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Carbon farming, overestimated negative emissions and the limits to emissions trading in land-use governance: the EU carbon removal certification proposal

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Abstract

This article conducts a qualitative governance analysis of the European Commission's 2022 proposal for a certification framework for carbon removals (CRCF). It highlights potential challenges and legal implications—with a specific focus on carbon farming. While the European Union (EU) acknowledges carbon farming as an important strategy to offset residual emissions, such carbon removal activities are prone to reversals and models often overestimate their sequestration potential. The CRCF aims to account for these issues, but the analysis shows that the proposal may, in part, undermine international climate and biodiversity goals set by the Paris Agreement and the Convention on Biological Diversity. Key concerns include its failure to consider the normative hierarchy between emission reductions and removals mandated by EU and international law, the introduction of a temporary removal crediting system, the extensive delegation of powers to the Commission, the possibility that it may incentivise shifting effects, and its lack of alignment with other EU environmental policies. Additionally, the CRCF's failure to restrict the use of carbon credits after certification increases the risk of double claiming of removal activities—and the proposal may open the door for to future integration of carbon removals into the EU's emission trading scheme, which should be avoided for various reasons. As an alternative, member states should consider targeted subsidy schemes and regulatory instruments to navigate these challenges in carbon farming effectively.

Keywords Carbon farming, Carbon dioxide removal, Certification of carbon removals, EU law, Soil carbon sequestration, International law, Paris Agreement, Convention on Biological Diversity, Climate change, Net-zero emissions

Background

Addressing residual greenhouse gas emissions (GHG) is crucial to limit global warming. Article 4 para. 1 of the Paris Agreement (PA) requires net-zero emissions to be achieved in the second half of the century. However, the legally binding obligation to limit global warming to well below 2 °C and to strive to stay below 1.5 °C under Article 2 para. 1 lit. a PA and relevant human rights guarantees (which both have legal precedent over Article 4 para. 1 PA [1]) imply that a balance between GHG emissions and removals must be achieved much earlier—even well ahead of 2050 or 2040 [2, 3]—if we exclude the possibility

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of a temperature overshoot. As a result, countries are obligated to offset residual emissions more quickly than anticipated. Similarly, according to the 2022 report from the International Panel on Climate Change (IPCC), carbon dioxide (CO_2) removal (CDR) from the atmosphere and storage is a necessary measure for achieving net-zero emissions [4]. The exact amount of negative emissions needed varies based on factors such as the expected remaining carbon budget and whether policies like phasing out fossil fuels and reducing livestock will be favoured over utilising negative emission technologies. In any case, most residual emissions are attributed to agriculture and industry [5].

Countries are expecting the land use, land-use change, and forestry (LULUCF) sector to become a carbon sink and compensate for about a quarter of total emissions in their nationally determined contributions. However, they have mostly failed to disclose how to achieve this goal [6]. Currently, all land-use sectors in the European Union (EU), except forests, are net carbon sources [7]. One way to address residual emissions is by adopting carbon removal activities, which can be incentivised through certifications. These certifications could potentially be used in various contexts in the future, such as voluntary carbon markets, compliance markets like the EU Emissions Trading Scheme (EU ETS), or even innovative mechanisms like an EU carbon central bank [8, 9].

Against this background, this article assesses the European Commission's 2022 proposal for a regulation on a certification framework for carbon removals [10] (hereinafter referred to as the CRCF). The CRCF is part of the European Green Deal and seeks to achieve climate neutrality in accordance with the PA and the European Climate Law (ECL). The ECL mandates net-zero emissions by 2050 and negative emissions thereafter [2, 11]. To achieve this goal, the Commission has developed several strategies: firstly, it is imperative to reduce GHG emissions across all economic sectors by improving energy efficiency and expanding renewable energy sources, including green hydrogen, power-to-x, and energy storage facilities, within the coming decades. To this end, the EU plans to adopt the Net-Zero Industry Act, which aims to ease the conditions for investment in these sectors [12]. Secondly, EU member states should reduce emissions by utilising sustainable alternatives, including recycled carbon from waste streams and biomass sources, as well as extracting carbon directly from the atmosphere. Thirdly, it will also be necessary to offset hard-to-abate emissions from industries such as agriculture, cement, steel, aviation, and maritime transport by implementing carbon farming and industrial removal activities to capture and remove increasing amounts of CO_2 from the atmosphere [10]. Thus, the EU needs to adopt policies that support both natural ecosystems and industrial activities to annually remove several hundred million tonnes of CO_2 from the atmosphere [10]. In fact, according to the Fit for 55 legislative package, which proposes the 2030 target for the LULUCF sector, 310 megatonnes of CO_2 equivalents ($MtCO_2eq$) must be removed from the atmosphere [10, 13]. Moreover, in February 2024, the Commission released its new target strategy, which aims for the EU member states to remove 400 $MtCO_2eq$ annually by 2040 [14]. These endeavours also aim to support the achievement of environmental goals, including zero-pollution and biodiversity conservation objectives outlined in the European Green Deal.

Concretely, with the drafting of the CRCF, the Commission has developed a framework for ensuring the quality of voluntary carbon removals. Emissions that fall under the ETS—the EU's primary compliance carbon market—are excluded under the Commission's proposal (Article 1 para. 2 CRCF). At present, there is a diverse range of certification approaches in voluntary carbon markets, which often leads to a lack of transparency and also increases the risk of greenwashing. To address these issues, the Commission's proposal aims to enhance transparency, environmental integrity, and market harmonisation. Central to any certification scheme is defining eligible carbon removal activities, which may encompass or omit certain negative emission technologies (NETs). According to Article 2 para. 1 lit. a CRCF, "carbon removal" means the "storage of atmospheric or biogenic carbon within geological carbon pools, biogenic carbon pools, long-lasting products and materials, and the marine environment, or the reduction of carbon release from a biogenic carbon pool to the atmosphere." As the definition is very broad and thus includes virtually all NETs, there are some methodological and legal problems associated with it—most notably the inclusion of emission reductions as eligible activities. Furthermore, the proposed CRCF rules introduce additional hurdles, such as the utilisation of these credits, ensuring the long-term storage of CO_2, mitigating the risk of double claiming removal credits, and addressing potential impacts on other environmental challenges, like biodiversity loss [10].

