuring an RCS does not harm their international competitiveness by examining whether carbon leakage policies could be employed in tandem (building on the CBAM). On the other hand, by stimulating CDR build-out, an effective RCS will also generate significant economic benefits for the wider EU economy, namely in the form of new high-quality jobs, deployment of innovative technologies made in Europe, investment opportunities, and more.

Given the above points, there is a clear need to be strategic in the design of an RCS. Proposals for a CDR compliance market are much-needed by the CDR industry but include specific policy design challenges related to political feasibility. Such challenges could be addressed via the following:

- **Spreading costs** – An RCS should cover a large group of obligated entities, which can reduce costs to individual firms.

- **Allowing a portfolio of methods** – To comply with the RCS, eligible CDR methods could go beyond BioCCS and DACCS to include methods like biochar and ERW, which would reduce the cost of compliance. However, extending the portfolio of suitable methods should only be allowed if these methods demonstrate a high standard of measurement, reporting and verification (MRV), or has a justifiable use case for the compliance units.
- **Proactively bringing forward supply** – Supplementary policies, such as forward purchases of CDR through an intermediary institution, could be a further cost-cutting measure that would encourage near-term deployment and learning and hopefully bring projects down the cost curve.
- **Addressing the enabling conditions** – An effective long-term CDR market will rely on underpinning physical and policy infrastructure, including a robust MRV framework, continued research and innovation, and access to infrastructure for transport and storage. Getting real projects up and running will be key to bringing down costs, demonstrating benefits, and bolstering the case for CDR. As discussed earlier, an EU-level CDR target is also needed to set a direction for developers and buyers alike.

6.2 Conclusions regarding a polluter-pays RCS (Option 1 & 2)

Key message: An obligation based on major sources of emissions is a promising starting point for an RCS, but does not provide longevity.

For Option 1, we considered how to create an RCS that is linked to emissions, ensuring that polluters are responsible for CDR costs. We presented two variants – one that makes high-emitting sectors carry the burden for all EU CDR needs (Option 1a) and one that considers a ramp-up from 0% to 100% of emissions covered by a CDR obligation, mirroring a corporate net-zero trajectory (Option 1b). Option 1a thus explores the relationship between total EU CDR needs and the emissions of high-emitting sectors, making contemporary emitters directly responsible for all EU CDR demand. Option 1b looks at precedents like California SB308 and SBTi to find a CDR obligation trajectory, revealing how effective they could be in contributing to overall EU CDR needs.

Since ETS sectors generate huge emissions, they carry a strong potential to drive CDR demand in the near term. Due to its broad coverage, estimated ETS emissions are substantial. In particular, ETS emissions are large relative to EU CDR needs in the 2030s, though this gap closes in the 2040s. Option 1a shows that no more than 21% of ETS emissions would need to be covered by an RCS in 2040 to meet EU CDR needs. **This finding makes ETS integration seem a promising opportunity if it can** be designed correctly (see Box 8 for more detail).

Assigning responsibility for CDR and implementing "polluter pays" is challenging in practice. Though an obligation based on major sources of emissions is a promising starting point for an RCS, we also identify challenges with this approach, especially Option 1a. The EU's need for CDR serves different goals over time: bringing down net emissions on the way to climate neutrality, balancing residual emissions for climate neutrality, and ultimately, reaching net-negative to balance out historical emissions. It is thus challenging to determine how much different emitters should contribute at each of these stages, and at all stages there is a risk that some emitters are overpaying or underpaying relative to their actual contribution to the problem over a given timeframe. Where the proportionality between emissions and CDR obligations breaks down, Option 1 can become much closer to Option 3 (turnover-based obligation) in nature. Option 1b (focused on non-CO_2 emissions) faces a similar challenge. We know that polluters should cut their emissions as much as possible and balance out any residual emissions with removals, moving from 0% of emissions being covered by CDR to 100% eventually. But how that trajectory ramps up over time at the level of a specific sector or entity is unclear.

Entities with high Scope 3 emissions should clearly contribute to paying for carbon removal. When designing our policy options, we looked for sectors that contribute heavily to residual or remaining emissions, as part of a "polluter pays" approach. Such entities could include, for example, oil and gas producers. There are also other large energy users such as data centres, which may not have made a large contribution to historical emissions but could be large contributors going forward. However, targeting these users is practically challenging. Most of their emissions are generated upstream or downstream, and these emissions are largely covered under the ETS regime and paid for at the installation level. Costs are likely to be passed on to end consumers. There is thus limited scope to introduce new emissions-based obligations that specifically target other points in the value chain.

