EU 2040 Climate Target and Framework: The Role of Carbon Removals

Potentials, incentives, and regulation

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Abbreviations

BAT	Best Available Technique
BECCS	Bioenergy with carbon capture and storage
CARE	Climate Action Regulation for Europe (aka Effort Sharing Regulation)
CCB	Carbon Central Bank
CCS	Carbon capture and storage
CCU	Carbon capture and utilization
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
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
JI	Joint Implementation
lCER	Long-term certified emission reduction
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
tCER	Temporary certified emission reduction

Executive summary

The EU will adopt a climate target for 2040 in the coming years. The 2040 climate target will be a **pivotal milestone** on the EU's journey towards achieving climate neutrality by 2050 and subsequently attaining net negative emissions. If the EU does not manage to adopt the required targets for 2040 as well as a robust framework for implementation, achieving climate neutrality by 2050 becomes unlikely. The EU would fail to make its required contribution to achieving the temperature targets of the Paris Agreement.

The EU's new 2040 climate target and implementation framework are **bound to regulate carbon removals**. The rules on carbon removals will be very important. The integrity of the EU's climate policies hinges on their strength and effectiveness. There is the risk that the new framework could deter emission reductions if it treats emission reductions and removals alike, although their climate impacts can differ drastically. There is also a danger of conflating removals with temporary and permanent storage, even though their contributions to climate action vary significantly. Moreover, there are concerns about a lack of incentives to remove carbon permanently in a sustainable manner. Given their incomplete and often weak rules on carbon removals, national climate policies are presently unable to compensate for gaps in the EU framework.

To address these risks, the EU 2040 climate targets and removal framework should be built on **these principles**:

- **Emission reductions first**: The European Climate Law (ECL) stipulates that the EU and Member States must *prioritize* "swift and predictable emission reduction". This provision constitutes a pillar of robust climate policies because – compared to emission reductions – removals are an inherently weaker way of climate action. No carbon removal option is as safe as gas, coal and oil in the ground, the world's best carbon "sinks".

- **Keeping reductions and removals separate**: Because of the reduction-first principle and the inherent differences between removals and reductions, carbon removals and reductions of fossil fuel emissions must be kept separately. This distinction applies in particular to temporary removals, which rerelease the stored carbon after specific periods, whereas – in principle – permanent removals can become a compliance unit for meeting reduction requirements if they ensure permanent storage and compliance with other sustainability requirements. Targets that distinguish between removals and reductions are instrumental to uphold this principle. They can also help achieve net negative emissions and to reverse the trend of ever-increasing CO_2 concentrations in the atmosphere.

- **Only removals with permanent storage can fully counteract the warming effects of CO_2 emissions**: Carbon removals serve two fundamental purposes: (1) to counteract the warming effects of CO_2 emissions and (2) to reverse the trend of the ever-increasing CO_2 concentration in the atmosphere. Carbon removals can only fully serve these purposes if they counteract the warming effects of emissions as long as emissions expose their warming effects. Because CO_2 stays in the atmosphere in parts for more than 1000 years, carbon removals can only make a full contribution to climate action if they remove and store the emitted CO_2 for same time span.

  Presently, only direct air capture with carbon storage (DACCS), bioenergy with carbon capture and storage (BECCS), biochar and enhanced weathering (EW) have – in principle – the capacity to store carbon for this period. However, they are not fully equivalent to emission reductions due to leakage risks, energy consumption, land use and possible negative

impacts on ecosystems. Moreover, these types of removals are currently extremely scarce, and it is uncertain whether they will mature in time to make meaningful contributions to climate action.

- **Removals with temporary carbon storage can only complement emission reductions, not substitute them**: In contrast to permanent removals, temporary removals store carbon only for limited periods. After the end of storage, the carbon is inevitably reemitted. In turn, temporary removals cannot fully compensate for the warming effects of emitted CO_2. Although temporary carbon storage cannot offset the permanent effect of CO_2 emissions, it can marginally contribute to the Paris Agreement's temperature goals if it is used to complement emission reductions. Temporary removals complement climate action if they do not offset emissions and if their use is limited to (1) complying with removal obligations, (2) voluntary uses for purposes other than offsetting, such as contribution claims, and (3) disbursing subsidies.

- **Turning temporary removals into permanent removals is practically impossible**: There are several proposals to align temporary removals with permanent removals, encompassing (1) an obligation to consistently renew expiring removals over the atmospheric lifetime of CO_2, (2) a mandate to replace temporary removals with permanent ones, and (3) the application of discount factors. While these ideas may augment the pool of available carbon removals, none of them achieves complete equivalence between temporary and permanent removals. Each option has specific shortcomings.

  First, the obligation to perpetually renew temporary removals is a risky bet on an uncertain future, especially as the carbon storage capacities of ecosystems deteriorate in a changing climate. Second, replacing temporary removals with permanent ones upon expiration necessitates the availability of permanent removals in the requisite quantities in the moment when temporary removals expire. This is an uncertain prospect. Third, discount factors are difficult to set. They cannot ensure the renewal of temporary removals is physically possible after their expiration, in particular because of the high degree of uncertainty about how natural sinks develop as climate change alters their very basics.

There are many **options available to regulate and incentivise carbon removals**. These options can – to some extent – be combined. It is crucial to emphasize that each option can vary significantly, depending on the details of its specific regulatory framework. In broad terms, the following optional measures are conceivable:

- **Integration of removals into the ETS**: With the new linear reduction factors (LRFs), the ETS 1 will stop issuing emission allowances in 2039; the ETS 2 is expected to run out of allowances in 2043. As residual emissions in some sectors are likely to continue thereafter, allowances are often expected to become scarce and potentially expensive. To address scarcity and high carbon prices, carbon removals could be integrated into the ETS, which can be done in various ways, such as the full integration of all removals, partial integration of only certain types of removals, and a cap for removals.

  Each option has distinct advantages and disadvantages, but the full integration of all removals is not a viable option. As it would include temporary removals, it would undermine the integrity of the ETS. All other options depend on their specific design details, but all of them need to address problems of emission reduction deterrence. None of them is likely to help achieve net negative emissions as credits would be used to offset emissions.

  Temporary removals should not be integrated into either the ETS 1 or 2, not even in small volumes. The integration of permanent removals should be limited by a clearly defined cap

that corresponds to the amount of available permanent removals. Only removals with permanent storage (largely in geological formations) should be eligible, provided they are compatible with requirements of ecosystem protection as well as energy and resource efficiency. Because of its many adverse impacts on ecosystems, BECCS should be strictly limited to using waste biomass only.

- **Carbon Central Bank (CCB) or another intermediary**: The establishment of a so-called CCB or another intermediary agency is an important governance element that is being discussed. According to this proposal, a CCB or another intermediary agency would be mandated to procure physical carbon removals, to issue carbon removal credits and to auction them. The CCB could incentivize investments in removals at an early stage, stabilize carbon prices later, while maintaining the net-emissions path.

  While these are important benefits, the CCB also raises concerns. According to some proposals, the CCB's mandate would encompass the procurement and auctioning of *any* type of removal credits, regardless of whether it stores carbon permanently or only short-term, or whether it has a negative or positive impact on ecosystems. In this design, the CCB's mandate would undermine the integrity of climate policies and could harm ecosystems.

  Depending on the scope of its mandate, the CCB could also be entitled to determine the amount of the EU's residual emissions as well as the amount of permanent and temporary carbon removals. Such far-reaching decisions have significant implications for the EU, its Member States, and its citizens. They should be assigned to the democratically elected legislators only, not to bodies with limited democratic legitimacy, such as the CCB.

- **Removal Trading Scheme (RTS)**: Unlike the ETS, the 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 the proportion of current or future emissions of the entity covered by the RTS. As one possible option, covered entities could be those falling under the ETS 1 and 2.

  This proposal could significantly advance the polluter pays principle within the sphere of climate action, as it would oblige individual entities to remove carbon 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. The Carbon Removal Market Development Act that is currently being negotiated in the Legislature of California could inform this proposal. As the RTS puts additional costs on covered entities, support mechanisms will be an important element of the RTS.

- **Feed-in-Tariffs (FiTs), contracts for difference and targeted competitive bidding**: FiTs, contracts for difference and targeted competitive bidding are widely used government policies to support the deployment of renewable energy. In principle, these instruments could also be used to incentivize carbon removals. For this purpose, governments would enter long-term contracts with carbon removal producers, guaranteeing a fixed price over the contract duration. Similar to the development of renewable energy, these schemes could help expensive and scarce removal options to mature into competitive instruments.

  These incentive schemes offer several advantages. They are relatively simple and tested. Long-term contracts with prices guaranteed by governments provide transparency, predictability, and security, lowering investment risks and financing costs significantly. At the same time, however, in the case of FiTs, it is difficult to set the right remuneration levels. FiTs can also be expensive, and they can require considerable amounts of public funding. Contracts

for difference, targeted competitive bidding, and reverse auctioning attempt to solve these problems.

- **Carbon removals for complying with energy taxes:** As another option, tax laws could be amended to allow carbon removals to reduce energy taxes. The pertinent tax laws in Colombia and South Africa could inform this idea. These laws permit the use of carbon removals to comply with tax obligations. They define eligible removal activities.

  The integration of carbon removals into carbon tax schemes serves one of its purposes well – to lower the tax burden – but falls short of achieving its other purpose – to effectively combat climate change. It can deter emission reduction. It could also undermine incentives to invest in innovative but currently expensive removal options. Carbon tax schemes could effectively become a system of tax avoidance, decreasing revenues from energy taxes. Furthermore, it should be noted that amendments to the EU Energy Taxation Directive (ETD) require unanimity in the Council of Ministers.

- **Carbon removals as a permitting requirement**: It is conceivable that carbon removals may be required for the issuance of permits, including those for industrial installations falling under the Industrial Emissions Directive (IED). There are several approaches to making removals a prerequisite for obtaining these permits, all of which can act as a strong incentive to foster the development and implementation of innovative removal solutions. None of these options, however, should diminish the emission standards specified in a permit under the IED. If the ETS were to regulate removals, removals should not be integrated into the permitting process under the IED.