One notable carbon removal activity that the Commission aims to upscale and promote through its proposed certification scheme is carbon farming. According to the definition under Article 2 para. 1 lit. h CRCF, carbon farming covers all carbon removal activities "related to land management that increase carbon storage in living biomass, dead organic matter, and soils by enhancing carbon capture and/or reducing the release of carbon to the atmosphere". Carbon farming has a direct and indirect impact on climate and biodiversity, making it a potential contributor to achieving diverse environmental goals.

Flower strips in croplands are an example of this, as they not only enhance biodiversity, but also increase soil organic carbon [15]. In addition, optimising soil structure and enhancing microbial activity through the addition of soil organic matter, such as organic fertilisers or biochar, can benefit nutrient management and thereby improve phosphorus and nitrogen use efficiency [16, 17]. Furthermore, the sustainable use of rewetted peatlands (paludiculture) reduces GHG emissions while also enhancing biodiversity [18]. Conversely, biodiversity faces risks when intensive agroforestry systems or large-scale negative emissions approaches are implemented in biodiversity-rich regions [19–21]. Consequently, it is essential to maintain intact ecosystems for climate and biodiversity protection. In any case, it is questionable whether or not the diverse package of measures summarised under the umbrella term "carbon farming" can do justice to the pivotal role assigned to it by the European Commission and other actors.

Since the publication of the Commission's proposal, the CRCF has received much criticism in the literature and from environmental associations [22–25]. However, the proposal is only the first step towards the adoption of the final EU regulation. The Commission still needs to propose the first certification methodology, a process unlikely to occur before 2026. In February 2024, the European Parliament and the Council of the EU reached a provisional political agreement, forming the tentative basis of the future CRCF [26]. Some key elements have been improved, in contrast to the Commission's proposal, while other issues (still) loom large. At the time of writing, only a brief bulleted summary of the provisional political agreement is available. For the purposes of this article, we will therefore focus primarily on the Commission's proposal. However, we will discuss the content of the provisional political agreement if it differs significantly from the content of the proposal.

Methodology

In this article, we conduct a qualitative governance analysis to assess the EU's proposed Union certification framework for carbon removals. This analysis concentrates on carbon farming and mostly omits industrial carbon removal methods such as bioenergy coupled with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS), and other large-scale geoengineering strategies, which have already been examined elsewhere [3, 20, 21]. With regard to land use, the article draws on earlier research, specifically pertaining to forests and peatlands, which identified several notable challenges [18, 27–29]. These issues will be further examined in the subsequent sections.

Our qualitative governance analysis seeks to assess the effectiveness of policy instruments to achieve certain policy goals [30]. In this context, we understand governance to be much broader than regulation. While governance encompasses the decision-making process and accountability structure for providing and distributing resources, regulation pertains to directing activities and behaviours within the overarching governance structure [31]. Moreover, governance extends beyond national administrations to include the participation of various levels of government, the private sector, and civil society actors [32].

The policy instrument subject to the governance assessment is the EU proposal for a certification framework for carbon removals [10]. We aim to examine the effectiveness of the CRCF in contributing to the legally binding objectives of the PA and the CBD. We have selected international climate and biodiversity policy goals as benchmarks because these environmental aspects are closely linked (e.g., [33–35]), and the Commission's proposed framework aims to benefit both. Regarding the relevant policy goals mandated by the respective environmental treaties, the PA aims to keep global warming to well below 2 °C and to pursue efforts to limit warming to 1.5 °C—as required by Article 2 para. 1 PA [2, 36]. In addition, the CBD sets out to ensure the conservation and sustainable use (of the components of) biological diversity (Article 1 CBD). As shown in an earlier contribution, the goal of halting the loss of biodiversity has been legally binding since at least 1993 and has been continuously violated since then, at least in Western countries [37].

Against the backdrop of this normative framework, the qualitative governance analysis is founded on several building blocks (see Fig. 1). The first building block entails a thorough assessment of the contentious scientific discourse surrounding carbon farming. To this end, we summarise and critically review research articles and reports on carbon land sequestration and carbon farming. Sources include, inter alia, official reports by the EU and the IPCC and peer-reviewed articles that discuss carbon farming practices and policies in the EU during the last years. The results of this review are outlined in Section "Results: natural scientific background". The second building block is focused on understanding human behaviour because policy instruments always aim to alter the behaviour of the target group. In earlier research, we examined technological and behavioural modifications and pinpointed various obstacles that impede change, encompassing emotional factors, conceptions of normality, and self-interest [30, 39]. These hindrances obstruct sustainability transitions not only directly but also indirectly through governance problems, such as shifting