CDR obligations could target multiple value chain players at once. An RCS could be designed to target multiple actors in the same value chain, even if emissions are overlapping. For example, an RCS based on production output could charge multiple actors involved in creating the same product, spreading the costs more evenly among the different firms involved. It would make clear where CDR responsibilities fall, highlighting that CDR need is not just a result of energy supply (for example) but also stems from producing and consuming energy-intensive products and services. It would allow both historical contributors and new high-emitting industries to contribute to CDR demand, perhaps at differential rates. This design would require careful scoping to select the covered activities and set appropriate obligation levels and would need to account for different levels of price elasticity in different sectors.

6.3 Conclusions regarding an ability-to-pay RCS (Option 3)

Key message: An obligation based on companies' financial performance better spreads costs across the economy while also focusing on the entities most able to pay

A broader pool of obligated entities clearly enhances affordability. Though this principle departs from polluter pays, Option 3 shows that CDR costs can be effectively spread across the economy while also focusing on the entities most able to pay. We have shown that the number of firms defined as "large" in the EU economy is twice that of firms covered by ETS I and II. Firms covered by Option 1 generate a large number of emissions (note that we have expressed RCS costs in relation to the total emissions of covered sectors), but costs will in reality be borne by a relatively small pool of firms. On the other hand, under Option 3, total EU CDR needs can be borne at well under 0.5% of turnover, potentially less than 0.1% depending on the chosen CDR scenario. We also see that expanding the pool of obligated firms from large firms only, to large, medium and small firms reduces the annual cost per firm by 40% (though involving smaller firms could bring large administrative burdens).

However, turnover is an imperfect metric and will face serious challenges as a basis for CDR obligations. In particular, using turnover does not take into consideration the different profit structures of covered entities. Some single-digit profit margin industries would struggle more with such an obligation than others that have stronger double-digit margins. This challenge stresses the importance of carefully looking at financial health metrics that differ across industries and the need for further thinking about how an ability-to-pay obligation could be delivered in practice.[17]

6.4 Recommended sequencing of a CDR compliance system

Discussions on the long-term market for CDR at scale need to begin. This report aims to provide a useful basis for such discussions, rather than present a fully-fledged policy proposal. Below we present a series of observations about the design of an RCS based on the modelling carried out with CONCITO.

- **ETS integration (with a sub-mandate) is an important short-term route to generate CDR demand.** Integration of domestic CDR into the ETS, as is currently under consideration by the European Commission, can generate near-term CDR demand by leveraging an established policy framework. If CDRs are integrated, we recommend maintaining the gross cap on emissions to limit mitigation deterrence, while adopting a CDR "sub-mandate" to drive sustained and predictable CDR demand.

- **Proposals for a separate RCS should be developed to ensure long-term, large-scale demand. Combining elements of Option 1, 2 and 3 could enable an appropriate balance of large-scale demand and longevity**. While the RCS should ideally target polluters (per Option 1), a focus on emissions may be inappropriate to deliver demand at scale in the long-term, while ability-to-pay (Option 3) could be politically challenging. An RCS could be based on multiple criteria simultaneously, (e.g. considering both emissions and financial criteria), or sequenced over time. New policy proposals could perhaps be explored, such as an RCS placed on **production levels** for pre-identified sectors and activities, allowing the most responsible sectors to be targeted, as mentioned above.

- **The RCS scope should be broad, balancing the need for CDR at scale with the large costs of CDR units**. Covering a wide array of sectors would allow an RCS to spread the costs widely – including entities covered (directly and indirectly) by ETS I and II, and additional sectors.

- **Obligations should be introduced very gradually, with a focus on building a politically resilient tool that can grow towards 2050 and beyond**. This phased approach will need strong, long-term consensus building and advocacy to ensure that politicians, firms, and the public understand the need for and function of the policy.

- **Complementary policies like a separate CDR target for 2040, 2050 and beyond will be key to secure support**. This combination will in turn rely on the preparation of a politically agreed EU CDR scale-up trajectory. Ramp-up rates should complement EU climate goals, such as the 2030 injection capacity target.

Designing an RCS is not just a technical exercise, it is inherently political. The system will need to navigate trade-offs across sectors, Member States, and stakeholder interests. Decisions about targets, eligible removals, cost allocation, and governance will have significant implications for climate ambition and industrial policy. As such, political leadership and inclusive stakeholder engagement will be critical to developing a compliance policy framework that is both effective for CDR scale-up, equitable in terms of cost distribution and durable from an environmental perspective.

ANNEXES

Limitations and Research Gaps

The theorised options for an RCS evaluated in this report are simplified and stylised versions of the real-world policy options. We focus on possible demand sectors (ETS, non-CO_2, whole economy) as well as possible obligation rationales (polluter pays, ability to pay). In reality, a host of other design features are possible, and in fact likely necessary, in a real RCS. For example, a real-world RCS would potentially contain trading, as well as the option of delayed fulfilment of CDR obligations, and even interest rates on those delays to fulfilment. Such design features were not modelled here, as they rely on data that is not readily available or on more sophisticated modelling methods.