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. Once the target is adopted, the EU is also set to adopt a legislative package to implement this target. This package will reform relevant EU laws and policies.

The EU's new 2040 climate framework and target **are bound to regulate the role of carbon removals**. Rules for carbon removals respond to a scientific necessity. To limit an increase in temperature to well below 2°C or below 1.5°C compared to pre-industrial levels, drastic and immediate reductions of greenhouse gas (GHG) emissions are essential, but likely insufficient. The reality is that all emission reduction pathways that limit warming to 1.5°C assume that CO_2 is removed from the atmosphere.[1] The Intergovernmental Panel on Climate Change (IPCC) considers the deployment of CDR removals "unavoidable".[2]

Moreover, **removals are already embedded in the ECL**. The EU's' climate neutrality target requires a balance between GHG emissions and removals by 2050, as reported in GHG inventories. The ECL also states that the EU shall aim at achieving net negative emissions in the second half of the century. Apart from continuing to balance any remaining residual emissions, significant amounts of removals will be needed throughout and beyond the second half of the century to generate net negative emissions to reduce the atmospheric CO_2 concentration.

The **Commission's public consultations on the 2040 climate target** made clear that stakeholders expect removals to play a role in the EU's climate framework for 2040. Many stakeholders recognize the importance of removals. At the same time, many stakeholders also raised concerns. One reoccurring concern is that removals could replace and deter emission reductions. There are also concerns that removals and reductions are conflated and that removals with temporary and permanent storage are treated alike although they have very different climate impacts. Moreover, stakeholders worry about a lack of incentives for companies, individuals, and other stakeholders to permanently remove carbon in a sustainable manner.[3]

Against this backdrop, **this paper explores** the role of carbon removals in the EU's climate framework for 2040. To provide context for this analysis, Chapter 2 gives an overview of past trends in carbon removals in the EU. Chapter 3 explores potential contributions from natural as well as technical sinks to reaching the 2040 climate target. Chapter 4 discusses which existing regulation already governs carbon removals in 2040 and which gaps exist. Before discussing the options to incentivize removals (Chapter 6), the paper explores the extent to which temporary removals could contribute to achieving the EU's 2040 climate target (Chapter 5). The paper builds and expands on previous work by Ecologic Institute and Öko-Institut.[4] This paper does not address issues of target designs, although they are intertwined with carbon removals. Another paper by Ecologic Institute and the Öko-Institute discusses these issues in detail.[5]

[1] IPCC, 2021
[2] IPCC, 2021
[3] See https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13793-EU-climate-target-for-2040/public-consultation_en
[4] Meyer-Ohlendorf, 2023
[5] Meyer-Ohlendorf, 2023,2

What is a carbon removal?

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".[6] 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*".[7]

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 recognizes 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**[8], which is up to 1000 years and more. This definition is also used by the Frontier Initiative.[9]

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.

2 Past trends of carbon dioxide removals

GHG emissions in the EU have decreased in a sustained and consistent manner since 2003 – with a few standout years.[10] The EU significantly surpassed its 2020 GHG reduction target of 20% by achieving 32% (compared to 1990 levels). This reduction in emissions was also driven by the coronavirus pandemic. In 2021, the EU experienced a "post-pandemic rebound", but emissions remained below pre-pandemic levels.[11] Figure 1 shows latest aggregated GHG emission projections of EU Member States including additional policies and measures. Accordingly, the reduction pace of GHG emissions is expected to slow down after 2030; EU wide GHG emissions are considerably higher than net LULUCF removals in 2050. There is a gap to a net zero target that technical removals cannot fill.

Total net carbon removals in EU Member States, which are relevant for measuring the progress towards the target, accounted for at least 300 Mt CO_2e/y in the period 1995–2016 but decreased in 2021 to 230 Mt CO_2e – or around 7% of the EU's GHG emissions (excluding LULUCF).[12] These numbers are taken from the GHG inventory report 2023 and refer to the sum of emissions and removals from source category 4. Ageing forests with decreased carbon sequestration, increased harvest of trees, natural disturbances such as wildfires and droughts,

[6] Supervisory Body, 2022, IPCC, 2018
[7] IPCC, 2022
[8] Meyer-Ohlendorf, 2023
[9] Frontier, n.d.
[10] European Environment Agency, 2010
[11] European Environment Agency, 2022
[12] European Environment Agency, 2023

and slower net forest area expansion have contributed to the decline in removals. Forest land provided net removals of 281 Mt CO_2e at the EU level in 2021, while cropland, grassland, wetlands, and settlements were sources of emissions.[13] These trends are projected to continue until 2050, without a considerable increase of natural net removals.

Currently, there are no **technical removal** facilities in the EU, and there are virtually no technical sinks in Europe, with the only facilities being a demonstration DACCS plant in Iceland and a BECCS plant in the UK.[14]

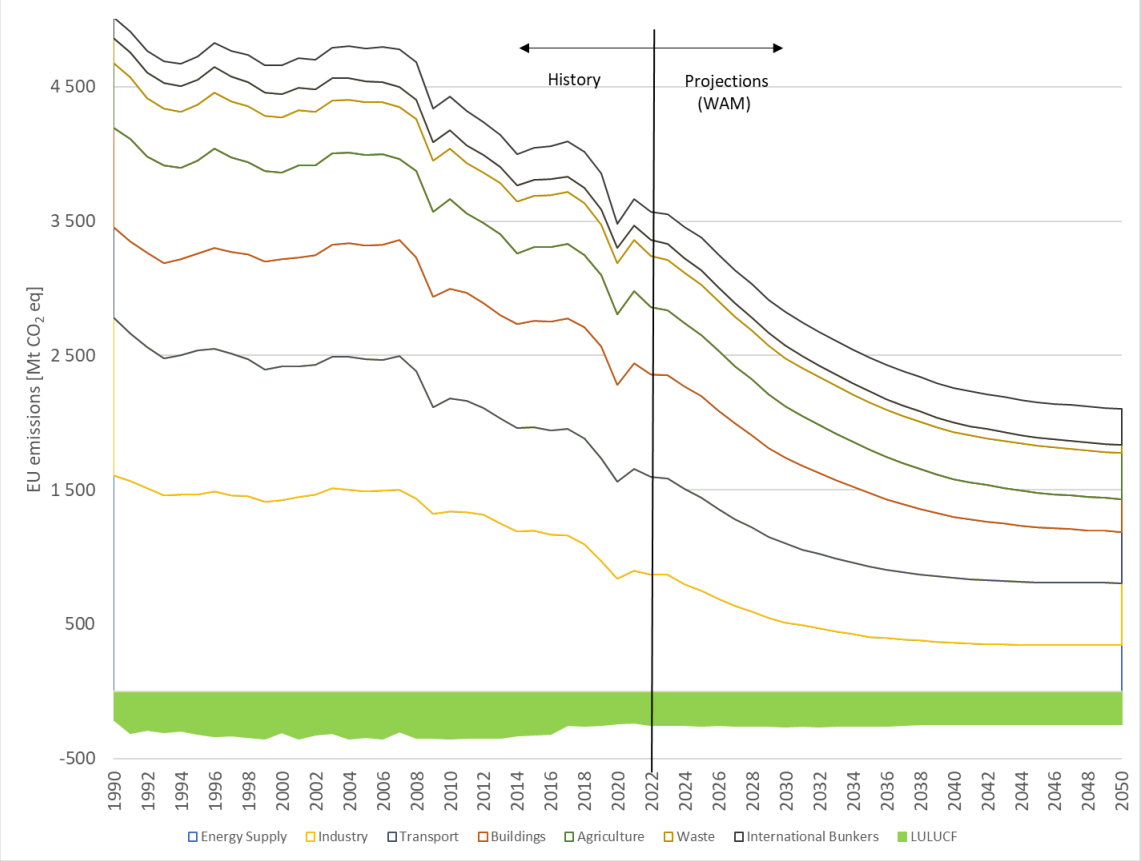

Figure 1: Historic and projected development of GHG emissions by sector. Highlighted: LULUCF sector. [15]

[13] European Environment Agency, 2023

[14] Velten et al., 2023

[15] European Environment Agency, 2023, 1

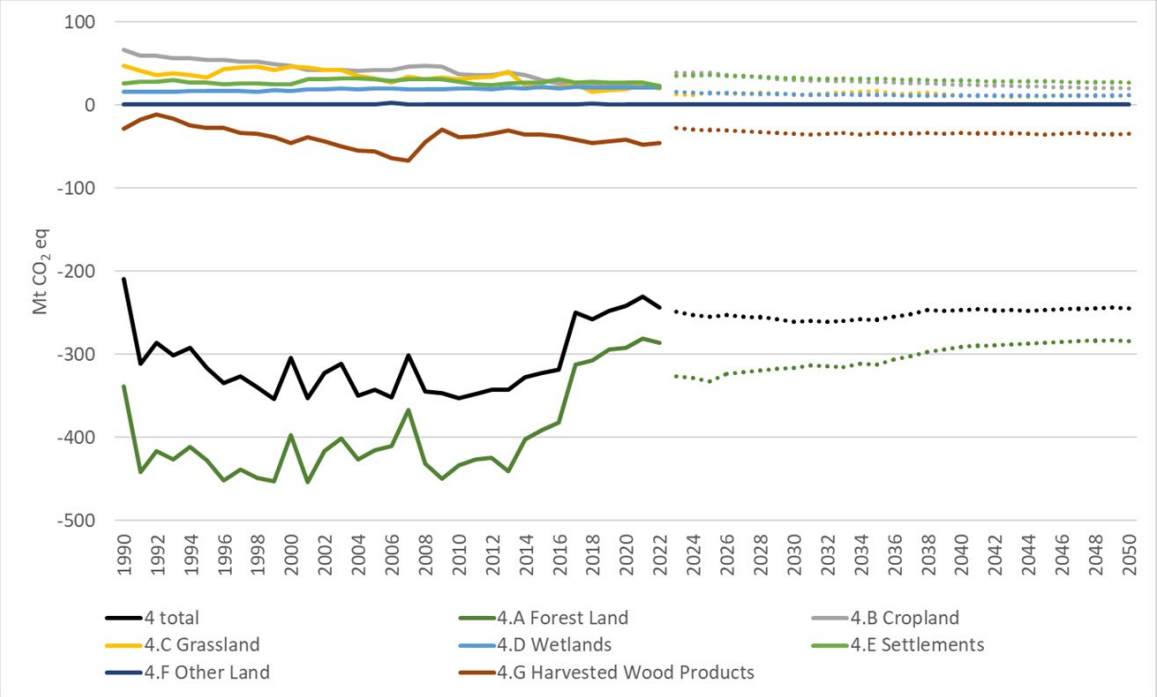

Figure 2: Historic and projected development of GHG emissions and removals by LULUCF. Source: Öko-Institut with EEA data.

