EU Climate Framework for 2040: How to Incentivise Carbon Removals?

Selected EU policies and measures for carbon removals

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Abbreviations

BAT	Best Available Technique
BECCS	Bioenergy with carbon capture and storage
CCB	Carbon Central Bank
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CDM	Clean Development Mechanism
CDR	Carbon dioxide removal
CRCF	Carbon Removal Certification Framework
DACCS	Direct Air Capture and Carbon Capture and Storage
ECL	European Climate Law
EJ	Exajoule
EPA	Environment Protection Agency
ESABCC	European Scientific Advisory Board on Climate Change
ESR	Effort Sharing Regulation
ETD	Energy Taxation Directive
ETS	Emissions Trading Scheme
EW	Enhanced Weathering
FiT	Feed-in-Tariff
GHG	Greenhouse gas
Gt	Gigaton
IED	Industrial Emissions Directive
IPCC	Intergovernmental Panel on Climate Change
LTS	Long-Term Strategy
LRF	Linear Reduction Factor
MSR	Market Stability Reserve
NECP	National Energy and Climate Plan
RES	Renewable Energy Source
RTS	Removal Trading Scheme

Executive summary

Carbon removal is a double-edged sword. On the one hand, the EU cannot achieve its climate neutrality target and net negative emissions without carbon removals. On the other hand, carbon removals can delay and deter emission reductions. Certain carbon removal technologies require substantial amounts of renewable electricity and can divert significant financial resources away from direct emissions reduction efforts. Technologies such as BECCS and biochar production can pose serious risks to ecosystems, compromise food security, and may even exacerbate climate impacts. Temporary removals cannot, by definition, cancel out the warming effects of CO_2, that partially remains in the atmosphere essentially forever. No carbon removal option is as safe as leaving fossil gas, coal, and oil in the ground – the world's best carbon "sinks".

Policies and measures to scale up and incentivise carbon removals must take account of the ambivalent nature of each type of carbon removal. Support schemes must be designed to avoid undermining emissions reduction efforts. They should not conflate removals with temporary and permanent storage. Given the negative impacts of BECCS and biochar on ecosystems and biomass availability, support measures should, in principle, not support these technologies.

There are **several options** to scale up and incentivise carbon removals. **These options can be grouped into two broad categories.** First, policies that oblige companies or countries to remove CO_2. Second, subsidy schemes that support the removal of CO_2. Both categories should be combined. Because carbon removals are primarily a public good with very limited market value, obligations to remove CO_2 are essential to scale up removals but alone they can overburden companies. For this reason, support schemes are another critical part of removal policies.

Concerning the **first category – obligations to remove carbon** – the **following options** are available:

- **Removal Trading Scheme (RTS)**: A Removal Trading Scheme (RTS) would put an obligation on covered entities to remove and store specific minimum quantities of carbon. Covered entities would either be obliged to remove carbon themselves or buy removals. The quantity of carbon to be removed could be determined based on historical emissions and/or a proportion of current or future emissions of the entity covered by the RTS. As one option, the covered entities could be those falling under ETS 1 and 2. The RTS would operate independently of the ETS. It could be introduced after 2030, operate in parallel with the ETS until the latter ceases to issue allowances – under current legislation anticipated in the late 2030s or early 2040s – and subsequently replace it.

  The RTS could significantly advance the polluter-pays principle, as it would oblige polluters to clean up, i.e. to remove CO_2 from the atmosphere according to their responsibilities. Such an obligation could become an important pillar in the EU's efforts to reach climate neutrality and – ultimately – net negative emissions. Given the numerous issues associated with temporary removals – including leakage and ecosystem impacts – only permanent removals should, in principle, be eligible to comply with RTS obligations, and only provided they do not harm ecosystems.

  As the RTS puts additional costs on entities covered, support mechanisms will be an essential element of the RTS. To avoid overburdening companies covered by the RTS and to

prevent carbon leakage, the amount of carbon removals should be small at the beginning and should increase only gradually over time. For the same reasons, the RTS should not primarily be based on historical emissions, but on a proportion of current emissions.

- **Carbon removals as a permitting requirement under the Industrial Emission Directive**: It is conceivable that carbon removals may become a requirement for the issuance of permits. Permits for industrial installations falling under the Industrial Emissions Directive (IED) are a particularly relevant use case. The IED has been revised in 2024. The revised IED opens up new possibilities to incentivise scaling up carbon removals. The revised IED, for example, requires operators to implement so-called transformation plans. These plans could request operators to remove carbon. However, transformation plans are legally non-binding, and a request to remove CO_2 would be based on an extensive interpretation of the IED.

  If the IED were to include stronger rules on carbon removals, it would require further revision. Such a revision could include a permit requirement to remove carbon. The revision could explicitly allow the adoption of Best Available Technique (BATs) that include standards and requirements for carbon removal and storage.

  Another potential reform with direct implications for permitting under the IED is the inclusion of CO_2 within the scope of a revised Waste Framework Directive. In this case, covered installations would be required to prevent the generation of CO_2. Should this not be feasible as determined by the Directive, installations must prepare for the re-use, recycling, or recovery of CO_2. Only when this is technically and economically impossible, installations may dispose, i.e., emit CO_2 while avoiding or reducing any impact on the environment.

- **Removal targets under the Effort Sharing Regulation:** A revised Effort Sharing Regulation (ESR) should continue to set targets for the time after 2030, including quantified removal targets for Member States. Because of the many issues of temporary removals, only permanent removals may be used to meet these targets provided they do not harm ecosystems.

  There are strong arguments in favor of establishing such removal targets. First, removal targets enable the EU to hold Member States – key actors in EU climate policies – accountable in a politically meaningful manner. Second, quantified national removal targets would help tracking progress towards climate targets and would thereby enhance transparency. Third, since removal targets under the ESR would be legally binding, they would help ensure high levels of compliance.

- **Carbon removals eligible for complying with the Effort Sharing Regulation:** Currently, the ESR makes a limited amount of carbon removals from the land sector eligible for compliance purposes (Article 7 of the ESR). This provision is problematic because it conflates emission reductions and removals. Worse, it makes temporary removals an eligible compliance unit for the reduction obligations under the ESR. It thereby constitutes an exception to the principles of EU climate law that removals should not substitute reductions. Article 4.1. of the ECL stipulates that "relevant EU institutions and the Member States shall prioritise swift and predictable emission reductions".

  The system under Article 7 of the ESR should be discontinued. If the ESR were to include removals, these removals would have to be truly permanent and compatible with sustainability criteria. BECCS should be excluded unless it only uses narrowly defined waste biomass.

Concerning **the second category – carbon removal support schemes** – the **following options** are available:

- **Competitive bidding**: Government purchase programmes through competitive bidding is a standard method for the procurement of goods and services. Several countries have introduced such programmes for carbon removals or are discussing their introduction. A clear benefit of competitive tendering is that it establishes investment certainty, and it can be built on well-established procedures.

  However – given the costs involved, limited public budgets in Member States, the complexity and lengths of procurement processes – these procurement programmes are only a vehicle to promote carbon removals at smaller scales. They cannot deliver large-scale removal of CO_2. They also tend to favour technologies that can offer comparatively low removal prices but that are not innovative or have other negative side effects. It is possible to address these issues – for example through competitive bidding only for specific technologies with high innovation potential – but such approaches often lead to more complexity and bureaucracy.