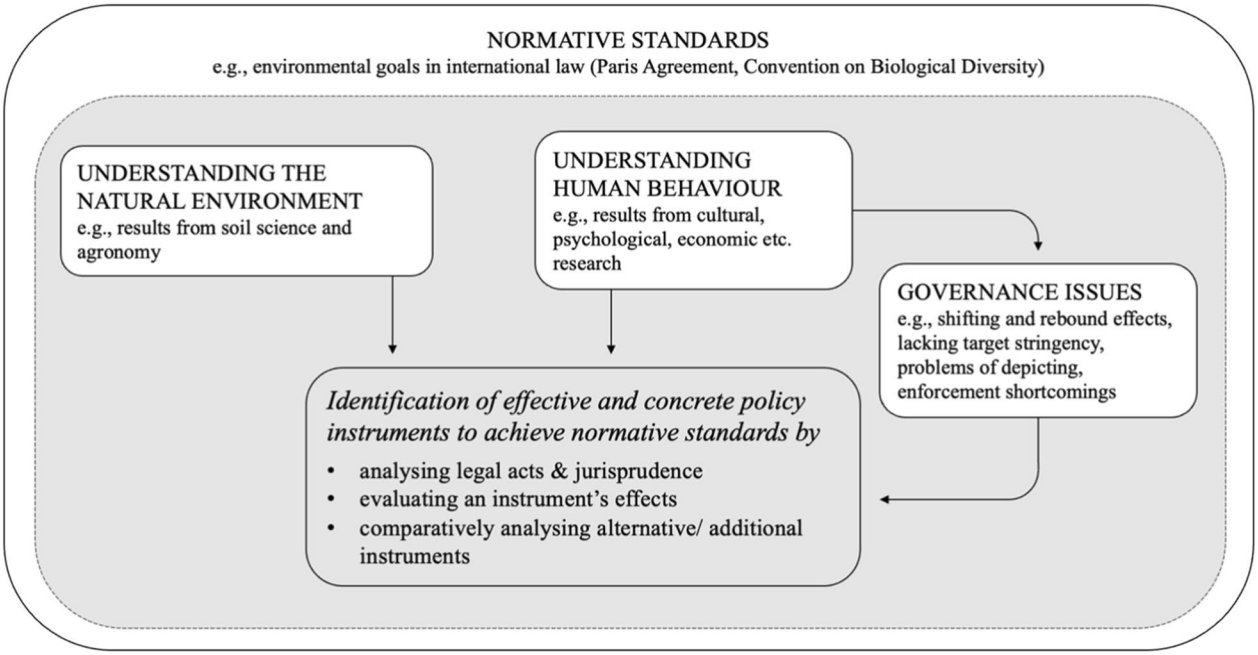

Fig. 1 Methodology (based on [38])

and rebound effects, lack of enforcement, and lack of target stringency [17, 40, 41]. Another issue of governance embedded in the nature of the subject and relevant to the analysis at hand is the problem of depicting. This governance issue describes a situation in which the complexity of the subject makes it difficult to measure through policy instruments because there is no clear governance unit [42]. Policy instruments have to overcome these motivational and governance problems to achieve an effective steering effect. Overall, combining these observations and results allows for a thorough evaluation of the EU's proposal for a certification framework on carbon removals and its capacity to achieve legally binding objectives for climate and biodiversity.

Results: natural scientific background

Soils, carbon, and EU soil status

Intact ecosystems play a significant role in safeguarding the climate. To reach the climate objectives mandated by the PA, a mixture of intact forests, floodplains, soil, peatlands, oceans, water bodies, and natural green spaces in both urban and rural areas is essential. At present, land sinks capture almost one-third of global emissions and are closely followed by oceans, which capture a quarter of these emissions [43]. The majority of terrestrial organic carbon is held in soils. Soil carbon consists of two primary components: inorganic carbon originating from the parent material of the soil and organic carbon resulting from biological sources such as plant and animal materials [44]. CO_2 cycles naturally between the atmosphere and soil. Plants sequester atmospheric CO_2 through the process of photosynthesis, subsequently storing carbon within the soil via their roots and residual plant matter. Alternatively, organic fertilisation can supply CO_2 to the soil. In turn, microbial decomposition releases soil-bound organic carbon back into the atmosphere in the form of CO_2. Thus, this process exhibits a degree of reversibility.

A fraction of the carbon contained within the soil remains resilient against decomposition. Typically, the topsoil boasts the highest organic matter content, while the subsoil exhibits comparatively lower levels. This variance in organic matter, which contains carbon, manifests not only across distinct soil types, but also within various soil horizons and is subject to seasonal fluctuations. Overall, the quantity of carbon sequestered within the soil is intricately shaped by a constellation of factors, including climate conditions, vegetation cover, agricultural or land management practices, soil composition, and groundwater levels [45, 46].

If the carbon stock of soil is increased, atmospheric CO_2 is sequestered. However, carbon sequestration is constrained by sink saturation dynamics [47, 48]. Furthermore, environmental conditions, including climate and nutrient availability, can impact the potential for soil organic carbon sequestration. When soils are below their sequestration potential, increasing soil organic carbon is most effective in the early treatment phase, but its

effectiveness diminishes until reaching a new steady state [49–51]. Concerning soil carbon sequestration potential in EU countries, the majority of soils in the EU are currently below their potential carbon stock. Approximately half of all soils in the EU have an unhealthy soil organic carbon stock, which is well below the maximum potential carbon stock [44, 52]. It follows that there is, in principle, a substantial carbon sequestration potential in EU soil that remains underutilised due to declining soil health.

Currently, wetlands, croplands, and grasslands in the EU are a net carbon source, while forests are a net carbon sink (emissions from cropland and grassland in the EU discussed here do not include direct and indirect nitrous oxide (N_2O) emissions from managed soil). According to the EU's National Inventory Report to the United Nations Framework Convention on Climate Change (UNFCCC) [53], EU forest land was a net sink of 292,922 kilotons (kt) of CO_2 in 2020. However, harvest rates and ageing forests have caused these forest sinks to decrease since 1990 [53]. The conversion of grassland and cropland into forest land represents a significant carbon sink, accounting for 11% of the total forest carbon sink while covering only 4% of the forest area. In contrast, wetlands covering diverse surface areas across member states—including lakes, reservoirs, riverbeds, and peatlands—act as a source of carbon emissions. In 2020, wetlands emitted 9,314 kt of CO_2. The member states with productive peatland management report the highest emissions, where peat extraction serves as the primary contributor to said emissions [53]. Besides wetlands, cropland in the EU and in the United Kingdom (UK) emitted 11,230 kt CO_2 and remains a net source, although emissions decreased by 64% between 1990 and 2020. While some countries, including France, Romania, and Spain, are already reporting net CO_2 removals, others continue to emit significant net CO_2 emissions, notably the UK, Germany, and Finland [53]. Similarly, grasslands in the EU (plus the UK) remain a significant source of carbon, with Germany accounting for 60% and Ireland approximately 16% of these emissions. This fact may seem counterintuitive, especially considering that grasslands are considered net carbon sinks on a global scale [54]. However, at the European scale, the intensive management practices employed on grasslands, coupled with the high livestock density per hectare, have led to their transition into net carbon sources [55]. Nevertheless, as with croplands, emissions have decreased since 1990 [53].