3 Possible ranges of carbon dioxide removals and emissions in 2040

Scenarios offer insights into the expected GHG emissions and carbon removals in 2040. Figure 3 offers a summary of nine scenarios. According to the scenarios, net **natural removals** as reported in GHG inventories span from 313 Mt CO_2eq (Climate Analytics, 1.5°C compatible range) to 601 Mt CO_2eq (European Scientific Advisory Board on Climate Change (ESABCC), mixed options), while **technical removals** range from approximately 36 Mt CO_2eq (95% net scenario) to 160 Mt CO_2eq (high renewable energy). These scenarios indicate that **net GHG emissions** range from 111 Mt CO_2eq (95% net scenario excl. international transport) to 564 Mt CO_2eq (Climate Analytics, 1.5°C compatible range).

It has to be noted that all these results only refer to removal effects as they can be accounted for in **GHG inventories**. As international rules have neither been defined for accounting of technical removals nor for the differentiation between natural and technical removals, there will be discrepancies on this between scenarios depicted.

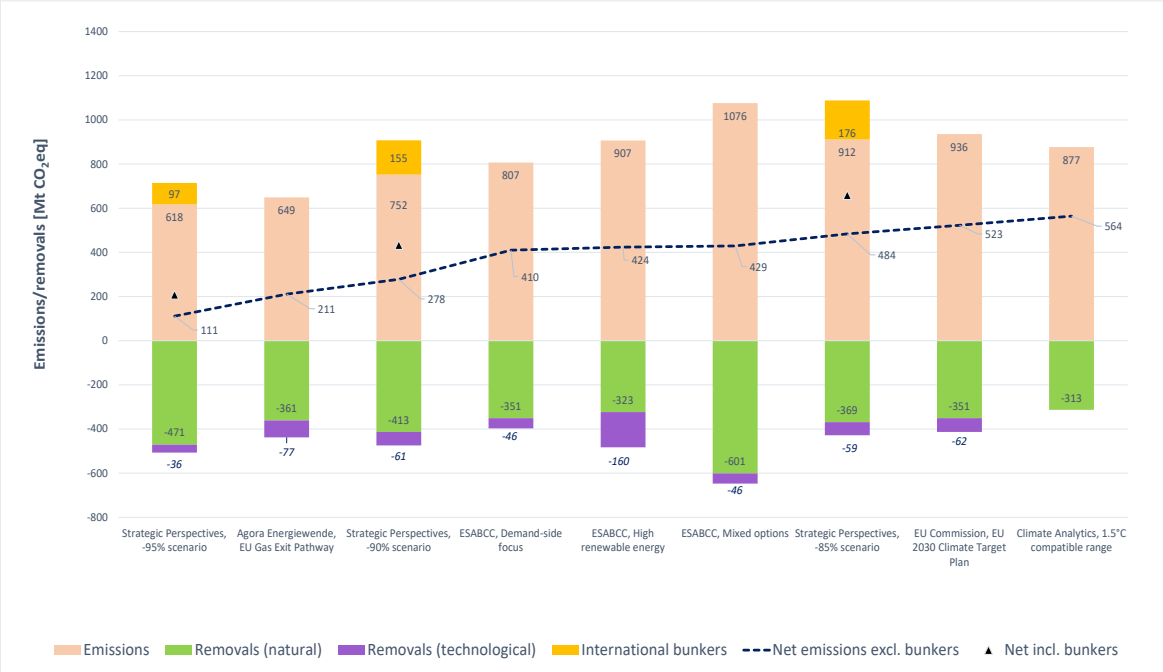

Figure 3: Scenarios for GHG emissions and removals in 2040. Own depiction based on data from 2040 scenarios[16].

4 Carbon dioxide removals in EU climate legislation: Which rules relevant for 2040 do already exist?

Existing EU climate legislation regulates carbon removals for the time after 2030 only to a very limited extent. In fact, only the EU's climate neutrality target for 2050 and the net negative aspiration for the time after 2050 contain rules relevant for removals. According to these rules, "Union-wide greenhouse gas emissions and removals regulated in Union law shall be balanced within the Union at the latest by 2050, thus reducing emissions to net zero by that date, and the Union shall aim to achieve negative emissions thereafter" (Article 2.1 of the ECL). This provision only determines that removals can be used for achieving the climate neutrality target, however, it does not quantify the overall amount of carbon removals eligible for target achievement, hence allowing unlimited use of removals for target achievement. Moreover, the provision does not regulate which type of removals can be used to achieve the target either. The net negative aspiration for the time after 2050 stipulates that carbon removals must exceed emissions, but it establishes no legal obligation. It contains only a political aspiration, as it only requires the EU to *aim* at negative emissions.

All other EU rules pertinent to removals cease to have regulatory force after 2030. The LULUCF Regulation regulates removals and emissions from the LULUCF sector, but it only sets targets until 2030. Apart from a few procedural rules, it effectively loses effect after 2030,

[16] Kalcher et al., 2023; European Scientific Advisory Board on Climate Change, 2023; Graf, Gagnebin, Buck, 2023; Climate Analytics, 2022; European Commission, 2020

leaving a significant regulatory gap for the next decades. Similarly, the Climate Action Regulation for Europe (CARE) also contains only a few provisions relevant for carbon removals, but like the LULUCF Regulation, its current regime depends on the 2030 target. Finally, the Emissions Trading System (ETS) Directive does not allow the use of removals. It only recognizes the capture and storage of fossil CO_2 from the installations covered under the ETS. The revised ETS Directive only allows aircraft operators to use certain removal units, provided the requirements of Article 11.a in conjunction with Article 24 are met. Article 30.a requires the Commission to publish a report on the integration of carbon removals into the ETS.

While existing EU rules hardly regulate carbon removals for the time after 2030, **several regulatory developments** relevant for removals in 2040 are already underway. If adopted, these legislative developments would shape the role of carbon removals significantly for the time after 2030.

- **Certification of carbon removals:** If adopted, the Carbon Removal Certification Framework (CRCF) would establish a voluntary EU framework for removal certification. The CRCF introduces criteria for the certification of removals, rules for the certification process as well as the recognition of certification schemes. Although the use of credits certified under the CRCF is still a matter of considerable debate, there is a reasonable or even high likelihood that the CRCF will be instrumental in making removal credits a compliance unit in the ETS or other instruments of EU climate policies. It is the intention of the Commission that the CRCF supports the effective upscale of carbon removals.[17]
- **Integration of carbon removals into the ETS:** The ETS Directive requires the Commission, "by 31 July 2026, to report to the European Parliament and to the Council (a) how negative emissions resulting from greenhouse gases that are removed from the atmosphere and safely and permanently stored could be accounted for and how these negative emissions could be covered by emissions trading, if appropriate, including a clear scope and strict criteria and safeguards to ensure that such removals are not offsetting necessary emissions reductions in accordance with Union climate targets as laid down in Regulation (EU) 2021/1119." This report could become instrumental in integrating carbon removals into the ETS.

5 The contribution of national climate laws and policies to the EU 2040 removal targets

National climate laws and policies of Member States contain various rules and descriptive information on the potential role of carbon removal technologies for 2040. These provisions are enshrined in national climate laws, national long-term strategies (LTSs), and other national policy. National Energy and Climate Plans (NECPs) are intended to provide a vision until 2030 and thus generally do not provide information about the period thereafter.

5.1 National climate laws

As of August 2023, 16 EU Member States have a national climate law in force. However, **only the climate laws of France, Germany and Portugal contain rules regulating carbon**

[17] European Commission (2022)

removals. The climate laws of these three countries determine the overall contribution of removals and do not distinguish between the contributions of natural and technical sinks. Table 1 presents the relevant information found in the three laws.

Germany's climate law contains a target of at least 35 Mt CO_2eq from the LULUCF sector for 2040 and at least 40 Mt CO_2eq for 2045. Draft revisions of this law feature a placeholder for setting of targets for technical sinks. In **France**, the 83.3% reduction target for 2050, combined with the country's climate neutrality goal, implies a target of 16.7%, or a maximum of approximately 80 Mt CO_2eq removals, compared to 1990 net GHG emissions level. The French law does not distinguish between natural and technical sinks. **Portugal** has set a target of on average at least 13 Mt CO_2eq from the LULUCF sector between 2045 and 2050 but provides no information on technical removals.

Additionally, although it contains no quantitative targets, **Luxembourg's** climate law defines net-zero as "the state in which any residual anthropogenic greenhouse gas emissions are balanced by equivalent anthropogenic removals". In **Ireland**, the climate law requires the Government to make separate regulations on how removals are accounted for in the carbon budgets.

The climate laws of Bulgaria, Croatia, Denmark, Finland, Greece, Hungary, Ireland, Lithuania, Malta, the Netherlands, Spain, and Sweden contain no targets for long-term or interim carbon removals.

Table 1: Overall contribution of removals and removal options according to national climate laws.