- **Feed-in-Tariffs for carbon removals (FiTs):** FiTs for renewable energies could inspire a similar scheme for carbon removals. Like a FiT for renewable energies, such FiT would guarantee producers of carbon removals a price for the CO_2 removed and stored. This price could be paid by specific government programmes or levied on ETS revenues or other services and goods. Such a FiT has several advantages: It can provide transparency, predictability, and security. Since FiTs can be open-ended, they are not constrained by budget cycles or subject to budget negotiations with unpredictable outcomes.

  At the same time, however, FiTs present several disadvantages. Setting appropriate remuneration levels is complex and prone to inefficiencies. FiTs may also require substantial public funding and can therefore raise state aid concerns. Moreover, if financed through revenues from the Emissions Trading System (ETS), FiTs would face funding challenges once the ETS ceases to issue allowances – under current legislation expected in the late 2030s or early 2040s – necessitating the identification of alternative funding sources.

- **Carbon contracts for difference:** Under a Carbon Contract for Difference (CCfD) for carbon removals, a project developer offers to remove carbon at a price that covers its costs – the so-called ‘strike price’. A government counterparty guarantees to pay the difference between this strike price and the market price. Project developers pay back surpluses above the strike price to the government.

  CCfDs for carbon removals can have various benefits. For investors, they can provide financial viability and certainty. For governments, a major advantage lies in the efficient use of public funds: contracts can be awarded through competitive bidding processes, ensuring cost-effectiveness, and avoiding windfall profits.

  At the same time, however, setting the strike price is difficult if there is no market for carbon removals. Voluntary markets cannot help setting the right price as they are not transparent and produce very different prices. There are discussions in a few countries to use CCfDs for scaling up carbon removals, but they have not led to the implementation of CCfDs for carbon removals yet.

While the RTS and the inclusion of removals in IED permitting impose legally binding obligations on companies, the integration of removals into the ESR targets Member States directly. Given its greater flexibility and market-based approach, **the RTS is better positioned to scale up**

removals compared to the potential more bureaucratic nature of IED permitting. Although IED permits produce legally enforceable outcomes, their implementation has historically been slow. Removal targets for Member States under the ESR are an essential complement to removal obligations for companies.

Legally binding obligations in EU legislation to remove carbon are indispensable for scaling up carbon removals, but they are not sufficient on their own. They do not support investments in removal technologies and can overburden companies. Complementary support policies and measures are therefore essential for scaling up removals. CCfDs are a particularly useful tool to support required investments. They can be more cost-effective than government programmes that guarantee certain prices for removals – such as purchase programmes, competitive bidding or FiTs. Due to their relative cost-efficiency, CCfDs are also better suited to helping the scale-up carbon removals.

1 Introduction

The EU will adopt a **climate target for 2040** in the coming years. This is a legal obligation set out in the European Climate Law (ECL). Article 4.4 of the ECL stipulates that "a Union-wide climate target for 2040 shall be set" – with a view to achieving the ECL's climate neutrality objective. In early 2024, the European Commission recommended a 90% reduction in *net* greenhouse gas (GHG) emissions by 2040. The European Commission reconfirmed this overall target in the Communication on a Clean Industrial Deal published on 26 February 2025. Achieving *net* reductions of 90% will require deep and sustained emission cuts, while also necessitating the use of carbon removals — to a limited extent — to compensate for residual emissions (European Commission, 2024a). The 2040 target, communicated together with the Impact Assessment by the European Commission, stipulates a reduction of 83% of gross emissions compared to 1990, leaving room for removals in the range of 7% (European Commission, 2024a; Gores, 2024).

Against this backdrop, the EU's new 2040 climate framework and target **are bound to regulate the role of carbon removals** – but regulating carbon removals is a complicated and ambivalent matter. EU regulation on carbon removals must help meet objectives that are potentially conflicting. On the one hand, it must ensure that removals do not deter emission reductions and do not conflate removals with temporary and permanent storage. On the other hand, EU legislation must create incentives to remove carbon.

This paper explores how to incentivise carbon removals. It discusses **selected measures** that could help incentivise carbon removals at larger scale: (1) establishing a removal trading scheme (RTS), (2) removals as a requirement for granting permits, (3) integration of carbon removals into the EU Effort Sharing Regulation, (4) Feed-in-Tariffs for carbon removals, (5) contracts for difference for carbon removals and (5) competitive bidding or auctioning for removals.

There are **other options to incentivise carbon removals**, such as integrating carbon removals into the ETS or tax incentives.[1] Because many reports discuss the integration of carbon removals into the ETS, including a Central Carbon Bank (CCB) or another intermediary agency, these options are not part of this paper. The paper also does not discuss tax incentives. It is unlikely that this option would gain traction in the EU, as EU legislation on taxation, such as the Energy Taxation Directive (ETD), can only be adopted by unanimity in the Council of Ministers.

The paper is **part of a research project funded** by the German Federal Ministry for Economic Affairs and Climate Action.[2] This paper builds on previous research conducted within this project. It draws on analyses of carbon removals, the post-2030 EU climate architecture, and the design of the EU 2040 climate target, all developed as part of this initiative. (Meyer-Ohlendorf, Kocher, Gores, et al., 2023a; Meyer-Ohlendorf, Kocher, Graichen, et al., 2023b, 2023a).

[1] It should be noted that the certification of carbon removals is another instrument incentivising removals. However, this measure alone does not incentivise carbon removals but is a precondition to operationalising the measures discussed in the chapter. In the context of the negotiations of the CRCF, certification of carbon removals is discussed in detail, Meyer-Ohlendorf, 2023, 1.

[2] EU 2040 climate target: level of ambition and implications, https://www.ecologic.eu/19177

Text box 1: What is carbon removal?[3]

The **IPCC defines carbon removals** as human activities "removing CO_2 from the atmosphere and *durably* storing it in geological, terrestrial, or ocean reservoirs, or in products" (emphasis added). Accordingly, this definition includes "existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage but excludes natural CO_2 uptake not directly caused by human activities".[4] Importantly, the IPCC does not define the crucial adjective "durable". In its information note on carbon removal mechanisms, however, the Supervisory Body of the Article 6.4 Mechanism vaguely states that 100 years is a commonly used period and a "*commonly accepted normative choice*".[5]

Other relevant laws and political documents, such as the US Federal Carbon Dioxide Removal Leadership Act, and the EU's submission to Article 6.4, also recognises the criterion of durable storage, but do not specify the minimum duration of storage. To address this ambiguity, there is the proposal to define **permanent storage as the time that carbon is set to stay in the atmosphere**[6], which is up to 1000 years and more. This definition is also used by the Frontier Initiative.[7]

In this context, it is important to stress that **GHG inventories** serve as indicators to track progress towards climate targets, but that "removals" in this context only inform about the embedding of CO_2 from one year to the next. Inventories contain no information on the storage time of removals.

[3] Meyer-Ohlendorf (2023)

[4] Supervisory Body, 2022, IPCC, 2018

[5] IPCC, 2022

[6] Meyer-Ohlendorf, 2023

[7] Frontier, n.d.

2 Selected measures to scale up and incentivise carbon removals

There are **various options for scaling up and incentivising removals in the EU's new 2040 climate framework**. These options can be grouped into two broad categories. First, policies that oblige countries or companies to remove carbon. Second, subsidy schemes that support the removal of carbon. Both groups can and should be combined.