For the LULUCF sector as a whole, net CO_2 removals have increased between 1990 and 2020. However, in recent years, this positive trend has been reversing, with a decline of 3% between 2019 and 2020 primarily driven by the forestry sector [53]. Overall, preserving current soil carbon stocks is critical to halting this trend and enhancing carbon storage in soils. Thus, achieving a net carbon sink in agricultural soils and wetlands across the EU, while simultaneously restoring and protecting ecosystems like forests and peatlands, will require significant efforts.

Carbon mitigation and management on land

The potential role of various carbon farming practices in mitigating climate change by sequestering CO_2 appears significant, although projections may be somewhat overestimated. Moreover, the diversity of carbon farming measures available likewise have substantially different mitigation effects [56]. The IPCC provides an estimation of the mitigation potential of land management measures, which includes both emission reductions and enhanced CO_2 sequestration [43]. The 2022 report estimates that ecosystem protection (including forests, peatlands, wetlands, and grasslands) has the potential to mitigate 6.2 (2.8–24.4) gigatonnes of CO_2 equivalents per year (Gt CO_2eq yr^{-1}). In contrast, the potential for ecosystem restoration is estimated to be lower at 5 (1.1–12.3) Gt CO_2eq yr^{-1}. In this context, it is crucial to emphasise the significant potential of peatland conservation in mitigating different environmental problems due to its relatively small land demand. Peatlands cover only 3% of the world's land mass, yet they could potentially mitigate 0.86 (0.43–2.02) Gt CO_2-eq yr^{-1} [42, 57]. Agricultural CO_2 sequestration (soil carbon management in croplands and grasslands, agroforestry, and biochar) is estimated at 9.5 (1.1–25.3) Gt CO_2eq yr^{-1}. However, if nations were to implement a standardised carbon pricing system, the potential for reducing greenhouse gas emissions in agriculture would decrease significantly due to its perceived lower "economic potential". Furthermore, the carbon storage potential is frequently overestimated. Previous research indicates that carbon models do not adequately represent the complexity and sensitivity of forest ecosystems, leading to limitations in their accuracy for predicting carbon storage potential [27].

Assuming a carbon price of 100 US Dollars (USD) per tonne of CO_2eq^{-1}, agricultural CO_2 sequestration has a cost-effective mitigation potential of 3.4 (1.4–5.5) Gt CO_2eq^{-1} [57–59]. In its 2021 report, the IPCC differentiates between grassland and cropland mitigation potential and finds broadly similar potentials. Soil carbon management in croplands is estimated to sequester 1.4–2.3 Gt CO_2eq yr^{-1} (full literature range: 0.3–6.8 Gt CO_2eq yr^{-1}). The mitigation potential for soil organic carbon management in grasslands is estimated at 1.4–1.8 Gt CO_2eq yr^{-1} (full literature range: 0.1–2.6 Gt CO_2eq yr^{-1}) [43]. To put these numbers into context, global fossil fuel emissions reached 36.3 ± 1.8 Gt CO_2 yr^{-1} and land-use change emissions reached 3.9 ± 2.6 Gt CO_2 yr^{-1} in 2021 [60].

Thus, the annual cost-effective global mitigation potential of agricultural CO_2 sequestration could cover about 9% of current global fossil fuel emissions. However, it is important to note again that modelling results are unable to fully capture the complexity of the underlying processes, which limits their significance [27, 42]. Overall, it appears that protective measures have the greatest potential for climate mitigation. Additionally, relying solely on soil management for biophysical mitigation potential may not provide a realistic understanding of feasible rates for carbon sequestration. Furthermore, the uncertainties associated with these processes, as reflected in the large literature ranges, are of immense magnitude [27].

For the EU, carbon sequestration measures are expected to have a high cost-effective mitigation potential [58]. In this context, we focus on agricultural management measures. According to Zomer et al. [61], croplands in Europe have an overall sequestration potential of 110–230 megatonnes (Mt) CO_2 yr^{-1} over a 20-year period. A closer look at different carbon sequestration measures reveals that these measures achieve very different effects. For example, modelling results show that, generally, measures that protect ecosystems achieve the highest mitigation potentials (see above and [58]). In the agricultural sector, the conversion from arable land to grassland appears to be a measure with a high carbon sequestration potential—although effects vary regionally [62–64]. This high sequestration rate is due to carbon accumulation through photosynthesis by perennial vegetation, increased litter input, and no-tillage [45, 50, 65]. Although all grasslands in the EU act as net CO_2 sources (see above), converted grasslands are net CO_2 sinks, sequestering 25,375 kt CO_2. On 17% of the total grassland area, these areas offset about 70% of the emissions from perennial grasslands [53]. Vice versa, the conversion of grasslands into croplands results in significant CO_2 emissions. For example, the conversion of 5% of grassland areas is projected to release 300 Mt CO_2eq over 50 years [63].

Another example of soil carbon sequestration management is conservation tillage [66]. If applied to the entire cropland area in the EU, this technique is estimated to achieve between 0.23 t CO_2 ha^{-1} and 0.38 t CO_2 ha^{-1}, excluding methane (CH_4) and N_2O emissions. When factoring in a carbon price, findings demonstrate that through 2050, EU cropland could sequester between 9 Mt CO_2 yr^{-1} (USD 10 tCO_2^{-1}) and 38 Mt CO_2 yr^{-1} (USD 100 t CO_2^{-1}) due to declining cropland areas and emission factors, including changes in tillage management [67]. An additional carbon farming method involves planting cover crops. Lugato and colleagues [68] modelled the potential for mitigating emissions by incorporating cover crops into the crop rotation in the EU. They concluded that by 2050, there could be an average cumulative reduction of emissions (CO_2 and N_2O) up to 12.4 t CO_2eq ha^{-1}. In the short term, a combination of different soil management measures on 12% of EU agricultural land is estimated to sequester 101 Mt CO_2 yr^{-1} [63].