	Overall contribution 2040 / 2045 / 2050	Contributions from removals' options	Comment
DE	● 2027 – 2040: (at least) 35 Mt CO_2eq from LULUCF on average ● 2042 – 2045: (at least) 40 Mt CO_2eq from LULUCF on average	**Natural**: Quantified **Technical**: might be included following revision	
FR	2050: (roughly) 80 Mt CO_2eq	n/a	Reduction target combined with climate neutrality implies a goal of at most 16.7% removals compared to 1990 net GHG emissions level (=roughly 80 Mt CO_2eq)
PT	2045 – 2050: (at least) 13 Mt CO_2eq from LULUCF	**Natural**: Quantified **Technical**: n/a	

5.2 National long-term climate strategies

Out of the **24 LTSs** published as of August 2023, only the strategies of Czechia and Greece contain no information regarding the contribution of removals to reaching long-term climate goals. All other strategies provide some information on the overall contribution of carbon removals and/or the contribution of natural and technical sinks. In total, nine countries mention

the overall contribution of removals, 21 mention natural removals, and 11 acknowledge technical removals (Table 3).

Overall contribution

The LTSs of five countries – Italy, Lithuania, Portugal, Slovenia, and Spain – include quantified indicative targets for carbon removals in the period 2040–2050. Austria, Finland, France, and Slovakia provide scenario outcomes. In Italy, a 'historical maximum' of 45 Mt CO_2eq from the LULUCF sector in conjunction with carbon capture and storage (CCS) for the remaining emissions is planned. In Slovakia, scenario outcomes determine 7 Mt CO_2eq removals by 2050 – which, however, would not be sufficient to meet the national objective of achieving climate neutrality.

Contribution of natural removals

The LTSs of four countries – Italy, Portugal, Slovenia, and Spain – contain indicative targets about natural removals, with all targets focusing on the LULUCF sector in 2050. Additionally, 10 Member States provide scenario outcomes (Austria, Bulgaria, Cyprus, Denmark, Finland, France, Hungary, Malta, Slovakia, and Sweden). For example, Sweden mentions supplementary measures to achieve net-zero emissions, such as CCS and bio-CCS. Five countries do not provide quantitative information but rather focus on descriptive text only – Croatia, Germany, Latvia, Luxembourg, and Portugal. The LTSs of Belgium, Czechia, Greece, and the Netherlands do not contain information about the contribution of natural removals.

Contribution of technical removals

With a few exceptions, LTSs do not elaborated on the role of technical removals.[18] Lithuania aims for up to 15% emission removals from the LULUCF sector with CCS/CCU in 2040 and up to 20% in 2050. If at all, LTSs (e.g., Bulgaria, Croatia, the Netherlands) contain only qualitative information or refer – confusingly – to CCS as a removal option. In Belgium, Wallonia seeks to achieve carbon neutrality by reducing emissions by 95% in 2050 and implementing additional measures relating to carbon capture and utilization (CCU) and BECCS.

Denmark is an exception to this rule. The **Danish Climate Agreement for Energy and Industry** from June 2020 includes a subsidy pool "to capture, utilize and store CO_2" of DKK 16 billion, which is estimated to have a reduction potential of 0.4 Mt CO_2eq/yr in 2025 and 0.9 Mt CO_2eq/yr in 2030.[19] The 2021 Climate Program of the Danish government discusses DAC which is expected to result in removals of 0.5 Mt CO_2eq by 2030 and to be further developed until 2050. The potential of BECCS is estimated to be 0.1 – 3.1 Mt CO_2eq in 2030, and BECCS, DAC, and pyrolysis[20] could be used to offset the remaining emissions in all sectors in 2050, and their removal potential is estimated at 8.5 – 14 Mt CO_2eq in 2030.

[18] Meyer-Ohlendorf (2022)

[19] Government of Denmark, 2021

[20] Pyrolysis is the process of converting agricultural residues into fuel and biochar through thermal decomposition in the absence of oxygen. Biochar is obtained from the thermochemical conversion of biomass and can trap CO_2 in soil for thousands of years.

Table 2: Targets, scenario outcomes and qualitative data in Member States' LTSs.

LTS element	Country
Indicative target	• **Italy**: 45 Mt CO_2eq LULUCF • **Lithuania**: 6.5 Mt CO_2eq (2021-2030), up to 15% in 2040 and up to 20% in 2050 LULUCF + CCS/CCU • **Portugal**: 11.8 – 13.4 Mt CO_2eq LULUCF (2050) • **Slovenia**: 2.5 Mt CO_2eq LULUCF (2050) • **Spain**: 37 Mt CO_2eq LULUCF (2050)
Scenario outcomes	• **Austria**: 12.7 – 22.2 Mt CO_2eq NBS+TBS (2020-2050) • **Bulgaria**: 8.4 Mt CO_2eq LULUCF (2040); 8.1 – 8.3 Mt CO_2eq LULUCF (2050) • **Cyprus**: 0.75 – 0.85 Mt CO_2eq LULUCF (2040); 0.85 – 1.1 Mt CO_2eq LULUCF (2050) • **Denmark**: -25% LULUCF emissions (2040 compared to 1990) • **Finland**: 40 Mt CO_2eq LULUCF (2050); 16.4 Mt CO_2eq LULUCF • **France**: ~82 Mt CO_2eq LULUCF • **Hungary**: 4.5 – 5 Mt CO_2 LULUCF (2050) • **Malta**: 2 Mt CO_2eq LULUCF (2050) • **Slovakia**: 7 Mt CO_2eq LULUCF (2050) • **Sweden**: 40.6 Mt CO_2eq LULUCF (2040); 42.2 Mt CO_2eq LULUCF (2050)
Descriptive information only	• Belgium, Croatia, Germany, Latvia, Luxembourg, Netherlands
No information	• Czechia, Greece

6 Implementing the EU 2040 climate target: The role of permanent and temporary removals

Temporary removals through biogenic sinks and permanent removals through geologic sinks are **distinct activities** that have very different characteristics and impacts on the atmosphere.[21] They differ in scale and require different incentives and safeguards. Because of these differences, the EU's new 2040 climate framework must clarify the contributions of these different

[21] Bellona (2023)

removal options to target achievement and define the overall governance of different removal technologies.[22]

6.1 Implementing the 2040 climate target: The role of permanent removals

Carbon removals serve **two fundamental purposes**: (1) to counteract the warming effects of CO_2 emissions and (2) to reverse the trend of ever-increasing GHG concentration in the atmosphere by removing historic emissions. The ECL exemplifies these purposes. According to this law, carbon removals may help achieve climate neutrality by 2050; after 2050, they are meant to generate net negative emissions (Article 2 ECL).

To serve these purposes, one **fundamental characteristic of CO_2 emissions is essential**: Once emitted, CO_2 partly remains in the atmosphere for an extremely long time. Approximately 15 – 40% of the *mass* of emitted carbon emission remains in the atmosphere for over 1000 years after it is emitted;[23] about 20% remains for longer than 10.000 years.[24] The complete degradation process takes several hundred thousand years.[25] During this period, carbon exposes its warming impact on the atmosphere and the oceans. According to the Supervisory Body of the Article 6.4 mechanism of the Paris Agreement, "*the time rate of marginal warming, at any point in time, is proportional to the fraction of CO_2 remaining in the atmosphere*".[26] In other words, **the warming effect of emitted CO_2 partly exceeds the scope of written human history**.[27]

Because of this long atmospheric lifetime of CO_2, carbon removals can only fully serve their fundamental purposes if they effectively counteract the warming effects of emissions – meaning, if they keep CO_2 out of the atmosphere for the same period, i.e., for 1000 years or more. In turn, **carbon removals only make a dependable contribution to climate action if they remove and store the emitted CO_2 for such timespans**. If a removal does not last for at least the same length of time or is replaced with new removals for the same period (see below 6.2.1.), it does not fully compensate for the effect of emitting CO_2.

Presently, only **removal options that securely store carbon in geological formations or mineralize it** have the potential of directly adhering to these temporal requirements. Exclusively these methods align with the fundamental objectives of carbon removal. Currently, only DACCS, BECCS, biochar and enhanced weathering (EW) qualify, as they exhibit the capacity to store carbon over these timespans. In principle, these permanent removal options could be used to meet the mitigation obligations (see below 6.2).

However, while these permanent options can store carbon for such periods, they are **not fully equivalent to emission reductions for the following reasons**:

- **Leakage risks**: The IPCC's 2005 Special Report on CCS concluded that appropriately selected and managed geological reservoirs are 'very likely' to retain over 99% of the sequestered CO_2 for longer than 100 years and are 'likely' to retain 99% of it for longer than 1000 years.[28] However, long-term evidence on leakage from CCS pilot sites is not yet available.

[22] It should also be noted that the impacts of the various removal options on ecosystems, biodiversity and resources differ considerably. These differences need to be reflected in regulation, which is the focus of section 6.2.
[23] Supervisory Body, 2022, see also Umweltbundesamt, 2022 (2) In this context, it should be noted that there is no single atmospheric lifetime for CO_2 because of the different rates of uptake by different removal processes.
[24] Supervisor Body, 2022, Cullenward, 2023.
[25] Umweltbundesamt, 2022 (2)
[26] Supervisory Body, 2022
[27] Cullenward, Hamman, Freeman, 2020
[28] European Commission, n.d.