Options of the first group include, among others:

- Establishing a separate trading scheme for removals, the Removal Trading Scheme (RTS).
- Removals as a requirement for granting permits.
- Integration of carbon removals into the Effort Sharing Regulation (ESR).

Options of the second group are:

- Competitive bidding for removals.
- Feed-in-Tariffs (FiTs).
- Government purchase programmes.
- Carbon Contracts for Difference (CCfDs)

It is important to stress that these measures and policies should not only contribute to achieving the EU's new 2040 climate target through removing and storing carbon. **They must also take account of impacts and co-benefits regarding other policy objectives, especially potential impacts on biodiversity, water, soils, energy, and resource consumption.** The combined effects and trade-offs of measures need to be fully considered.

2.1 Removal Trading Scheme

An EU Removal Trading Scheme (RTS) is one option to scale up carbon removals. **The RTS would oblige companies covered by the scheme to remove and store specific minimum amounts of carbon**. This obligation would exist strictly independently from existing ETS obligations. In other words, the obligation under the RTS to remove carbon does not impact the reduction obligations under the ETS, i.e. removals cannot be used to offset emissions.

In more detail, the RTS could feature these **design elements** which can be combined:

- **Covered entities:** Covered entities could be companies currently obliged by the ETS – as one possibility. As another possibility, covered entities could be companies that have emissions that are above a certain threshold. Other options are conceivable. Given the administrative capacities of entities covered by the ETS, it makes sense that ETS entities are also those covered by the RTS. The scope of the RTS could be informed by a legislative proposal for a Carbon Removal Market Development Act that was discussed in the California Legislature in 2024 (see text box 2). According to this proposal, the covered entities are those currently obliged by California's ETS.

- **Obligation to remove carbon or to buy carbon removals:** Covered entities would either be obliged to remove carbon themselves, or to buy removal units from companies or other entities that had removed carbon or had surplus removal units in their portfolio.
- **Market for carbon removals:** The RTS would be the basis for a market for carbon removal units. Similar to the markets created by the ETS, the removal market would allow for selling and buying removal units.
- **Volumes to be removed:** As one option, the quantity of carbon to be removed could be determined based on historical emissions. Historical emissions could be defined as the emissions released by an RTS entity since its establishment, or alternatively, since any year following the entry into force of the UNFCCC in 1992 – when climate change became a prominent issue in political discourse.

  As another option, the volume of carbon removals could be calculated as a proportion of annual emissions of the entity covered by the RTS. Accordingly, the entities covered by the scheme would remove a specific percentage share of their annual emissions each year. To reach net negative emissions, the required amount of removals would exceed emissions at some point later in the century.
- **Obligation to store carbon permanently:** The RTS could impose an obligation on covered entities to ensure the permanent removal of carbon – meaning that the sequestered carbon must be stored for a duration equivalent to its atmospheric lifetime, which, in part, extends to at least 1,000 years. As another option, the RTS could use the definition of permanent storage included in the CRCF or the CCS Directive. These pieces of legislation define permanent as “several centuries”.

  Alternatively, temporary removals could be eligible but need to be replaced by permanent removals upon expiry. Accordingly, emitting entities can use so-called two-phase negative emissions credits to meet their carbon removal obligations. These two-phase credits consist of (1) a negative emissions credit utilising a temporary carbon sequestration method and (2) a legally binding commitment to purchase an additional negative emissions credit utilising a durable carbon sequestration method upon the expiration of the guarantee period associated with the original temporary negative emissions credit. In this respect, the RTS would feature a key element of the Carbon Removal Market Development Act (see text box 2).[8]
- **Cap on the use of temporary removals:** In case of the two-phase approach, the amount of eligible temporary removals should be capped to ensure that permanent removals are available in sufficient volumes when temporary removals expire.
- **Buffer pool:** To safeguard its integrity, the RTS could establish a buffer pool whereby a certain amount of permanent removals is set aside as a security guarantee.
- **Introduction after 2030 and increasing removal volumes over time:** The RTS could be introduced after 2030. The amount of carbon to be removed would increase over time. It should start with small amounts and increase significantly in the course of the coming decades. Using the example of the proposal for a Carbon Removal Market Development Act in California, 1% in 2030, 8% in 2035, 35% in 2040 and 100% in 2045. This system would

[8] In theory, there is a third option: The RTS could include temporary removals as another compliance unit. However, given the very limited climate value of temporary removals, this option should not be pursued.

also serve as a strong incentive to reduce emissions because lower emissions would reduce the amounts of carbon to be removed.

The RTS offers **several important advantages**:

- **No offsetting:** The RTS is an obligation to remove carbon. It is not a scheme that allows to offset emissions with removals. It does not conflate emission reductions and carbon removals. In this respect, the RTS addresses a major shortcoming of proposals to integrate any type of removal into the ETS.
- **Implement the polluter-pays principle:** The RTS could significantly advance the polluter-pays principle within the sphere of climate action. It would also oblige individual entities to remove carbon, remedying – to some extent – the warming effect and damage caused by their emissions.
- **Vehicle to net negative emissions:** The RTS could become an important vehicle in achieving net negative emissions. It supports activities that actually decrease the GHG concentration rather than just offsetting emissions. In this regard, the RTS could uniquely contribute to the ultimate objective of climate policy: achieving net negative emissions.
- **Addresses the permanence problem of carbon removals:** The RTS addresses the central shortcoming of a system that would allow the use of temporary removals for meeting removal obligations. By including an obligation to replace expired removals with permanent ones – as one possible design feature – the RTS addresses a key flaw of systems reliant on the continuous renewal of temporary removals after their expiry. Given the impact of climate change on ecosystems and their capacities to store carbon, it is often not possible to renew an expired temporary removal. As carbon stays partly in the atmosphere for extremely long periods, the constant renewal of expired removals for that period is an implausible prospect.
- **Creates a market for carbon removals:** The RTS creates a new market for carbon removals, potentially providing a market-based and cost-effective system for the removal of carbon. Such a market could be a strong incentive for the development and deployment of permanent and innovative removal technologies.
- **No public funding:** As a market-based system solely obliging companies, the RTS itself does not depend on public funding.
- **Buys time:** With a two-phased approach as outlined above, the RTS could buy time for decarbonising economies while keeping GHG concentrations at potentially safer levels.
- **Relation with the ETS:** The RTS is independent of the ETS and would operate in parallel during the initial phase. However, as the ETS phases out allowance issuance under current legislation in the late 2030s or early 2040s and the EU transitions into a period of net negative emissions, the RTS would eventually replace it. Stepwise, the RTS would establish ongoing obligations to remove CO_2.

However, while these are important advantages, the **RTS also has several disadvantages** that need to be addressed:

- **Implementation costs for entities covered:** The RTS imposes additional costs on companies. Some of those are already under economic pressure to achieve the emission reductions required. The RTS could open another debate on international competitiveness, carbon leakage and relocation.

- **RTS can create risky path dependencies**. The RTS builds on the assumption that permanent removals will be available in sufficient quantities after the temporary removals have expired. The availability of permanent removals in sufficient quantities is essential for the environmental integrity of the RTS but this is an uncertain prospect. Given their economic costs, permanent removals are scarce, and it is unclear whether they will become available at bearable costs and in sufficient quantities on time.
- **Moral hazard:** Depending on its design, linking the polluter-pays principle to historical or cumulative emissions could be very difficult to implement and could create moral hazards. Companies could file for bankruptcy largely for the reason of avoiding to remove historical emissions and paying their historical carbon debt. Companies covered by the RTS could also create new legal entities with no historical emissions to avoid responsibility.