Our report also does not evaluate the dynamics of an RCS post-2050, including the achievement of net-negativity in the EU economy. This limitation is due to the high levels of uncertainty regarding emissions over this time frame.

In terms of sectors which could contribute to an RCS, this report has excluded the agriculture and land sectors, both as sources of emissions and of removals, for various reasons including the challenges (already identified by many stakeholders) of establishing a centralised demand-side instrument on agricultural emissions. Nonetheless, we see a strong need to consider these sectors, both as a source of emissions (upon which to place CDR obligations) and of removals. In particular, we see a strong need for further research examining how to generate demand for temporary removals.

Another sector bearing high potential to drive removals demand is international aviation and its related emissions, which are currently not covered by the EU ETS. This aspect has not been analysed in this report, so it is something worth exploring in any upcoming analysis on CDR compliance policy.

A key challenge for this research was data availability, which prevented using a common metric to assess the cost of compliance under each design option. Option 3, in contrast with Option 1 and 2, is framed differently (using the "ability to pay" rationale) and draws on financial metrics rather than emissions data. This alternative framing makes comparison of the cost of the three options more difficult. While an "annual cost per firm" is presented for Option 3, this calculation was not possible for Options 1 and 2 due to limited data on how ETS emissions are distributed among firms, and how this might change over time. Thus, for Option 1 and 2, we instead presented the "cost of RCS compliance per unit of emission", which calculates the cost of the CDR units required under the RCS relative to the total emissions of covered entities.

The analysis in this report represents the first attempt to quantitatively examine different options for a dedicated compliance system for CDR. As such, this exercise is valuable for assessing the advantages of an RCS compared to other policy options to create a market for permanent CDR (see Table A1). Nonetheless, the findings should not be seen as exact predictions, but rather as illustrative, scenario-based estimates of how an RCS might influence obligated entities and the adoption of permanent carbon removal technologies given underlying cost assumptions and economic conditions.

Table A1: Qualitative comparison of policy options for a CDR compliance market, considering both ETS and RCS

(Detailed legend below the table)

Policy choice		Predictability of removal demand	Impact on abatement incentives	Support for a balanced CDR portfolio	Cost of compliance for firms	Public fiscal exposure	Impact on firm competitiveness	Time for policy implementation
ETS integration with expanded cap		Low	Negative	Low	Low	Low	Very low	Short
ETS integration with maintained gross cap	No CDR sub-mandate	Low	Neutral	Low	Low	Low	Very low	Short
	With CDR sub-mandate	Medium	Positive	Low[2]	Medium-High	Low	Medium-High	Short to Medium
	With CDR sub-mandate & Deployment incentives (CCfDs)	High	Positive	High	Medium	Medium to High	Low to Medium	Medium
RCS Option 1: ETS entities	1a: Removal Targets (IAS3-JRC)	High	Positive	High[1]	Very high	Low	High	Short to Medium
	1b: Share of Emissions (SB308)	Medium	Positive	Low[1]	Medium-High	Low	Medium-High	Short to Medium
RCS Option 2: non-CO2 GHG emitters	2a: Non-CO_2 only (IAS3)	Medium	Positive	Medium	Very high	Low	Medium to High	Medium
	2b: ETS + non-CO_2 (IAS3)	High	Positive	Medium	Medium	Low	Medium	Medium
RCS Option 3: Whole economy	3a: Large firms only (IAS3-JRC)	High	Neutral	High	Medium-Low	Low	Medium-Low	Long
	3b: Large & Medium firms (IAS3-JRC)	High	Neutral	High	Low	Medium	Medium	Long
	3c: Large, Medium, Small firms (IAS3-JRC)	High	Neutral	High	Very low	High	High	Long

Legend for the assessment

Predictability of removal demand: How reliably the policy creates predictable and sustained demand for permanent removals over time.

- **High:** Clear, binding demand (e.g., sub-mandate/obligation with clear trajectory). Investors can underwrite projects on this signal.
- **Medium:** Demand exists but is partly contingent (price-dependent, narrow scope, or significant political/administrative discretion).
- **Low:** No guaranteed demand; uptake depends on voluntary action or volatile market conditions.

Impact on abatement incentives: How the policy impacts (or not) the existing incentives to abate, particularly relevant in case of ETS integration.