Some studies assume that CCS only stores 65-80% of captured CO_2 permanently, while the rest might leak. In addition, there is a risk of CO_2 stored in geological formations polluting groundwater.[29] Other studies have assessed the risks associated with storage in the seabed of the North Sea and concluded that the likelihood and severity of risks such as leakage, earthquakes, and pollution largely depend on the specific site conditions.[30]

- **Energy consumption**: Industrial removals consume considerable amounts of clean energy.[31] According to the Rocky Mountain Institute[32], for example, scenarios for DACCS's demand for low-carbon electricity could amount to 0.9 exajoules (EJ) by 2040 and 4.4 EJ (range of 2.2–6.2 EJ) by 2050, an amount greater than Japan's 2020 total final electricity demand or about 5% of total global electricity consumption in 2020 (81.8 EJ). In scenarios of even greater DACCS deployment, the 2050 electricity demand for DACCS reaches 7.9 EJ (3.9–11 EJ). Energy consumption for heat is also sizeable, depending on the scenario. Importantly, this energy demand will compete with other technologies that are essential to decarbonizing economies and to reducing emissions, such as electric vehicles, heat pumps and the production of green hydrogen.
- **Land use and water consumption**: Depending on the scale of its uptake, BECCS could entail the use of very large areas of land. This use of land would compete with other uses, especially food production and ecosystem protection. Although only partly related to BECSS, it is noteworthy that the total area of land needed to meet the projected biological carbon removal in national climate pledges amounts to almost 1.2 billion hectares, which is equivalent to all currently available global cropland.[33] Moreover, some scenarios estimate that producing enough biomass for BECCS to meet the 2°C objective would require more than doubling the amount of water currently used to irrigate food production.[34] These levels of water consumption can harm ecosystems and their capacities to adapt to climate change.

6.2 Implementing the 2040 climate target: The role of temporary removals

In contrast to permanent removals, temporary removals **only store carbon for limited periods**. After the end of storage, the carbon is **inevitably reemitted into the atmosphere**. In effect, temporary carbon storage only delays emissions, and has little to no cooling effect on the planet's long-term equilibrium temperature.[35] Because of the mismatch between the effectively permanent impacts of CO_2 emissions and the limited climate benefits of temporary storage, relying on temporary carbon storage can lead to higher GHG concentrations in the atmosphere and therefore higher long-term temperatures.[36] Importantly, in GHG inventories, the effects of temporary and permanent removals are the same: Both are reported in the same way under category 4 and are both relevant for target achievement in a certain year.

[29] Umweltbundesamt, 2022
[30] Wallmann et al, 2022
[31] IPCC, 2018
[32] Kahsar, et al, 2022
[33] Dooley, 2022
[34] Fern, 2022
[35] Cullenward, 2023, Cullenward, Hamman, Freeman, 2020
[36] Carbon Market Watch, 2023

The storage duration of temporary removals varies significantly. Carbon farming activities, such as planting of cover crops, are examples of sinks only storing carbon for months or even less. Chemical capture and subsequent use of CO_2 in products, such as plastics or synthetic fuels, only provides short-term storage for a few days or years, depending on the specific uses and the possibility to recycle. Storing carbon in other products has the potential to prolong storage for periods spanning decades – or even centuries. In wooden buildings, as well as minerals, for example, storage can last for centuries. However, even in these circumstances storage is shorter than the atmospheric lifetime of carbon.

As a result, **temporary removals cannot contribute to achieving the temperature goals of the Paris Agreement in a way that is equivalent to permanent removals or even to reduction of emission**.[37] However, there are various options how to turn temporary removals into a useful and possibly equivalent tool of climate protection:

- **Mastering the Sisyphean task**: This option includes the constant renewal of temporary carbon removal during the atmospheric lifetime of CO_2. Given the length of time CO_2 remains in the atmosphere, this constant renewal has been termed a Sisyphean task.[38]
- **Temporary removals as a bridge**: Temporary removals could serve as an interim solution that is functionally equivalent to permanent removals, provided that they are replaced by permanent removals upon their expiration. In this regard, temporary removals could serve as a bridge for a scenario in which permanent removals have matured and are available in greater quantities. The requirement to replace temporary removals with permanent ones is a conceivable strategy for complying with emission reduction and/or removal obligations.
- **Storage only up to peak temperatures**: According to this option, temporary removals are not required to store carbon for the entirety of its atmospheric lifespan but only until peak temperature is reached.
- **Discount factors**: Discount factors could be used to establish equivalence between temporary and permanent removals.

6.2.1 Constant renewal of temporary removals – the Sisyphean task (option 1)

One way to solve the problem of temporary storage is to require the emitter, government, or other entity to permanently renew expired emission reductions that have been used to meet mitigation and/or reduction commitments. This obligation would last as long as the carbon stays in the atmosphere, i.e., in parts for 1000 years or longer. Given these timespans, the constant renewal of temporary removals has been dubbed a **Sisyphean task or "a chain of perpetual removal activities"**.[39] This approach would be different from the Kyoto Protocol that established temporary certificates (tCER) and long-term certificates (lCER). This system did not include an obligation to renew expired certificates as long as CO_2 remained in the atmosphere. Moreover, the validity of tCER of lCER was shorter than the atmospheric lifetime of CO_2.

Given the large amounts of temporary removals – temporary removals from natural sinks account for the largest share of removals in most scenarios – it is the **main advantage of this option that it promises to remove carbon quickly and – in theory – permanently in large volumes**. It can also build on technologies and management practices already available while

[37] Cullenward, 2023 (2)

[38] Edenhofer et al., 2023

[39] Edenhofer, 2023

the technological development of many of the permanent removal technologies is still in the early stages.

However, this option has **significant problems**:

- **Managing risks and uncertainties over long periods of time**: Unlike other examples of regulation spanning millennia, i.e., the storage of nuclear waste and liability regimes for depleted mines, the constant renewal of carbon removal credits requires an active and constant management of forests or other natural sinks over millennia – all of which are complex and dynamic systems. The management of natural sinks becomes even more challenging as the climate changes and the capacities of ecosystems to store carbon deteriorates. In other words: Unlike Sisyphus' boulder, the carbon removal challenge is likely to become more difficult over time as climate change impacts the storage capacity of ecosystems.
- **Asymmetry in the effect of carbon removal relative to CO_2 emissions**: An extensive use of temporary removals today can result in higher GHG concentrations in the atmosphere in the future, as temporary removals inevitably reemit. Higher GHG concentrations are more likely to trigger tipping points of the climate systems, which – in turn – can lead to additional emissions and thus an acceleration of climate change.[40] As a result, the obligation to constantly remove carbon may turn into an escalating need to remove an increasing amount of CO_2. There is an asymmetry in the effects of carbon removal relative to CO_2 emissions. One ton of removal cannot simply repair delayed or foregone emission reduction of one ton of CO_2.[41]
- **Expensive approach**: While many temporary removal options are cheap today, particularly afforestation and reforestation, they can become very expensive in the long run. This is not only due to the impact of climate change on ecosystems, but also because of increases in land prices and the anticipated tightening of regulations on carbon certification requirements. Regulators will probably tighten rules on carbon certification in response to concerns about additionality and baselines. Crucially, a commitment to perpetual renewal over millennia will dramatically increase the costs of these renewals.

6.2.2 Temporary removals to meet removal obligation combined with an obligation to replace them with permanent removals after expiry (option 2)

This option would **also oblige specific entities to remove carbon from the atmosphere**. In contrast to option 1, this option would entitle the committed entities to remove carbon either through permanent or temporary removals. If carbon is only temporarily removed, entities covered by this scheme could be obliged to replace the temporary removal with a permanent removal after its expiry. In contrast to Option 1, this option would only allow the use of temporary removals to meet a separate removal obligation, but not to meet an emission reduction obligation (as is the case for option 3). In essence, this option could act as a bridge until a time when sufficient permanent removals are possible.

This option is currently negotiated in the **Legislature of California** – under the proposal of a Carbon Removal Development Act.[42] According to this proposal, 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 utilizing a temporary carbon

[40] IPCC, 2021

[41] Zickfeld, 2021

[42] Senate Bill, California, 2023

sequestration method and (2) a legally binding commitment to purchase an additional negative emissions credit utilizing a durable carbon sequestration method upon the expiration of the guarantee period associated with the original temporary negative emissions credit. Importantly, no more than 50% of the negative emissions credits used by an emitting entity to meet its obligation may be two-phase emissions credits.

This proposal has **various important advantages**. First, it addresses the central shortcoming of the Sisyphus approach by not requiring a constant renewal of removals in an uncertain environment over extremely long periods. Second, it supports activities that actually decrease the GHG concentration rather than just offsetting emissions. In this sense, like no other instrument, it serves the ultimate objective of climate policies, namely to achieve net negative emissions Third, it commits emitters and complies with the polluter pays principle. Fourth, it does not conflate emission reductions and carbon removals. Fifth, it creates a market and strong incentives for the development and deployment of permanent and innovative removal options. Sixth, it does not depend on public funding. Seventh, it could buy time for decarbonizing economies while keeping GHG concentrations at potentially safer levels.

However, the **proposal also creates path dependencies**. It assumes that permanent removals will be available in sufficient quantities after the temporary removals have expired. This is an uncertain prospect, as the amount of temporary removals is only capped to 50%. This cap could result in a quantity of temporary removals expiring at a time when an equal quantity of permanent removals is not available. The proposal must also settle liability issues. It must outline the procedures when a committed entity goes bankrupt prior to the temporary carbon credit's expiry.

6.2.3 Temporary removals to offset emissions combined with an obligation to replace them with permanent removals after expiration (option 3)

In contrast to option 2, this option would allow specific entities to **use carbon removals to offset emissions to meet their reduction obligation**. Similar to option 2, this option would also permit temporary removals if the removing entity or another entity commits to replacing the temporary removals with a permanent removal after its expiration.

This option could also function as a strong driver to incentivize the development and deployment of removals. However, it would **conflate reductions and removals**, thereby acting as a factor that delays emission cuts. In fact, this option has been used to justify continued oil and gas exploration and even enhanced oil recovery well after 2050.[43] Consequently, this design option compromises the environmental integrity of climate policies, albeit to a limited extent, given that temporary removals must eventually be replaced by permanent removals. Additionally, similar to option 2, potential liability issues need to be thoroughly addressed.