To reconcile these advantages and disadvantages, the RTS should include these features:

- **Volumes of removals should correspond to emissions:** To establish another incentive to reduce emissions, the volumes of carbon to be removed should be calculated corresponding to emissions volumes. Entities covered by RTS should be obliged to remove an amount of carbon that equals a share of current emissions. This share should increase over time providing a strong incentive to cut emissions and to scale up and improve removal technologies at the same time. With emissions decreasing steadily, the RTS will have to decouple from emission shares and will set fixed amounts of CO_2 to be removed. Under current legislation, this will probably happen at the beginning of the 2040s.
- **Modest removal obligation at the start:** The RTS should require only small amounts of carbon removals at its start. The required amounts of removals should increase over time, eventually going up to 100% of current emissions and then beyond. As removals technologies mature and emissions decrease, the RTS could start requiring net negative emissions. At this point in time, the RTS could require removing more CO_2 than the obliged company emits at a given year. Depending on design details and the availability of reliable emission data, historical emissions can be taken into account when setting the required amounts of net negative emissions.
- **Support systems:** The RTS should be combined with support systems as discussed below.
- **Liability**: The RTS must also settle liability issues. It must regulate what happens when a committed entity goes bankrupt prior to the temporary carbon credit's expiry, or if the removals are reversed and re-enter the atmosphere before the agreed storage duration has passed.
- **Cap on temporary removals in a two-phased system:** If the RTS would make temporary removals eligible and would require replacing them with permanent removals after expiry, the scheme should cap the maximum volume of temporary removals permitted. Accordingly, the RTS should limit the share of temporary removals that can be used to fulfil removal obligations. According to the proposal discussed in California, for example, no more than 50% of the negative emissions credits used by an emitting entity to meet its obligation may be two-phase emissions credits.

  However, a cap at 50% is too high. This cap could result in a quantity of temporary removals expiring at a time when an equal quantity of permanent removals is not available. This could

also result in the price gap between permanent and temporary removals remaining prohibitively large.

Text box 2: Proposal for a Carbon Removal Market Development Act in California (SB 308)

The RTS could draw inspiration from California's **proposal for a Carbon Removal Market Development Act, also known as Senate Bill 308 or SB 308**. According to this proposal, the state board adopts – by the end of 2027 – a regulation requiring "emitting entities" to purchase negative emissions credits. These credits are equivalent to an increasing portion of the entity's GHG emissions: 1% in 2030, 8% in 2035, 35% in 2040 and 100% in 2045. Emitting entities are installations that are subject to the California ETS, which is triggered by emissions ≥ 25 kt CO_2e/year.

To fulfil their negative emissions obligation, emitting entities are only **permitted to utilise negative emissions credits obtained through "durable carbon sequestration methods**". Durable carbon sequestration methods are methods "that can reasonably be projected to retain a large majority of the carbon atoms out of the atmosphere for 1,000 years and for which the responsible entity provides a guarantee period of at least 100 years" (section 39742.1). **Alternatively**, emitting entities can use so-called two-phase negative emissions credits – provided the state board has adopted pertinent rules.

The Senate of California approved the proposal on a 24-9 vote in May 2023, but the California Assembly, California's second chamber, did not adopt it in November 2024. At this point in time, as the legislative session concluded in 2024 without passage of the proposal, SB 308 is currently inactive. To pursue the proposal, a new version of the bill would have to be reintroduced for the current session (covering 2025-2026). The Assembly did not adopt the proposal because of its implementation costs, but also because the California Air Resources Board (CARB) argued that it already has the mandate to introduce and implement the obligations proposed by SB 308.

2.2 Carbon removals as a requirement for permits under the Industrial Emissions Directive?

Another option is to make **carbon removals a condition for granting permits**. In this option, an applicant seeking a certain permit would be required to commit to removing or purchasing a certain amount of carbon from the atmosphere and ensuring its storage for a duration defined in the permit.

In principle, carbon removals could be required for issuing various types of permits, such as construction permits or import licenses. However, **permits for industrial installation falling under the scope of the Industrial Emissions Directive (IED)** are a particularly relevant use case. The IED covers some 50,000 large industrial installations and intensive livestock farms in Europe, which cause around 40% of EU GHG emissions.[9] Installations covered by the IED are typically operated by large companies with significant administrative and economic capacities.

[9] European Commission, 2022, IED

The **IED was revised in 2024**.[10] The revised IED establishes stricter emissions limit values and more stringent conditions on granting derogations. It also covers more activities and strengthens rules on public information, participation, access to justice and compensation. In addition, the revised IED contains several new provisions particularly relevant for the removal of CO_2:

- **Decarbonisation is a new IED objective:** It is the explicit objective of the revised IED to promote the circular economy and decarbonisation.
- **Transformation plan:** Article 27d of the revised IED introduces new rules on the "transformation towards a clean, circular and climate-neutral industry". According to these rules, Member States must require operators – by 30 June 2030 – to include in their environmental management system (EMS) an indicative transformation plan. This plan must "contain information on how the operator will transform the installation during the 2030-2050 period to contribute to the emergence of a sustainable, clean, circular, resource-efficient and climate-neutral economy by 2050".
- **Delegated act on transformation plans:** According to Article 27d.5, the Commission adopts – by 30 June 2026 – a delegated act to specify the content for these transformation plans.
- **Audits of transformation plans:** An audit organisation assesses whether the transformation plans are consistent with the requirements set out in the delegated act.

While these provisions can eventually become relevant for the removal of CO_2, **they do not introduce strong rules for carbon removals:**

- **Carbon removal is not a condition for permits:** The revised IED does not require that covered installations remove carbon to receive permits.
- **Transformation plans are a weak vehicle for carbon removals:** In an extensive interpretation of the IED's objectives, transformation plans could request that operators start removing carbon from the atmosphere. For this purpose, the Commission's delegated act to specify the transformation plans could include such a request.

  It should be noted, however, that this interpretation of the IEDs decarbonisation objective is very extensive, as the IED does not include any provision on carbon removals, let alone an obligation to remove CO_2. In addition, the delegated act cannot make transformation plans binding. These plans are indicative as stipulated by Article 27d. A delegated act cannot override this provision.

If the IED were to include stronger rules on incentivising carbon removals, the directive would require additional reforms. In principle, there are the following options to make the IED a vehicle for scaling up carbon removals in the future:

- **Treating CO_2 as waste:** The IED sets requirements for the treatment and generation of waste. It mandates that the generation of waste must be prevented in accordance with the requirements of the Waste Directive 2008/98/EC. If waste is generated, it must be prioritised for re-use, recycling, or recovery. Only when these options are technically and economically impossible may waste be disposed of "while avoiding or reducing any impact on the environment", in order of priority. Currently, CO_2 is excluded from the scope of the Waste

[10].

Directive. According to Article 2.1 (a), gaseous effluents emitted into the atmosphere do not fall under the Directive.

Repealing this limitation of the Directive's scope would reclassify CO_2 as waste in the sense of the Directive.[11] Such an amendment would not automatically oblige installations covered by the Directive to remove carbon from the atmosphere, but it would oblige them to comply with the Directive's requirements relevant for waste. Accordingly, installations would be required to prevent the generation of CO_2 as a matter of priority. If this is not feasible as determined by the Directive, installations must prepare for the re-use, recycling, or recovery of CO_2. Only when this is technically and economically impossible, installations may dispose of, i.e., emit CO_2, while avoiding or reducing any impact on the environment.