- **Positive:** The policy strengthen abatement incentives (e.g. through independent targets for reductions and removals, no cap dilution/higher ambition).
- **Neutral:** The abatement incentives are broadly preserved or the policy has no direct impact on such incentives (e.g. as for the RCS Option 3 which focuses on firms' financial performance).
- **Negative:** Produces a material mitigation-deterrence risk (e.g., cap expansion or rules that let removals displace required abatement).

Support for a balanced CDR portfolio: How the policy ensures balanced support for a portfolio of CRCF-aligned permanent methods, beyond the price criteria.

- **High:** Explicit portfolio rules or targeted instruments that enable support for a range of high-integrity methods to scale.
- **Medium:** Some diversity is likely, but design leaves strong bias toward a subset (e.g., least-cost options dominate without correctives).
- **Low:** Little to no portfolio shaping; demand will concentrate in narrow/least-cost segments.

Cost of compliance for covered firms: Measures the costs for the firms covered by the obligation.

- **High:** Significant compliance cost for firms.
- **Medium:** Moderate compliance costs for firms.
- **Low:** Low compliance costs for firms (e.g. thanks to a wider distribution across firms or emissions.

Public fiscal exposure: Accounts for the burden on public finances due to direct budget outlays (grants, procurement), incentives (CCfDs), tax expenditures, and other administrative costs.

- **High:** Significant public spending or liabilities at scale (e.g., broad CCfDs or large public procurement).
- **Medium:** Targeted/limited support or partial guarantees; exposure is bounded.
- **Low:** Very limited outlays or contingent liabilities.

Impact on firm competitiveness: Assesses adverse competitiveness effects for trade-exposed firms.

- **High:** High competitiveness risk (sharp cost increases, asymmetric exposure vs non-EU competitors, or volatile compliance costs).
- **Medium:** Manageable risk; varies by sector and pass-through ability; may require flanking measures.
- **Low:** Low competitiveness risk (predictable costs, modest shares, mitigation via design features or compensatory measures).

Time for policy implementation: Time required to design and adopt the policy, not considering the actual kick-off of the obligation; ranges are indicative and consider 2026 as a starting point.

- **Short (fast): ~1-2 years.** Requires legislative tweaks and delegated/implementing acts.
- **Medium: ~2-4 years.** Requires ad-hoc assessment and a new legislative proposal; moderate administrative build-out.
- **Long (slow): ~4+ years.** New legal framework needed in addition to legislative proposal; significant capacity building required.

Table A2: Summary of quantitative results for each RCS Policy Option

Policy option	Sub-option	2035			2040			2050		
		CDR demand generated ($MtCO_2eq/year$)	Percentage of emissions	Compliance cost (EUR/tCO_2eq)	CDR demand generated ($MtCO_2eq/year$)	Percentage of emissions	Compliance cost (EUR/tCO_2eq)	CDR demand generated ($MtCO_2eq/year$)	Percentage of emissions	Compliance cost (EUR/tCO_2eq)
Option 1: ETS entities	1a: Removal Targets (IAS3-JRC)	7-52	1-5%	0.69-7.10	75-107	21%	29-32	115-209	106-131%	178-215
	1b: Share of Emissions (SB308)	78	8%	12	125	35%	57	88	100%	122
Option 2: non-CO_2 GHG emitters	2a: Non-CO_2 only (IAS3)	7	5%	55.10	75	89%	125	115	210%	287
	2b: ETS + non-CO_2 (IAS3)	7	1%	0.60	75	17%	24	115	81%	110
		CDR demand generated ($MtCO_2/year$)	Compliance cost for large firm (EUR/year)	Compliance cost for large firm as share of turnover (%)	CDR demand generated ($MtCO_2/year$)	Compliance cost for a large firm (EUR/year)	Compliance cost for large firm as share of turnover (%)	CDR demand generated ($MtCO_2/year$)	Compliance cost for a large firm (EUR/year)	Compliance cost for large firm as share of turnover (%)
Option 3: Whole economy	3a: Large firms only (IAS3-JRC)	7-52	12,600-133,500	0.003-0.036	75-107	197,800-313,300	0.054-0.085	115-209	295,600-796,000	0.080- 0.216
	3b: Large & Medium firms (IAS3-JRC)	7-52	9,400-99,000	0.003-0.027	75-107	146,800-232,400	0.040-0.064	115-209	219,300-590,600	0.060- 0.162
	3c: Large, Medium, Small firms (IAS3-JRC)	7-52	7,600-80,500	0.002-0.022	75-107	119,300-189,000	0.033-0.052	115-209	178,300-480,300	0.049- 0.132

ABOUT US

Carbon Gap is an independent, Brussels and UK-based non-profit organisation supporting Europe's unique opportunity to lead the responsible deployment of carbon dioxide removal (CDR) to fight climate change through independent and science-led advice.

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