This brief literature review highlights that the impacts of various carbon sequestration methods are highly variable. The efficacy of these methods in capturing CO_2 relies on multiple factors, such as local and regional conditions, past management practices, and seasonality. As a result, estimating the carbon sequestration potential of carbon farming practices remains a challenging task.

Climate change is another factor that is expected to impact carbon sequestration and soil carbon management. On the one hand, a warming climate will promote heterotrophic respiration and result in soil carbon losses. On the other hand, climate change will also contribute to soil carbon accumulation through enhanced biomass production and litter input ("CO_2 fertilisation") [45]. If the carbon gains exceed the carbon losses, climate change will result in a net soil carbon gain, and vice versa. From 2012 to 2021, the global land sink has decreased due to warming, but there are regional differences. For instance, in South-Eastern Europe, reduced rainfall had a greater impact than the positive effects of CO_2 fertilisation—making it one of six adversely affected regions [60].

Adopting a future perspective, global soil carbon stocks are expected to experience a net loss in the coming decades. According to Crowther and colleagues [69], climate-induced soil carbon losses vary depending on the initial carbon stock and across regions. Soil carbon stocks in Arctic and Subarctic regions, including in Northern Europe, are anticipated to bear the brunt of global carbon losses. Overall, assuming a 2 °C global temperature increase by 2050, global upper soil horizons (top 10 cm) are expected to lose 55 ± 50 Gt of carbon globally. Focussing on the EU only, Smith and colleagues [70] likewise found that rising temperatures will increase the decomposition of cropland and grassland, leading to a decrease in carbon stocks. However, technological enhancements and CO_2 fertilisation will result in a significant increase in net primary production, substantially offsetting these carbon losses. When further incorporating land-use changes though, under most scenarios, croplands and grasslands show overall soil carbon losses of 39– 54% and 20–44%, respectively, by 2080. In contrast, a more recent study found an overall soil carbon increase in EU agricultural soils under different climate and land-cover developments. Soil carbon will increase by 7–13 Gt of carbon by 2050, with some regions experiencing soil carbon losses [71]. Similarly, Lugato and Panagos [72] anticipate an increase in soil carbon levels throughout

Europe. Specifically, they project an increase from 17.63 Gt to roughly 18 Gt of carbon by the year 2080. However, regional variations exist, with around 30% of the region experiencing a net loss of carbon. Therefore, due to the research design and inclusion of various variables along with significant uncertainties, the effects of climate change on soil carbon-stock development differ considerably, thereby magnifying the difficulties of establishing a common carbon market.

Agricultural carbon sequestration as a mitigation measure—different perspectives

While there is widespread consensus regarding the substantial negative emissions achieved through forestry and peatland measures [57], the extent to which carbon sequestration of agricultural soil can contribute to climate change mitigation is subject to debate. Some researchers [61] suggest that adopting soil carbon-enriching measures offers a significant opportunity to mitigate emissions from the land-use sector and contribute to global climate mitigation. Their findings indicate that implementing corresponding measures could lead to global cropland sequestering 0.90–1.85 Gt CO_2 per year at a depth of up to 30 cm. However, the study does not factor in sink saturation dynamics and other soil and climate processes. To put this number into perspective, global land-use change is estimated to have caused 37 Gt of carbon losses in the upper 30 cm of soil globally [73]. Other researchers emphasise the vast size of soil carbon stocks for their argument. Accordingly, even small changes in the large soil pool through carbon sequestration measures can significantly impact the climate [74].

Researchers who highlight the limited mitigation potential of carbon sequestration argue that only a small portion of emissions can be offset through soil carbon sequestration. For example, Sommer and Bossio [48] find a "limited" mitigation potential and emphasise that carbon sequestration is subject to sink saturation dynamics. Their study estimated the carbon sequestration potential of global agricultural land by 2100. To that end, an optimistic and a pessimistic scenario based on the adoption of soil organic carbon sequestration measures were developed. The results indicate that agricultural land could mitigate a maximum of 8.9% of global emissions in 2023–2033 under the optimistic scenario and a maximum of 4.3% of global emissions under the pessimistic scenario. These values decrease to 1.9% and 3.9%, respectively, after 87 years (see also [75]).

Another study estimates that adopting a carbon price on soil organic carbon could have a positive impact on the mitigation potential of cropland in the EU. Depending on the carbon price, cropland could potentially remove up to 7% of agricultural GHG emissions by adopting conservation tillage on 100% of the EU area. According to the study, a carbon price of USD 100 per tonne of CO_2 would yield this result [67]. The researchers estimate that carbon leakage effects may cause a reduction in CO_2 removals due to emission relocation to third countries to some extent. The authors thus conclude that "carbon sequestration on managed cropland will likely not contribute substantially in climate change mitigation" [67]. Likewise, other scientists found that the mitigation potential of terrestrial carbon sequestration is "small". The study estimates carbon stock developments in the EU under different climate change and land-use scenarios without mitigation measures. Results show that about 3.1–6.9% of the EU's total fossil fuel emissions could be removed between 1990 and 2100 [76].

The previous critical analysis of recent literature suggests that the role of carbon sequestration in mitigating climate change is uncertain and subject to debate. However, it is certain that reducing emissions in all sectors is the most effective way to address climate change [30]. Because the agriculture, forestry, and land-use sectors cannot fully compensate for the mitigation shortfalls of other sectors, offsetting residual emissions is a secondary and complementary measure, achieved through methods such as forest conservation, peatland restoration, and engineered removals (see also [5, 57]).