- **Carbon removals as the best available techniques?** The IED stipulates that permit conditions, such as emission limit values, must be based on the Best Available Techniques (BATs). In the past, this system had deficiencies.[12] It did not promote new production processes, technologies, and innovation, as BATs are inherently retrospective. By definition, they are based on current, already established practices, hindering the development and deployment of more effective and/or innovative techniques.

  To address this issue, the revised IED opens BATs to more innovative approaches. The new definition of BAT conclusions also includes "emerging techniques".[13] In this context, it is conceivable that the revised IED allows the adoption of BATs that also include standards and requirements for carbon removal and storage.

  It should be noted, however, that the revised IED also does not apply to GHG emissions covered by the ETS. According to Article 9 of the IED, permits may not include an emission limit value for "direct" GHG emissions. In light of this, it could be argued that the IED may not regulate GHGs, including carbon removals. Only an amendment of the revised IED could address this ambiguity.

- **Outright permit conditions to remove carbon?** In contrast to the previous options that build on BATs, it is also conceivable that the IED *itself* sets conditions requiring the removal of carbon. This option could be informed, for example, by draft standards for large polluters proposed by the US Environment Protection Agency (EPA) in 2023. According to these draft rules, new and existing gas power plants would be required – except those that only run part-time – to capture 90% of their emissions by 2035 (Chemnick, 2023). Existing coal-fired power plants would need to achieve the 90% target by 2030, but only if operators plan to keep them in operation until 2040.

  Expanding on these EPA draft rules, it is an option that the IED could not only require the capture of carbon, but also the active removal from the atmosphere or purchase of removals. Such an obligation could be imposed on all installations currently covered by the IED or, as with the EPA's draft rules, be limited to specific installations. Initially, the removal obligation could be small, requiring only a minor quantity of removals, but it could increase over time, then mandating larger amounts of carbon removals.

  As a design feature of this option, it is conceivable that only removals that are certified according to specific certification schemes (i.e., the CRCF) can be used for granting a

[11] Article in conjunction with Article 3.1 directive defines 'waste' as any substance or object which the holder discards or intends or is required to discard.

[12] European Commission, 2022, IED SWD.

[13] Article 3 point 12 of the revised IED: "BAT conclusions" refer to a document containing the parts of a BAT reference document laying down the conclusions on best available techniques and emerging techniques.

permit. Permanent storage could be another condition for permitting. Because of their many negative side effects, this option could exclude carbon removals from BECCS from permitting in principle (see text box 3).

To varying degrees, all these options would **scale up** the generation of carbon removals. Similar to the RTS, they could also support activities that actually decrease GHG concentration, rather than only compensating for emissions. These options would help implement the "polluter pays" principle and would not depend on public funding.

However, while these are important benefits, it should be noted that **all options face a number of challenges**: First, the IED was revised only a year ago, making it politically difficult to start a new reform process now. Second, the IED has been slow in setting and implementing higher standards. Third, there is the risk of double regulation for installations that fall under the ETS if carbon removals are integrated into the ETS.

Text box 3: Bioenergy with Carbon Capture and Storage (BECCS)

In various climate neutrality scenarios, Bioenergy with Carbon Capture and Storage (BECCS) is expected to play a major role, with projections suggesting it could remove more CO_2 than any other technology (IPCC, 2019).

These assumptions are problematic for several reasons:

- **BECCS emits GHG:** BECCS relies on the assumption that the amount of biomass burned eventually regrows and sequesters the CO_2 released. This assumption is problematic, as regrowth of burned biomass is an uncertain prospect – in particular as climate change undermines the storage capacity of ecosystems.

  Moreover, carbon capture and storage (CCS) only captures emissions released from burning biomass, neglecting indirect emissions from foregone sequestration, biomass production, harvest, transport, refinement, capture, and storage. These life-cycle emissions can outweigh the CO_2 sequestered. One study estimates that for every tonne of CO_2 stored, 1.11 tonnes of emissions are generated along the supply chain (FERN). Another study finds that after 20 years of operation, only 37% of the CO_2 stored geologically originates from the atmosphere. The rest is carbon transferred from biogenic carbon pools in forests into the ground (Weidmann).

- **Large demand for land:** Depending on the scenario and assumptions, removing CO_2 through BECCS can entail the use of enormous amounts of land. According to one estimate, limiting the global temperature rise to 2°C would require the removal of some 600 gigatonnes of CO_2 over this century. This could require crops to be planted solely for the purpose of CO_2 removal on between 430 million and 580 million hectares of land – around one-third of the current total arable land on the planet, or about half the land area of the United States (Williamson).

- **Negative impacts on ecosystems and biodiversity:** The land used to grow bio crops for BECCS often overlaps with protected areas. BECCS accelerates the loss of primary forests, natural grasslands, and biodiversity.

To address these problems, removals from BECCS should only be considered for any compliance purposes if used biomass is strictly non-additional waste biomass (Schneider, 2024).

2.3 Integration of carbon removals into the Effort Sharing Regulation

There are at least **two ways to integrate carbon removals into the Effort Sharing Regulation**. First, a revised ESR could establish national targets for carbon removals, thereby obliging Member States to remove CO_2. Second, carbon removals are eligible to comply with the ESR's reduction targets.

2.3.1 Removal targets for Member States

Currently, the ESR does not establish removal targets for Member States. It "only" defines a national reduction target for 2030. Unless revised, the ESR will cease to set targets beyond 2030. However, if the ESR is revised and extended post-2030, it could also **introduce quantified national targets for carbon removals**. Given the various issues of temporary removals – such as leakage or impacts on ecosystems – removals targets under the ESR should only apply to technical sinks and permanent removals (Böttcher, 2025; Meyer-Ohlendorf, 2023).

There are **compelling arguments for establishing removal targets for Member States**. First and foremost, removal targets allow to hold Member States – central players in EU climate policies – accountable in a politically meaningful manner (Meyer-Ohlendorf, 2024). Second, quantified national removal targets would help tracking progress towards removal targets and would make an important part of EU climate policies – removal efforts of Member States – more transparent. Third, since removal targets under the ESR would be legally binding, they would ensure high levels of compliance. Fourth, removal can build on a tested and established system of national targets.

2.3.2 Use of carbon removals to comply with targets under the Effort Sharing Regulation

Carbon removals from the land sector are already integrated into the Effort Sharing Regulation (ESR). Article 7 of the ESR allows Member States to use up to 262 Mt of net removals accounted under the LULUCF Regulation to meet their reduction obligations under the ESR – provided they comply with their LULUCF obligations and face a deficit under the ESR in the same timeframe. These removals refer to removals reported in GHG inventories for the LULUCF sector. Article 7 of the ESR is intended to provide some flexibility to Member States by allowing them to use removals from another sector to reach their emission reduction targets under the ESR. This flexibility works both ways: If Member States do not achieve their LULUCF targets, they have to use ESR allocations (AEA) for compliance.