6.2.4 Temporary removals until peak temperatures are passed (option 4)

According to this option, **removal activities would not be required to store carbon as long as carbon stays in the atmosphere, but only until the world has passed peak temperatures**.[44] This could mean a significantly shorter period. According to the IPCC, temperatures are expected to stabilize in the second half of this century for 1.5°C scenarios, just before the end of the century for 2°C scenarios, and only after 2100 for higher warming scenarios. The

[43] Politico, 2023

[44] Cullenward, 2023

world is not yet on track for the 2°C scenario, suggesting the minimum durability is closer to 100 years than it is to 50 years.

This option has a **few advantages**. Depending on the time of peak temperatures, it would significantly shorten the required duration of carbon storage. With this shorter storage period, the amount of the removals available could be significantly increased.

However, this option also has **various problems**:

- **Uncertain timeframes**: The assumption of peak warming depends on many uncertainties, making it difficult to predict when peak temperatures have actually passed. Temperature stabilization is based to some extent on the timing of near-net-zero emissions but even near-net emissions do not automatically lead to peak temperatures. Earth's feedback on emissions and the corresponding GHG concentrations add significantly to these uncertainties.
- **Beyond national jurisdiction**: Policymakers do not control when temperature stabilization will occur, as it depends on global emissions rather than the emissions in any one jurisdiction.
- **Reversal of peak temperatures**: This option assumes that peak temperature is a static moment that cannot be reversed. This is a risky assumption. While it is very likely that the world will be essentially fully decarbonized when peak temperatures have passed, it is also possible that GHG emissions will resume at a later point. In turn, society would not know when peak warming has actually occurred.

6.2.5 Discount factors to make temporary and permanent removals equivalent (option 5)

In this fifth option, **discount factors are used to turn temporary and permanent removals into an equivalent climate protection tool.** Accordingly, discount factors value temporary removals relative to permanent removals, with a specific number of temporary removal credits equal to one permanent removal credit. For example, x temporary removal credits (where x > 1) may be required to replace one permanent removal credit. The IPCC information note on carbon removal mechanism contains an overview of tons of CO_2 needed to produce mitigation performance equivalent to one ton of CO_2 permanent removal stored over different periods of time.[45] In principle, this option can be combined with an obligation to constantly renew removals, or to replace expired removals with permanent removals, as outlined in the previous options.

In theory, such discount factors offer **several advantages**. They would significantly increase the amount of available removals, addressing the extreme scarcity of current permanent removals. Moreover, discount factors **increase the uniformity of removal credits** and thus market liquidity.

However, this option has **significant shortcomings**, including:

- **Uncertain future availability of replacement removals (or emission reductions)**: It is the ultimate objective of climate action to keep atmospheric GHG concentrations at safe

[45] IPCC, 2022. It should be noted that these discount factors are different from methods that aim to balance the economic costs of renewed temporary and permanent removals. For instance, CarbonPlan has developed a calculator to compare the costs of sequentially renewed temporary removals and permanent removals over the time that CO_2 stays in the atmosphere. While such cost models calculate economic costs over time, they do not establish regulatory equivalence between reductions and removals.

levels and to achieve the temperature goals of the Paris Agreement. However, discount factors alone cannot guarantee that removal credits can be renewed after they expire nor can they help ensure that GHG concentrations remain at the same level. It is possible that technical or nature-based removals will no longer be physically available once the credit has expired, rendering even high discount factors ineffective. Furthermore, discounting does not address potential issues of moral hazard and liability.

- **Challenging to determine the discount factor**: To create equivalence between reductions and removals with temporary storage, discount factors usually take account of storage duration. The IPCC information note on removal activities, for instance, states that respectively 5.48 tons of CO_2 and 2.14 tons of CO_2 are required to earn one credit if a discount rate of 1.75% applies and removals are stored for 10 years and 30 years respectively.[46]

  However, it is equally important that discount factors fully take into account whether specific types of removals are more or less likely to re-release carbon into the atmosphere. This is inherent to risk tools that are applied to varying degrees in voluntary markets.[47] However, as climate change intensifies, the risks and uncertainties increase, making it challenging to determine why a particular discount factor is preferable to another, or require adjusting discount factors over time. Exacerbating these uncertainties is the fact that even minor inaccuracies in assessing storage times, future discount rates and future removal costs can have significant financial implications for society.[48]

- **Misleading incentives**: Discount factors reduce the incentives for the discounted removals relative to non-discounted removals. However, if they are still cheaper after discounting, discount factors may create incentives to pursue cheap and temporary carbon removals today while discouraging investment in more expensive and effective approaches in the future.[49]

[46] IPCC, 2022

[47] Verra, 2019

[48] Edenhofer et al., 2023

[49] Cullenward, Hamman, Freeman, 2020

Table 3: Overview: Advantages and disadvantages of different options to turn temporary removals into a useful and possibly equivalent tool of climate protection.

	Advantage	Disadvantage
Constant renewal of temporary removals	• Promises to remove carbon quickly in large volumes. • Builds on available technologies and management practices.	• Constant management of natural sinks for millennia very uncertain. • Asymmetry in the effect of removal relative to emissions not taken into account.
Temporary removals to meet removal obligations combined with obligation to replace them with permanent removals	• No requirement to constantly renew removals over extremely long periods. • It supports activities that decrease GHG concentration, not only compensate emissions. • It does not conflate emission reductions and carbon removals.	• Path dependencies • Liability issues
Temporary removals to meet reduction obligations combined with obligation to replace them with permanent removals	Incentive for generating removals	• Environmental integrity by conflating removals and reductions. • Path dependencies • Liability issues
Temporary removals not required to store carbon for its atmospheric lifetime but only until peak temperature.	Increases the amount of removals	Uncertain when peak temperatures have been reached.
Discount factors	Increases the amount of removals	• Challenging to determine the discount factor. • Uncertain availability of replacement removals.

7 Possible measures and policies to govern and to incentivize carbon removals

There are **various ideas on how to incentivize removals in the EU's new 2040 climate framework**. These include:

- Integrating removals into the ETS.
- Integrating removals into the ETS with the help of a Carbon Central Bank or another intermediary agency.
- Establishing a separate trading scheme for removals.
- Feed-in-Tariffs (FiTs), contracts for difference or auctioning for removals.
- Removals as a tool to reduce carbon taxes.
- Removals as a requirement for granting permits.[50]

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.

7.1 Integration of carbon removals into the ETS

The reformed ETS 1, with its new linear reduction factor (LRF) of 4.3% and 4.4%, is expected to stop issuing emission allowances before 2040, leaving only banked allowances and allowances set aside in the Market Stability Reserve (MSR) available for use.[51] As residual emissions are likely to continue after 2039, emission **allowances are expected to become scarce and potentially very expensive**.[52] The political acceptance of the ETS could be at risk.

In response to this challenge, proposals on how to **integrate removals into the EU ETS are gaining traction**.[53] Some players see this as a central option to address the issue of residual emissions, scarcity of allowances and the resulting price spikes. It is also a tool to retain an efficient and liquid market and to scale up investments in removal technologies.[54] Carbon removal credits could potentially constitute a new source of supply that could be surrendered for compliance in the ETS.[55] However, the current ETS Directive does not allow the use of removal credits for compliance.

[50] It should be noted that the certification of carbon removals is another instrument incentivizing removals. However, this measure alone does not incentivize carbon removals but is a precondition to operationalize 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.

[51] Rickels, et al., 2022

[52] Pahle, et al., 2023

53 EEX, 2023

54 EEX 2023

[55] Pahle, et al., 2023, Rickels, et al., 2021

Although the proposals for integrating removals into the ETS are not yet fully developed, **several design options are conceivable**. These include:

- **Full integration of removals in the ETS with no limits on the types of removals allowed to offset emissions (Option 1)**: Under this option, carbon removals can fully substitute emission reductions. Any type of removal in any quantity could be used to meet the obligations under the ETS.[56]
- **Partial integration with only certain types of removals being eligible (Option 2)**: Option 2 proposes that only removal credits generated by specific types of removal activities would be eligible as a compliance unit. This could be achieved by using positive lists, where only listed activities would be eligible. For example, eligible removals could be limited to those with permanent storage in geological formations or those with specific benefits for ecosystems. Alternatively, this approach could be based on negative lists, where all removal activities would be eligible unless they are prohibited. For example, credits from afforestation or reforestation activities could be prohibited. It is also conceivable that removals from BECCS are fully excluded or limited to waste biomass use due to their many negative side effects on ecosystems.[57] These and other design options are possible.
- **Limited integration up to a maximum amount of removals (Option 3)**: Another design option is to limit the integration of all removals to a maximum amount eligible for compliance under the ETS Directive. The directive would set a ceiling for removals eligible for compliance purposes, either in a maximum amount in tons or a percentage share of the reduction obligations. Such a ceiling could be dynamic and decrease over time. Despite some important differences, the EU ETS phase 3 could inform this ceiling option – in principle. Accordingly, the ETS featured maximum limits on eligible international credits. Member States determined these maximum amounts, which became valid after approval by the Commission. For instance, in the 2008-2012 period, operators in Germany could use Joint Implementation (JI) and Clean Development Mechanism (CDM) credits equalling 22% of their individual allocation amount.[58] If they had not exhausted this maximum by 2012, they could use it in the third trading period.[59] California's ETS is another example that limits the contribution of removals.[60]
- **Limiting offsetting to certain types of emissions or to certain activities under the ETS**: The use of carbon removal credits could be excluded for emissions from fossil fuels or be limited to “residual process emissions” or to those process emissions that could not be captured and stored safely.

It is important to note that these **design options can be combined**. Neither of them, however, is suitable to help achieve net negative emissions as credits would most likely be used to offset emissions only.

[56] Rickels et al., 2022

[57] Umweltbundesamt, 2019

[58] DEHST, 2018

[59] Participants to the EU ETS used 1.058 billion tonnes of international credits in phase 2 (2008-2012) to account for their emissions. Unused entitlements were transferred to phase 3 (2013-2020).

[60] See also Badgley, 2021

Table 4: Overview – Advantages and disadvantages of the integration of removals into the ETS.