Results: the Commission's proposal for a regulation on a certification framework for carbon removals

The CRCF, released in November 2022, aims to facilitate the deployment of voluntary carbon removals by laying down (1) EU-wide quality criteria for carbon removal activities; (2) rules for verification and certification of carbon removals; and (3) rules for the functioning and recognition by the Commission of certification schemes (Article 1 para. 1 CRCF). The proposal does not aim to establish a central certification body for carbon removal, but rather to establish EU governance for the correct application and enforcement of a reliable and harmonised EU quality framework by establishing rules for operators, certification bodies, member states and the Commission for carbon removal activities. It should also be noted that the CRCF does not include specific accounting methods, but rather lays the groundwork for the adoption of such EU rules at a later stage.

The CRCF interacts with multiple existing EU policies. The overarching legal framework for CO_2 storage and the possibility of crediting in the EU ETS is established by the Carbon Capture and Storage (CCS) Directive 2009/31/EC [77] and the EU ETS Directive 2003/87/EC [78]. The proposed certification framework is in line with the rules laid down in these directives, e.g., with regard to the quantification of carbon removals for industrial

activities such as BECCS and DACCS. Regarding carbon farming and carbon storage products, the proposal builds on the LULUCF Regulation (EU) 2018/841 [79], which provides a blueprint for monitoring and reporting of carbon removal activities. In detail, data gathered by operators or operator groups of carbon farming activities have to be compatible with national GHG inventories. The blueprint is based on the IPCC's guidelines and encourages land-use monitoring at low cost through digital databases, geographic information systems (GIS), and remote sensing, including Copernicus Sentinel satellites and services [10]. Moreover, the proposal adopts sustainability standards for bioenergy outlined in the Renewable Energy Directive (EU) 2018/2001 [80], while also linking to the Good Agricultural and Environmental Conditions provided by the Common Agricultural Policy (CAP), specifically those related to the preservation of grassland and peatland [10]. Besides, policy initiatives of the EU Green Deal, such as the Farm to Fork Strategy, interact with the Certification Proposal [81]. For an overview of incorporated policy objectives and initiatives for carbon removals, see Fig. 2.

All carbon removals meeting the quality and verification criteria outlined in the Certification Proposal are eligible for certification (Article 3 CRCF). However, it should be noted that emissions falling under the scope of the EU ETS Directive 2003/87/EC are not included in the scope of the CRCF, as indicated in Article 1 para. 2 CRCF. One notable exemption from this exclusion is the storage of CO_2 from sustainable biomass that is zero-rated, i.e. carbon neutral in accordance with Annex IV EU ETS Directive.

Besides procedural provisions, key elements of the proposed regulation include rules on carbon removal quality. The proposal establishes quality criteria and assigns responsibility for the certification schemes to the Commission to guarantee the quality of carbon removals and a robust and harmonised certification process. Concretely, Articles 4 to 7 CRCF lay down "QU.A.L.ITY criteria" for quantification, additionality and baselines, long-term storage, and sustainability. Carbon removal activities have to provide a net carbon benefit, i.e. the carbon removals under the baseline minus the total carbon removal of the carbon removal activity minus the GHG

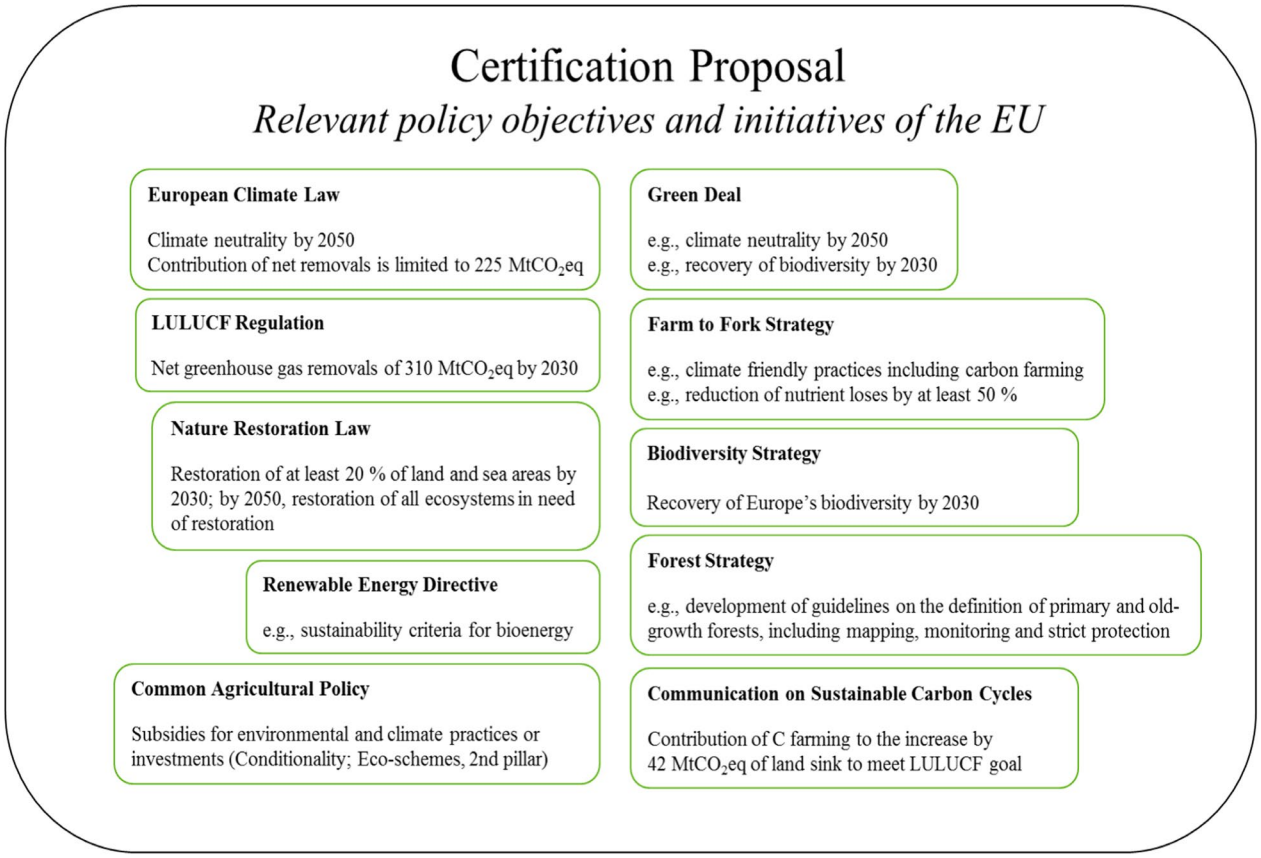

Fig. 2 Examples of policy objectives and initiatives that touch upon the CRCF

increase caused by the carbon removal activity have to be higher than zero (Article 4 CRCF):