Although limited to 262 Mt, the **integration of removals from the land sector into the ESR is problematic**:

- **Conflating removals and reductions:** The system treats removals and reductions as equivalent, despite their inherent differences. This undermines a core principle of EU climate law, namely that removals should not substitute for actual emission reductions. Article 4.1. of the ECL stipulates that that "*relevant Union institutions and the Member States shall prioritise swift and predictable emission reductions*".
- **Conflating temporary and permanent removals:** The system under Article 7 of the ESR does not only conflate removals and reductions but goes even a step further by accepting

temporary removals as compliance units for reduction obligations. This approach is particularly problematic because temporary removals re-emit carbon well before the warming potential of the original emissions has ceased. Only truly permanent removals – if at all – should be integrated into the ESR as a compliance unit.

- **Incentivising low-cost removals:** This system can be an incentive to prioritise removals that are low-cost in the short term, such as afforestation and soil carbon enhancement. Given their current costs, these removals can deter emission reductions and the development of more mature technical sinks with higher investment costs.
- **Monitoring and verification of LULUCF removals remain challenging:** Despite some improvements, monitoring and verification of removals from the LULUCF sectors remain challenging, as the complexity of natural sinks and their fluctuating capacity to store carbon make reliable accounting of these removals inherently difficult.

To address these shortcomings, there are two options:

- **No integration of removals into the ESR after 2030:** One option would be to explicitly prohibit the use of carbon removals for compliance purposes. Member States would not be permitted to use removals to meet their targets under the ESR. While this option would not conflate removals and reductions, it would also strip the ESR from any incentive to remove carbon.
- **Integration of only permanent removals into the ESR after 2030:** As another option, the ESR could only allow permanent removals to be used for compliance purposes. This option would provide incentives for Member States to promote the production of permanent removals.

Against this backdrop, **the ESR could integrate carbon removals for compliance purposes provided** that

- removals are truly permanent[14], meaning they store carbon for a duration equivalent to the atmospheric lifetime of the emitted CO_2 and its warming potential,
- removals meet criteria for biomass, which would allow only the use of waste biomass as feedstock, and which would exclude most BECCS appliances,
- removals meet other sustainability criteria as currently discussed in the EU Expert Group on Carbon Removals, including energy demand (see text below).

As an alternative, the **two-stage system proposed by SB 308** (see above) could also be used for compliance with ESR targets provided the same restrictions apply and the use of temporary removals is limited to a small percentage share.

Text box 4: Estimated energy consumption from DACCS[15]

Depending on the scenario, DACCS could require considerable amounts of clean energy. According to the Rocky Mountain Institute (Kahsar, et al., 2022), for example, DACCS's demand for low-carbon electricity (excluding any that is used for regeneration heat, addressed below) could reach 0.9 exajoules (EJ) in 2040 and 4.4 EJ (range of 2.2–6.2 EJ) by 2050, an

[14] As another option, temporary removals could be allowed to offset non-fossil emissions. However, this would require the ESR to distinguish between fossil and non-fossil emissions – a distinction that would significantly increase complexity and pose numerous compliance challenges, particularly in terms of data and inventory management.
[15] Meyer-Ohlendorf, 2023.

amount greater than Japan's 2020 total final electricity demand of 3.5 EJ. This is equivalent to about 5% of total global electricity consumption in 2020 (81.8 EJ). In scenarios of even greater DACCS uptake, the 2050 electricity demand for DACCS reaches 7.9 EJ (3.9–11 EJ). Heat demand for DACCS could grow to around 2.3 EJ by 2040 and 11.3 EJ (6.8–15.8 EJ) by 2050 or even up to an additional 20 EJ (12–28 EJ). By comparison, the global cement industry's total final energy consumption in 2019 was approximately 12 EJ.

Other scenarios project lower electricity demand from DACSS. According to the European Commission, for example, DACCS will likely only require a minor share of total electricity and energy supply to reach the EU's new climate targets for 2040. Based on the Commission's assumption, DACCS electricity demand could be up to 27 TWh in 2040, depending on the scenario. Compared to the energy sector's electricity demand and total electricity demand, consumption of DACCS is limited equaling less than 1.4% and 0.6%, respectively (Velten, 2025).

2.4 Competitive bidding

Competitive bidding is a **standard procurement method used by companies and government agencies to procure goods and services**. It involves soliciting bids from multiple vendors, typically through a request for proposals. This request outlines the requirements for procurement. By fostering competition between producers, competitive bidding can reduce public spending and help public budgets. It is particularly well suited for large-scale projects that have moved closer to commercial deployment but still face profitability issues.

Competitive tendering is evaluated typically based on **multiple criteria**, including price, quality, and potential for regional development or job creation. These criteria allow the procurer to use procurement decisions to meet the objectives of the purchasing programme. It is crucial that these criteria keep the procurement process manageable and unbureaucratic.

In principle, competitive bidding could serve as a valuable mechanism to incentivise carbon removals, particularly in the short term. In such a procurement scheme, removal projects would submit competitive bids to receive public subsidies based on the tCO_2 removed. The procuring agency would then award subsidies to the most cost-effective bids – e.g. those proposing the lowest price per tCO_2 – offering a fixed subsidy at this successful bid price (Lundberg and Fridahl, 2022). **Competitive procurement of carbon removals could be based on the following criteria:**

- Duration of storage
- Energy consumption
- Use of waste biomass and sustainable biomass
- Impacts carbon removal production on ecosystems
- Other sustainability aspects
- Innovation potential

A fixed subsidy for each tonne of CO_2 removed from the atmosphere provides certainty for producers of carbon removals and public budget planning (Schenuit and Treß, 2025). However,

given the costs involved, limited public budgets in Member States, the complexity as well as the duration of procurement processes, procurement programmes are only a possible vehicle to promote carbon removals **at smaller scale.** They cannot deliver large-scale removal of CO_2. There are also financial risks for the purchaser if a supplier defaults – particularly if they bid at the lowest price but are too ambitious and unable to deliver the removals at the agreed price. In this case, the subsidy would not deliver its objective. In light of these limitations, countries have only introduced competitive bidding programmes for carbon removals that a limited in scale and capped in spending (see text box 5 on the proposed purchase programme in California).

In the context of the EU, the **Innovation Fund** is an important tool to incentivise carbon removals through competitive bidding. The Fund provides support via several financial assistance instruments, including competitive bidding and auctioning. In the case of auctions, subsidies are awarded to the producers that can supply goods (e.g., hydrogen) at the lowest cost until the budget is exhausted, provided that the producers meet prequalifying criteria.

So far, the use of the Innovation Fund to support carbon removals has been insufficiently targeted. Out of its roughly €4 billion annual budget, approximately €299 million has been provided for CDR (Carbon Gap, 2025). Only a few large-scale projects have been supported. For instance, Sweden's Stockholm Exergi BECCS plant was the first and only BECCS project to receive funding from the Innovation Fund. Carbon removal projects are evaluated under the broader CCS/CCU category and have received less support than these technologies. This broad categorisation severely limits the scope of technologies that are eligible for funding. The Innovation Fund could launch a call focused on carbon removals to ensure adequate support is provided for promising technologies.

While not yet applied under the Innovation Fund yet, reverse auctions represent another option for supporting carbon removals. In this design, the procurer defines the quantity of emissions, and the removals contracts are awarded to the cheapest qualifying bids until the tonnes of removals (or the budget) are exhausted. Sweden's reverse auction system for BECCS is one example for such a procurement programme. This programme offers a total of €3.6 billion in state funding via a series of competitive bidding to be held in 2024-2028. Under 15-year contracts, successful BECCS projects receive subsidies per tonne of CO_2 removed (EC, 2024). The scheme allows the use of carbon credit sales from the suppliers receiving the funding to reduce the required subsidy level (Fridahl et al., 2024).