	Advantages	Disadvantages
Full integration of all removal types **(Option 1)**	• Possibly instrumental in cushioning ETS price spikes and in maintaining political support for the ETS. • Catering for residual emissions where there are no technologies to reduce for products that could not be substituted otherwise.	• Removals and reductions are fundamentally different and should not be interchangeable. For this reason, full integration is particularly risky. This applies to temporary removals in particular. • Unconditional and unlimited inclusion of removals would effectively abolish the ETS emission cap. The amount of residual emissions in the ETS would become unclear. This option has the highest risk of all options to deter emission reductions. • Risk of double-counting, as many nature-based removals are already accounted for under the LULUCF Regulation. • Incentivizes for prioritizing currently cheap removals (e.g. afforestation and soil carbon enhancement) over emission reductions. • Like other options to integrate removals into the ETS, this option is unable to support achieving net negative emissions.
Partial integration with only certain types of removals being eligible **(Option 2)**	• If, for example, only removals with permanent storage in geological formations are eligible, concerns of leakage and of liability could be solved. • By excluding temporary removals, for example, the system would not create incentives to primarily use cheap possibly unsustainable temporary removals. • Depending on its scope, it could incentivize the use of permanent removal options.	• Although to a lesser extent than option 1, this option could also deter emission reductions. It should be combined with stringent requirements for the eligibility of removals and a cap setting a maximum amount of eligible removals (next option). • If only removals with permanent storage are eligible, this option would limit the supply of removal credits, thus providing less liquidity to the market. In principle, this could change as permanent removal options mature.
Maximum amount of removals **(Option 3)**	Addresses problems of environmental integrity, provided that the ceiling only includes permanent removals and those that are likely to be available in the real world in a sustainable manner.	• Depending on the stringency of the cap, this option is principally able to maintain the priority of emission reductions compared to using removals. • As BECCS should be excluded or strictly limited to waste biomass,

		DACCS and EW are the only eligible removal options. As their removal potential is still minimal and future removal rates are uncertain, the ceiling for removals is bound to be very small at the start.
Limiting offsetting to specified types of emissions **(Option 4)**	Addresses problems of environmental integrity and maintains the need for urgent emission reductions and limits use to offset only “unavoidable residual emissions”.	• Requires defining ‘residual emissions’ taking into account technological progress and rising carbon prices. This is ultimately a political choice that makes establishing a robust definition difficult.

7.2 Carbon Central Bank or another intermediary agency

The establishment of a so-called Carbon Central Bank (CCB) or another intermediary agency is an important governance element in the discussion on integrating carbon removals into the ETS. This agency could address carbon price volatility as well as potential moral hazard and subsequent liability issues.[61] According to this proposal, a **CCB or another intermediary agency would be mandated for procuring physical carbon removals via carbon removal credits**.[62] This conversion process could involve discount factors to account for the risk of leakage or buffer pools to address non-permanence. The CCB would use these removal credits to establish a removal reserve or add them to the MSR. Procurement of removals could be organized through technology-specific tenders or forward transactions, with financing possibly provided by public budgets or ETS revenues. Carbon removal options with above-market prices, such as BECCS or DACCS, would particularly benefit from these advance purchase programs.

After the procurement and certification of removals, the **CCB or another intermediary agency would auction carbon removal credits directly or, alternatively, issue a proportionate number of allowances while keeping the carbon removal credits like a collateral in a separate account**. Auctioning would occur if ETS prices surpassed a maximum price ceiling or if other conditions were met. The CCB could also commence auctioning at its own discretion, which could be either conditional or unconditional. Companies obliged by the EU ETS would surrender allowances to meet their obligations. Under this system, there would be no direct transaction between emitting companies and carbon removal companies. In this setting, the CCB or an equivalent agency would act as a clearing house. Many other options for the CCB's mandate are conceivable, including that the CCB acts as a guarantor and/or supervisor of carbon removal activities in the EU.

Although crucial regulatory details need clarification, the **proposal promises several advantages**. The proposed system could stabilize carbon prices, particularly at a time when only hard to abate emission options are left and high carbon prices are likely, while maintaining the net-emission reduction path. It could create a new lead market for removal options that store carbon permanently but that have yet to achieve cost-competitiveness. A CCB with a broad mandate could allow for flexibility in response to future developments. The CCB could also invalidate credits after their expiration and replace them with valid credits to ensure the permanence of removals. With no direct exchange between emitting and removal companies, accounting issues would be less acute. Designed as an independent institution – possibly similar to central banks – the CCB promises to function shielded from political influence. **The CCB can be combined with all previous options.**

The proposal, however, also **raises concerns**. These include, in particular:

- **Emission deterrence**: Depending on its regulatory details, the CCB's mandate could encompass the procurement and auctioning of *any* type of removal credits, regardless of whether it stores carbon permanently or only in the short term, or whether its impact on ecosystems is positive or negative. In this design, the CCB's mandate would undermine the integrity of climate policies and could harm ecosystems. Discount factors are proposed to address these concerns, but are unlikely to perform this function (see above 6.2.5).

[61] Meyer-Ohlendorf, 2023

[62] Rickels et al., 2022 and Edenhofer et al., 2023 presented this idea with many similarities but also some important differences in detail.

- **Only legislators should take far-reaching decisions**: Depending on the exact design of the mandate, the CCB could determine the amount of the EU's residual emissions as well as the amount of permanent and temporary carbon removals. *De facto*, it would be the CCB's prerogative to set the emission budget of the EU. These far-reaching decisions have significant implications for the EU, its Member States, and its citizens. They should be assigned to the democratically elected legislators only, not to a CCB or an agency with limited democratic legitimacy. They should be part of an open political process that facilitates political debate and negotiations. This calls for a clear mandate of the CCB to be defined in primary legislation, including – for example – a predefined limit up to which the CCB may procure and/or auction removals.
- **Different carbon removal options should not be treated alike**: In principle, the CBB mandate could turn any type of removal credit into a full ETS compliance unit, regardless of whether it stores carbon permanently or only in the short term, or whether it has a negative or positive impact on ecosystems. It is equally problematic that removals with robust monitoring and accounting systems, such as most technical removals, and removals with weak monitoring and accounting systems, such as most nature-based removals, are treated alike. Discount factors and expiry dates of removal credits are supposed to address these problems, but are not very likely to provide the solution (see 6.2.5).
- **Unable to help achieve net negative emissions**: Depending on its mandate, the CCB is unlikely to help the EU achieve net negative emissions, which is the ultimate objective of EU climate policies as set out in the ECL. As an institution to facilitate the integration of carbon removals into the ETS, it is a tool to offset emissions, as opposed to achieving net negative emissions.
- **The CCB - a bad bank?** The management of credit, operational, market, and liquidity risks is central to bank operation. Banks typically manage such risks by reducing their exposure through diversification or by holding sufficient liquid assets. The CCB could use similar risk management approaches to manage the reversal risks.

  However, ecosystems and the biosphere cannot be treated like the financial system. While a collapse of the financial system can cause an economic crisis, it can be remedied. In contrast, a collapse of the climate system cannot be fixed – it is truly too big to fail. Therefore, the main concern is not merely ensuring that the CCB's mandate is sufficiently supported by public funds to guarantee the procurement and renewal of non-permanent removals, but rather to ensure that carbon removals are physically available in the real world. This is a risky proposition since it assumes that the carbon debt can be repaid in a world where carbon storage capacity is likely to be severely depleted as the climate crisis intensifies. Managing this risk responsibly and transparently, including its regular assessing and public reporting, will have to be part of the core mandate of such a bank.

7.3 Removal Trading Scheme

An EU Removal Trading Scheme (RTS) is another option to incentivize carbon removal, as it would create a market for removals. The RTS would put an **obligation on covered entities to remove and store specific minimum amounts of carbon**. The quantity of carbon to be removed could be determined based on historical emissions and/or the proportion of current or future emissions of the entity covered by the RTS. Covered entities would either be obliged to either remove carbon themselves, or to buy removals from companies or other entities that had

removed carbon or had surplus removal in their portfolio. This obligation would exist independently of the existing ETS obligations, where applicable. The RTS would be introduced after 2030, possibly running in parallel to the ETS during its initial phase and merging with it as the EU moves closer to climate neutrality.

The RTS could be inspired by the **proposal for a Carbon Removal Market Development Act which is currently discussed by the Legislature of California**.[63] 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 utilize 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 (see 6.2.2.).

The RTS offers **several important advantages** as outlined in section 6.2.2. In particular, it would significantly advance the polluter pays principle within the sphere of climate action, as it would also oblige individual entities to remove carbon in accordance with their responsibilities. Such an obligation could become an important pillar in the efforts to achieve net negative emissions.

In addition to the **disadvantages** outlined in section 6.2.2., the RTS imposes additional costs on companies that are already under economic pressure to achieve the emission reductions required, and would open another debate on international competitiveness, potential additional carbon leakage and relocation. Moreover, linking the polluter pays principle to historical or cumulative emissions could create moral hazard, i.e. companies dissolving to avoid paying their historical carbon debt.

7.4 Feed-in-Tariffs or targeted competitive bidding for carbon removals?

FiTs, contracts for difference and targeted competitive bidding are the most widely used **government policies to bolster the deployment of renewable energy**. In many countries, FiTs and targeted competitive bidding have stimulated a rapid and large-scale development of the market for renewable energy sources (RES), as well as the development of less mature RES technologies. These policies have been instrumental in reducing the costs of renewable energies drastically, facilitating their progress toward full competitiveness. In this respect, the policy has been very successful.

Typically, FiTs involve **long-term agreements that guarantee a price higher than prevailing market rates** throughout the designated payment duration. A contract for difference would guarantee only the price difference to, e.g., the actual carbon price. Through targeted competitive bidding, a volume of carbon removals is guaranteed at the level of the price offered by the

[63] Senate Bill, California, 2023. On 29 May 2023, the Senate of California approved the proposal on a 24-9 vote. The proposal is now headed to the California Assembly. It must pass several other legislative steps before becoming State law.

successful bidder. FiT rates are commonly pre-established through legislation or by national regulatory authorities. FiTs often have mechanisms to adjust price structures.