Carbon removals under the baseline	
Total carbon removal of carbon removal activity	
GHG increase caused by removal activity	
Net carbon removal benefit	> 0

The baseline assesses carbon fluxes without a given carbon farming measure. Baselines can be modelled; a reference scenario serves as a counterfactual to a scenario that estimates a project's ex-ante GHG impact [82]. Alternatively, carbon credits may be granted based on the difference between the initial carbon stock, determined via on-site measurement, and modelled carbon stock development without carbon payment (e.g., the forest scheme in the US) [83]. The CRCF, however, does not provide any further details on baseline determination and instead only offers general guidelines (see Table 1).

In general, carbon removals, expressed in tonnes of CO_2eq, have to be quantified in a relevant, accurate, complete, consistent, comparable, and transparent manner. Table 1 summarises the quality criteria for carbon removal activities.

An essential aspect of the evaluation of the CRCF is the certification methodology. However, the current proposal is not intended to contain detailed provisions on methodologies, but rather to provide the cornerstones for the certification methodology to be adopted in the future. To this end, the proposal empowers the Commission to adopt delegated acts to establish the technical certification methodologies for activities related to permanent carbon storage, carbon farming, and carbon storage in products (Articles 8, 15, and 16 CRCF). Furthermore, the Commission is allowed to adopt various implementing acts concerning the certification schemes and reporting (Articles 9, 11, 12, 13, and 14 CRCF).

According to Article 8 para. 3 CRCF, the Commission shall take into account the following criteria when preparing the delegated acts: (a) ensuring the robustness of carbon removals and recognising the protection and restoration of ecosystems; (b) minimising the administrative burden for (small-scale) operators; (c) complying with relevant EU and domestic laws; and (d) recognising relevant EU and international certification methodologies and standards. Besides, Annex I to the CRCF provides the minimum elements for the certification methodologies established by the delegated acts (see Table 2).

Table 1 Quality criteria for carbon removal activities

Quantification (Article 4 CRCF)
• For baseline setting, operators shall refer to the standard carbon removal performance of comparable activities under similar social, economic, environmental, and technological conditions, taking into account the geographical context • Derogation may be justified in single cases • The baseline is updated periodically (no further details on period length) • Statistical approaches have to be used to account for uncertainties in carbon removal quantification
Additionality (Article 5 CRCF)
• Carbon removal activity has to be additional, i.e. it goes beyond EU and national statutory requirements and is incentivised by the certification • Additionality is automatically considered to be complied with if the baseline is established according to the standard carbon removal performance of comparable activities in similar social, economic, environmental, and technological circumstances, taking into account the geographical context (pursuant to Article 4 para. 5) • Otherwise, if the baseline is based on individual carbon removal performance (pursuant to Article 4 para. 6, additionality has to be demonstrated through specific tests
Long-term storage (Article 6 CRCF)
• Operators or operator groups have to demonstrate that carbon removal activity aims at ensuring long-term carbon storage • To this end, they have to monitor and mitigate any release risk of stored carbon occurring during the monitoring period, while being subject to appropriate liability mechanisms to address any release of carbon during this period • For carbon farming and carbon storage in products, stored carbon by a carbon removal activity is considered to be released at the end of the monitoring period
Sustainability (Article 7 CRCF)
• Carbon removal activity has to have a neutral or positive impact on • Climate change mitigation (beyond the net carbon removal benefit); • Climate change adaption; • Sustainable use and protection of water and marine resources; • Transition to circular economy; • Pollution prevention and control: • Protection and restoration of biodiversity and ecosystems • Minimum sustainability requirements according to certification methodologies of the delegated acts are to be complied with • Certification methodologies have to incentivise co-benefits

Table 2 Minimum elements of the certification methodologies

Annex I to the CRCF—minimum elements of the certification methodologies
Description of the covered carbon removal activity, including its monitoring period
Rules for identifying all carbon removal sinks and GHG emission sources referred to in Article 4 para. 1 CRCF
Rules for calculating the carbon removals under the baseline referred to in Article 4 para. 1 lit. a CRCF
Rules for calculating the total carbon removals referred to in Article 4 para. 1 lit. b CRCF
Rules for calculating the increase in direct and indirect GHG emissions referred to in Article 4 para. 1 lit. c CRCF
Rules to address uncertainties in the quantification of carbon removals referred to in Article 4 para. 8 CRCF
Rules to carry out the specific additionality tests referred to in Article 5 para. 2 CRCF
Rules on monitoring and mitigating any release risk of the stored carbon referred to in Article 6 para. 2 lit. a CRCF
Rules on appropriate liability mechanisms referred to in Article 6 para. 2 lit. b CRCF
Rules on the minimum sustainability requirements referred to in Article 7 para. 2 CRCF
Rules on the monitoring and reporting of co-benefits referred to in Article 7 para. 3 CRCF

Article 9 CRCF describes the procedure for applying for a certification of compliance with the proposed regulation. In the first step, an operator or a group of operators submits an application to a certification scheme, which is the organisational unit managed by a private or public organisation overseeing the certification of compliance of operators. Upon acceptance, in the second step, a comprehensive description of the carbon removal activity has to be submitted to an independent, accredited, or recognised certification body (Article 10 CRCF). The certification body acts by appointment of the certification scheme but is institutionally separate from the certification scheme. In the third step, the certification body conducts a certification audit, the final result of which is a certification audit report that includes a summary and a certification containing, at a minimum, the information set out in Annex II (see Table 3). This Annex might be amended by the delegated acts of the Commission (Article 15 CRCF). A certification scheme managed by a private or public organisation controls the certification audit report and the certificate, which are both made publicly available in a registry.