A clear **benefit of competitive tendering in comparison to other subsidy** designs is that there is already a well-established evaluation procedure under the Innovation Fund that can be immediately used to ensure fast implementation. Hence, despite the costs involved with evaluating proposals, this design represents a practical approach to provide quick support to removal technologies before transitioning to more complex mechanisms that are better at ensuring cost-effectiveness. For example, to develop the market and ensure efficient use of public funds, reverse auctions could be introduced under the Innovation Fund after this initial technology building phase.

For the competitive tendering and auctioning options, one challenge is the tendency towards lowest-cost bids, despite wide variations in technology costs. **One possible solution to this is to run separate auctions for different technologies**: E.g., one week for the purchasing of DACCS units, another week for BECCS, another for biochar, etc. Some technologies could be grouped together if they have comparable costs and permanence risks. This model has been applied to renewable energy auctions. However, a challenge with separate calls is a potential lack of suppliers applying for the calls and hence a lack of a competitive process. Conflicts with

state aid rules are possible but likely can be overcome since Sweden's BECCS support scheme was already approved.

Text box 5: Proposal for Carbon Dioxide Removal Purchase Program in California (SB 643)

California has **state targets for carbon removals. According to this target,** 7 million metric tons of CO_2 equivalent should be removed by 2030 and 75 million metric tonnes by 2045. The State Air Resources Board's 2022 Scoping Plan for Achieving Carbon Neutrality has established this target.

To help achieve this target, the Legislature of California is currently discussing the **Proposal Carbon Dioxide Removal Purchase Program – SB 643**. This bill would establish the Carbon Dioxide Removal Purchase Program to purchase "carbon dioxide removal credits generated by eligible carbon dioxide removal projects". A commission set up by the bill would administer the programme. It is the commission's task to purchase and – importantly – "permanently retire from future exchange carbon dioxide removal credits in an amount totaling $80,000,000". The purchasing programme may include competitive bidding processes featuring – among others – a maximum carbon removal credit price per tonne.

The commission may only purchase carbon removal credits if these credits are

- issued by an eligible removal project,
- additional,
- and unique to the commission's purchase transaction and not claimed by another entity.

In its selection process, the **commission shall prioritise** – among others – removal projects that "accelerate development of carbon dioxide removal strategies to the scale needed to achieve the state target for total carbon dioxide removal by the year 2045". The bill would also mandate that the commission purchases credits issued by eligible carbon removal projects operating in at least two of the following categories: (1) Direct air capture. (2) Biomass carbon removal and storage, (3) Enhanced mineralisation or enhanced weathering, or (4) Marine carbon dioxide removal.

While SB 643 includes detailed requirements for the purchasing programme, it should also be noted that the **bill grants the commission considerable authority**. In particular, the commission is mandated to adopt **guidelines for the programme. These guidelines establish essential elements of the purchasing programme**, such as (1) standards for an eligible carbon dioxide removal project, (2) the minimum duration of sequestration that is sufficiently long enough to ensure that the risk of leakage poses no material threat to public health, safety, the environment, or the achievement of net zero greenhouse gas emissions in California, and shall not be less than 100 years or (3) a prohibition on the use of removal processes for purposes of enhanced oil recovery.

2.5 Feed-in-Tariffs for carbon removals

Feed-in tariffs (FiTs) are policies originally designed to promote the development of renewable energies. They offer producers of renewable energy a guaranteed, above-market price for the electricity they supply to the grid. The aim of FiTs has been to make renewable energy projects financially viable by providing long-term contracts and guaranteed prices. In broad terms, FiTs have been successful in scaling up renewable energies. FiTs can be designed in many different ways.

Inspired by FiTs promoting the renewable energies, a FIT for carbon removals is one option for incentivising carbon removals. As with renewable energy, such a scheme would **guarantee producers of carbon removals a fixed price for the carbon removed and stored.** This price could be paid by the government through a specific purchase programme underlined by a specific line in the state budget. It is also possible to levy a certain amount on ETS revenues or other goods and services. In theory, a levy on electricity prices is also conceivable. Payment could be due once the producer of carbon removals has stored the carbon as required by the FiT scheme.

In more detail, a FiT for carbon removals could feature the **following design elements**:

- **Type of technology:** FITs for renewable energy typically vary by technology to reflect differences in generation costs. In the case of the German EEG, for example, the FIT is calculated per kWh of electricity fed into the net and varies for wind energy onshore and offshore, solar and bioenergy. A FIT for removals could also vary depending on the type of technology. It could grant different levels of tariffs for specific types of removal technologies. Accordingly, the FIT would be different for removals generated by DACCS or by enhanced weathering.
- **Storage duration:** The duration of carbon storage is one of the most important considerations when designing FiTs for different carbon removal projects – the FiTs must reflect differences in storage permanence.
- **Project Size:** FiTs for renewable energy often differentiate between projects based on their installed capacity. To reflect the higher generation costs associated with small and medium-scale renewable energy projects, FiTs for these projects are typically set at higher rates. Applying this logic to carbon removals, a FiT for removals would grant higher tariffs to small and medium-sized removal projects, i.e. projects below a certain removal capacity.
- **Bonus:** In many FiT schemes, RE investors receive a higher FiT (bonus) for the use of certain biomass fuels (e.g. liquid manure), combined heat and power generation (CHP), repowering of older RE installations, or specific innovative applications (e.g. enhanced geothermal systems).

  A FiT could also include bonus payments for removal projects that meet certain conditions, such as storage duration, sustainability of used biomass and technologies, and technologies with innovation potential.
- **Tariff stability:** FITs for renewable energies are generally stable throughout the entire guaranteed payment period. In some cases, however, a higher FiT is paid during the initial years of operation, with a lower FiT applied for the remaining years. This “front-loaded” FiT structure supports the financing of capital-intensive projects. In other instances, FiTs increase over time to account for inflation in operation and maintenance costs. A FiT for removals could apply the same logic.

In principle, FiTs for carbon removals offer **several advantages**:

- **Investment security and stable markets:** FiTs offer producers of carbon removals prices guaranteed by the government, which is essential for ensuring transparency, predictability, and security. This significantly lowers investment risks and financing costs and contributes to stable market development.
- **Simple and tested systems:** In principle, FiTs are a relatively simple and tested concept with a decade of experiences in various countries.
- **Promoting SMEs:** Given their simplicity, FiTs allow promoting the participation of small and medium-scale companies.
- **Open-ended funding source:** FITs can be designed as an open-ended funding source, independent of state budget periods. This provides considerable investment security and makes it so that the FiT does not depend on budget periods and budget negotiations.

There are, however, also **several disadvantages** of FiTs:

- **Setting the right price for long periods:** The main challenge of FIT is to set the right price. Prices should neither be too low to attract investments, nor too high to avoid "windfall profits". It is difficult to anticipate rapid changes in costs and to adjust FiTs accordingly.
- **Expensive schemes:** FiTs can require considerable amounts of public funding – at a time when public funding becomes scarce and is required for supporting other investments to decarbonise economies. If the FiT would be levied on electricity prices, the scheme could increase electricity prices – when the prices are already high in some Member States. Low energy prices are essential for consumers, in particular low-income households and energy intensive industries, as well as for the electrification and decarbonisation of Europe's economies.
- **Degression schemes have problems:** FIT schemes without degression have proven to have a rather slow reaction time to rapid changes in RE costs (e.g. the cost reductions of photovoltaic systems during the past few years). Even if there is a degression mechanism, the degression might be set at a level that does not reflect the actual development of RE costs.
- **Distorts market signals:** FITs also do not provide incentives for producers of carbon removals to respond to price signals of the market.