Transposing this model, it is conceivable to use **either of these instruments for incentivizing carbon removals**. For this purpose, governments would enter long-term contracts with carbon removal producers, guaranteeing a fixed price over the contract duration. Fixed prices and multi-year contracts backed by law reduce revenue uncertainty, curtailing investment risk and costs for project developers, investors, and lenders.

Luxembourg, for example, is discussing a FiT for carbon removals. The bill has been introduced into Parliament. Under this FiT bill, eligible projects can enter into contracts with Luxembourg's government to benefit from subsidies for atmospheric CO_2 removal or long-term CO_2 sequestration.[64]

Luxembourg proposed FiT for removals

According to this proposal for Luxembourg's FiT for removals, negative emissions providers enter into a **contract** with the Ministry of Environment for a maximum period of five years for the delivery of negative emissions. Eligible projects capture or store at least 100 tons of carbon dioxide per year, and at most 10,000 tons of carbon dioxide per project per year. Projects must be located in Luxembourg or – if they are located outside of Luxembourg – 50% of the ownership of the assets of the project leader must be held in Luxembourg.

Under this system, financial assistance is calculated on a volumetric basis with a payment granted for each metric ton of CO_2 captured from the atmosphere and/or **stored durably during the term of the contract**. Financial assistance may not exceed the maximum payment levels established by the Minister. Payment to providers is based on the verified removal and/or storage or CO_2. Failure to verify delivery or suspension of service delivery results in non-payment.

In principle, these systems offer **several advantages**. First, they are a relatively simple and tested concept. Second, long-term contracts with prices guaranteed by the government provide transparency, predictability, and security, lowering investment risks and financing costs significantly. Third, they also contribute to a stable market development. Fourth, particularly FiTs allow promoting the participation of small and medium-scale companies.

At the same time, however, in the case of FiTs **it is difficult to set the right remuneration levels**. It is difficult to anticipate rapid changes in costs and to adjust FiTs accordingly. Degression mechanisms can address this problem. Moreover, FiTs can be expensive, and they can require considerable amounts of public funding – at a time when public funding becomes scarce and is required for supporting other investments to decarbonize economies. Contracts for difference and targeted competitive bidding are attempts to avoid these disadvantages.

[64] Manhart, 2023

7.5 Amending the EU Energy Taxation Directive: Carbon removals for complying with energy taxes?

The **EU Energy Taxation Directive (ETD)** lays down structural rules and minimum excise duty rates for the taxation of energy products used as motor fuel and heating fuel, as well as electricity. Member States are free to set their own rates provided they comply with the ETD's minimum rates. The ETD is currently being reformed. The Commission has proposed a new structure for minimum tax rates based on the real energy content and environmental performance of fuels and electricity, rather than on volume.

As a possible option to incentivize carbon removals, they could be used to **reduce tax liability**. The ETD could allow Member States to use carbon removals as a tool to reduce liabilities from energy taxes. It should be noted that amendments to the ETD require unanimity in the Council of Ministers.

Tax laws in Colombia and South Africa could inform this idea. These laws permit the use of carbon offsets – including carbon removals – to comply with tax obligations to varying extents. While the Columbian tax law allows entities in the country to offset up to 100% of their tax liability with certified carbon credits from projects in Colombia, pertinent laws in South Africa limit the use of offsets to up to 5 or 10% of their total greenhouse gas emissions contingent on the sector. These laws also contain requirements defining eligible removal activities.

The **integration of carbon removals into carbon tax schemes** serves one of its purposes – lowering the tax burden – well, but falls short of achieving its other purpose – effectively combating climate change:

- **Deterring emission reductions**: The integration of emissions and removals into carbon taxation laws does not address the issue of equivalence; it treats emissions reductions and removals as having the same tax value. This approach can create perverse incentives, as lower prices of some removal activities compared to the costs of mitigation can discourage emission reductions.[65]
- **Lower tax revenues**: The integration of carbon removals can result in a loss of tax revenues, as companies may choose to invest in carbon removals that are currently cheaper than mitigation measures. Since removals substitute emissions reductions, this system would reduce revenue from the carbon tax. There is a risk that such a scheme would effectively be one of tax avoidance.
- **Undermining incentives to invest in innovative removal options**: If the tax rate under a carbon tax is lower than the cost of more expensive emission removal options, it does not provide incentives for investing in those options, even though they may be necessary for permanent carbon storage. For instance, Colombia's carbon tax rate has not increased in real terms from its initial level of USD 5/t CO_2e,[66] as scheduled each year since its introduction. At this level, the tax rate remains drastically below the prices required to incentivize the scaling up of more expensive removal options. This also applies to the EU, as the EU-wide minimum carbon tax level is quite low. As EU-wide taxation rates have to be agreed upon unanimously, it has been impossible to set meaningful minimum carbon tax rates in the past decades. However, some Member States, such as Sweden, have successfully used carbon taxation to drive decarbonization.

[65] World Bank, 2020

[66] https://carbonpricingdashboard.worldbank.org/map_data (Accessed: 25.04.2023), latest update April 2022.

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

As another option, **carbon removals become a condition for granting permits**. In this option, a permission's applicant commits to removing or to purchasing a certain amount of carbon from the atmosphere and to store it for a period specified in the permit. As a design feature of this option, it is conceivable that only removals that are certified according to specific certification schemes can be used for granting a permit.

In theory, carbon removals could be required for issuing various types of permits, such as construction permits or import licenses, but **permits for industrial installation falling under the scope of the Industrial Emissions Directive (IED)** are potentially a particularly relevant use case. The IED covers some 50,000 large industrial installations and intensive livestock farms in Europe, causing around 40% of EU GHG emissions.[67]

The existing IED does not require that cover installations must remove carbon to receive permits. The IED is currently being revised.[68] The proposed amendments to the Directive are supposed to facilitate, inter alia, a higher uptake of innovative depollution techniques to promote resource-efficient, circular, and zero-carbon production methods.

In this context, there are **several options on how a reformed IED could help incentivize carbon removals.** In general terms, conceivable options include:

- **Treating CO_2 as waste?** The existing IED sets requirements for the treatment and generation of waste. The IED stipulates 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 prepared for re-use, recycled, recovered or, where that is technically and economically impossible, it must 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 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 turn CO_2 into waste in the sense of the Directive.[69] 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 techniques available?** The IED stipulates that permit conditions, such as emission limit values, must be based on the Best Available Techniques (BAT). According to the Commission, this system has deficiencies.[70] It does not promote new production processes, technologies, and innovation because BATs are inherently

[67] European Commission, 2022, IED

[68] European Commission, 2022, IED proposal.

[69] 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.

[70] European Commission, 2022, IED SWD

"backwards looking". By definition, they are based on current, already established practices, hindering the development and deployment of more effective and/or innovative techniques. The Commission's proposal for a revised IED aims to address this regulatory problem by opening BATs to more innovative approaches. In this context, it is conceivable that a revised IED could promote the adoption of BATs that also include standards and requirements for carbon removal and storage.

- **Broaden the scope of BATs:** The IED only gives a legal status to the parts of BAT conclusions that contain ranges for emission limit values in permits for pollutant emissions to air and water.[71] Other parts, such as waste prevention or the reuse of water and other materials, are only a 'reference' for setting permit conditions. It is conceivable that a revised IED could broaden the legally binding scope of BATs to include waste prevention and resource efficiency, specifying standards and requirements for carbon removal.
- **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). 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.[72] 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 these EPA draft rules, it is an option that the IED would not only require the capture of carbon, but also the active removal from the atmosphere or purchase of removals. It is possible to put such obligations on all installations currently covered by the IED or to limit the scope of these obligations to specific installations, as the EPAs draft rules do. This removal obligation could be small at the beginning – requiring only to remove a small quantity – and escalate over time – requiring larger amounts of carbon removals.

To varying degrees, all these options would **incentivize** the generation of carbon removals. Similar to the RTS, it could also support activities that actually decrease GHG concentration, not only compensate for emissions. It would help implement the polluter pays principle and it would not depend on public funding.

However, none of these options should lower the requirements for emission standards currently contained in a permit under the IED. It should also be noted that the **IED has been slow in setting and implementing higher standards**. Depending on which roles removals will play in the future ETS, there is also the risk of double regulation for installations that fall under the ETS. For sectors outside the ETS, such as livestock and CH_4 emissions and waste, there would be no risk of double regulation.

[71] European Commission, 2022, IED SWD

[72] Chemnick, 2023

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Annex

This annex provides a summary of the contributions of carbon removals mentioned in national climate laws and LTSs for the years 2040, 2045, and 2050. A report[73] by Ecologic Institute provides further elaboration of these documents.

Table 5: Contributions of removals mentioned in national climate laws and LTSs for the years 2040, 2045, and 2050.

- ● **indicates (indicative) targets,**
- ● **indicates scenario outcomes,**
- ● **indicates that *only* qualitative information is available.**

	Climate law			LTS		
	Overall contribution	**Natural removals**	**Technical removals**	**Overall contribution**	**Natural removals**	**Technical removals**
AT	*no climate law*			●	●	
BE	*no climate law*					●
BG					●	●
HR					●	●
CY	*no climate law*				●	
CZ	*no climate law*				●	
DK					●	
EE	*no climate law*				●	
FI				●	●	●
FR	●			●	●	●
DE	●	●			●	
EL						
HU					●	
IE				*no LTS*		
IT	*no climate law*			●	●	●
LV	*no climate law*				●	●
LT				●	●	●
LU					●	
MT					●	
NL						●
PL	*no climate law*			*no LTS*		
PT	●	●		●	●	
RO	*no climate law*			*no LTS*		
SK	*no climate law*			●	●	
SI	*no climate law*			●	●	●
ES				●	●	
SE					●	●

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