2.6 Government purchase programmes for carbon removals

Government purchase programmes are another option to incentivise the production of carbon removals. These purchase programmes are similar to competitive bidding in that they guarantee a purchase for producers of carbon removals and are limited to a specific amount available for the purchase of carbon removals. They also set requirements that removals must meet to be eligible for the purchase programme. However, unlike competitive bidding, these programmes set a fixed price for which they buy carbon removals that meet certain requirements.

Outside of the EU, there are already **examples of purchasing programmes** for carbon removals. For example, the Unites States launched a Purchase Pilot Prize ($35 million), where

cash prizes are offered to several winners evaluated by the Department of Energy (DoE). This option allows smaller funding amounts to be distributed to a wider range of suppliers (US DoE, 2024). In addition, through its Greening Government Strategy, Canada has committed to purchasing at least CAD 10 million worth of carbon removals by 2030 (Canadian Government, 2024).

In principle, purchase programmes for carbon removals offer some of the **advantages** that competitive bidding and FiTs can have. In particular, they can provide investment security and stable markets and allow promoting the participation of small and medium-scale companies. At the same time, they **have problems similar to FiTs**. It is challenging to set the right price for long periods. They can be expensive and distort the market.

2.7 Carbon Contracts for Difference

Contracts for Difference (CfDs) have been developed – primarily in the energy sector – to provide companies with financial certainty regarding price fluctuations. **Under a CfD, a project developer offers to implement a project at a price that covers its costs – the so-called 'strike price' – and a government counterparty guarantees to pay the difference between this strike price and the market price (e.g., for electricity).** This model can also be applied for carbon removals, where the government pays top-up subsidies if project revenues (e.g. from carbon markets) fall below this strike price (ESABCC). Crucially, however, CCfDs are not simply a subsidy programme. Project developers have to pay back surpluses above the strike price to the government.

The following graphic illustrates how CCfDs work (Clean Air Task Force, 2024a).

Figure 1. Illustrative payment flows in a carbon contract for difference. Implemented policies often exclude payment from the project to the government (asymmetric payment)

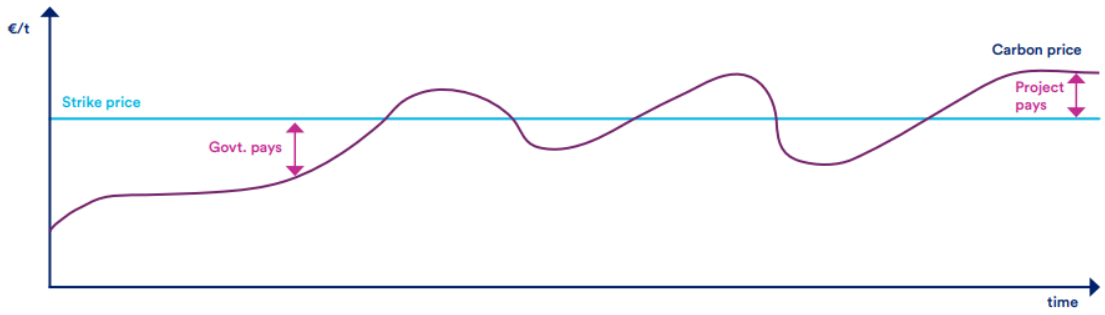

Figure 1: Illustrative payment flows in a Carbon Contract for Difference. Implemented policies often exclude payment from the project to the government (asymmetric payment)

CCfDs could be introduced as a mechanism to scale carbon removals (see e.g., Mistry et al., 2024; La Hoz Theuer et al., 2021; Tamme and Becks, 2021). Under this scheme, a producer of carbon removals and a government counterparty would enter into a CCfD. This CCfD would guarantee the carbon removal producer the strike price, e.g. the costs of the removal project. The producer of carbon removals would commit to pay back a surplus to the government counterparty if the strike price is below the revenues that the carbon removals generate.

Such CCfDs could have various benefits. Given the high investment costs of many carbon removal projects, in particular industrial removals, financial viability and certainty is a key aspect of incentivising a large deployment of carbon removal solutions. At the same time, CCfDs have the potential to lower fiscal costs for governments. For governments, a major advantage of

CCfDs is that the funding is used efficiently, because contracts can firstly be awarded through a competitive process and secondly, no windfall effects can occur (Schenuit and Treß, 2025).

To generate these benefits, **CCfDs for carbon removals need to solve these problems**:

- **Setting the right strike price is difficult:** A key issue with implementing CCfDs is the establishment of a strike price. As there is no compliance carbon market price for permanent carbon removals, there is no reference market price. This differs from the cases of hydrogen and renewable energies which have a clear market value. Carbon removals, in contrast, are primarily a public good with no market value. Voluntary market carbon prices cannot be used to establish a strike price. These markets cannot the absence of market prices, as they lack transparency and a common carbon price.
- **Strike price depending on ETS integration?** To solve the issue of establishing a strike price, it is conceivable that the carbon CCfD activates only when there is a compliance market for removals in operation. In this case, the market would create the strike price.
- **Long-term commitment for public budgets:** CCfDs run for long periods, often more than 15 years. This can pose a significant financing burdens for the public budget. In addition, it is difficult to calculate the overall commitment for public budgets, because the total commitment under a CCfD depends on unpredictable price developments.
- **In-built bias for BECCS?** CCfDs are particularly suited for supporting investments in large-scale industrial facilities. CCfDs are likely to particularly support investments in industrial bio-CCS projects, as they are cheaper than DACCS and can remove larger amounts of CO_2 (Schenuit and Treß, 2025). Because of the negative impacts of BECCS on ecosystems and its questionable real removal potential, there is a risk that CCfDs have an inherent bias towards BECCS. Competitive bidding has the same bias.

There are **several options to address these problems**:

- **Strike price through a flat rate:** When no compliance market exists, a flat rate price (agreed strike price) is paid for the volume of removals specified in the procurement contract.
- **Re-tendering:** This risk can gradually be better assessed through regular re-tendering of CfDs, and consequently, can be managed through the volume put out to tender.

Text box 6: Carbon Contracts for Differences and carbon removals in EU Member States and the UK

There are discussions in a few countries to use CCfDs for scaling up carbon removals, but they have not led to the implementation of CCfDs for carbon removals yet. There is no country that uses CCfDs for carbon removals.

The UK is currently exploring a CCfD framework for carbon removals, linked to the voluntary carbon market (UK Government, 2023). Through its greenhouse gas removals (GGR) business model and Power BECCS frameworks, they have developed two CfD contract models and issued these for consultation. For these designs, the government covers the difference between costs (CAPEX and OPEX) and revenues, which may be generated through by-products or the voluntary carbon market, over a period of 15 years.

CCfDs are already in effect in the Netherlands for CCS and CCU technologies, offering support of up to €400 per tonne of CO_2, linked to the EU ETS price (Netherlands Enterprise Agency, 2024). Denmark has similarly implemented CCfDs through its CCS fund. However, neither the Netherland's nor Denmark's schemes are designed to incentivise removing carbon from the atmosphere.

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