To reconfirm compliance with the carbon removal activity, Article 9 para. 3 CRCF requires the certification body to carry out periodic re-certification audits (without giving details on the period). Operators and operator groups are obliged to support the certification bodies during certification and re-certification by giving access

Table 3 Minimum information included in the certificate

Annex II to the CRCF—minimum information included in the certificate
Name and type of the carbon removal activity, including the name and contact details of the operator or group of operators
The location of the carbon removal activity, including the geographically explicit location of the activity boundaries, respecting 1:5000 mapping scale requirements for the given member state
Start date and end date of the carbon removal activity
Name of the certification scheme
Name and address of the certification body and logo
(Unique) certificate number or code
Place and date of issuance of the certificate
Reference to the applicable certification methodology referred to in Article 8 CRCF
Net carbon removal benefit referred to in Article 4 para. 1 CRCF
Carbon removals under the baseline referred to in Article 4 para. 1 lit. a CRCF
Total carbon removals referred to in Article 4 para. 1 lit. b CRCF
Increase in direct and indirect GHG emissions referred to in Article 4 para. 1 lit. c CRCF
Breakdown by gases, sources, carbon sinks and stocks with regard to the information referred to in points (j), (k) and (l) of this Annex
Duration of the monitoring period of the carbon removal activity
Any sustainability co-benefits referred to in Article 7 para. 3 CRCF
Reference to any other carbon removal certification

to the activity premises, relevant data, and documentation (Article 9 para. 4 CRCF). To set out the structure, format, and technical details of the description of the carbon removal activity as well as of the certification and re-certification audit reports, the Commission may adopt implementing acts (Article 9 para. 5 CRCF).

Article 10 CRCF provides rules on certification bodies appointed by certification schemes. Competent certification bodies should be accredited by a national accreditation authority pursuant to Regulation (EC) 765/2008. Certification bodies must be independent of operators and operator groups. This means that they should not own or be owned by operators or operator groups, nor have any relation with them that could influence their independence or impartiality. According to Article 10 para. 4 CRCF, member states shall supervise the operation of certification bodies.

According to Article 11 CRCF, certification schemes demonstrate an operator's compliance with the proposed CRCF. Certification schemes have to operate on the basis of reliable and transparent rules and procedures. In particular, these schemes verify whether the information and data submitted by the operators or operator groups were subject to independent auditing, and certification were carried out accurately, reliably, and cost-effectively. Besides, certification schemes are required to publish a list of the appointed certification bodies and establish and maintain a publicly accessible information registry on the certification process, the certificates and their updates, and the certified carbon removal quantity (Article 11 para. 4 and Article 12 para. 1 CRCF). To establish structure, format, technical and procedural details for all certification schemes as well as the public registries, the Commission has to adopt implementing acts (Article 11 para. 5 and Article 12 para. 2 CRCF). In general, certification schemes need to be recognised by the Commission through a decision. This decision demonstrates that the certification scheme in question complies with the proposed CRCF. Member states can raise concerns regarding the accordance of the certification schemes with the standards and rules set out in the implementing acts. The Commission is then required to investigate the matter and take appropriate action, including repealing its decision (Article 13 CRCF). For the Commission's notification and recognition process and for reporting requirements, the Commission may adopt implementing acts, too. Report requirements include an annual report on the operation of the certification system, cases of fraud, and corrective measures. (Article 14 CRCF).

As a whole, the proposed regulation shall be reviewed, taking into account relevant developments in Union and international law, technological and scientific progress, and market developments in the field of carbon removals and EU food security. The Commission shall report to the Parliament and the Council on the implementation of the Regulation three years after entry into force and not later than by the end of 2028 (Article 18 CRCF).

After examining the contents of the draft legislation, it becomes clear that the Certification Proposal contains only basic information for the idea of certifying carbon removals in the EU. The fact that crucial details, especially on methodology, are to be specified in the delegated acts and implementing acts does not allow for a final assessment. Further specification of the legislation, however, will not be able to address some fundamental shortcomings, such as the definition of carbon removal activities or the lack of restrictions on the use of removal units. These are addressed in the following section.

Discussion and critical assessment

As the current proposed regulation lacks legal precision in several key provisions, it is expected to undergo substantial changes with respect to the eligibility and certification process for carbon removal activities. The 2024 provisional political agreement already differs in some important respects. However, beyond the need for more precise legal language in the CRCF, there are a number of overarching issues that, if left unaddressed, could ultimately undermine the environmental integrity of the EU's carbon removal policy, and make the proposal incompatible with the binding international targets set by the PA and CBD. We will discuss these issues below and discuss their implications for EU carbon removal and climate policy, while also highlighting potential co-benefits of the proposed certification scheme with other EU environmental policies. It should also be noted that while the CRCF envisages a wide range of use cases, most of the arguments presented below relate to the use of carbon removal units in offset markets.

Priority of emission reductions

First, the legal priority of emission reductions over GHG removal activities—which is mandated under EU and international law [3, 20, 30, 84]—is not reflected in the proposal's language. Pursuant to Article 2 para. 1 lit. a CRCF, carbon removal means "either the storage of atmospheric or biogenic carbon within geological carbon pools, biogenic carbon pools, long-lasting products and materials, and the marine environment, or the reduction of carbon release from a biogenic carbon pool to the atmosphere." On its surface, the definition appears similar to other established definitions of carbon removal activities, such as the definition provided by the IPCC, which refers to "anthropogenic activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products" [85].

Nonetheless, the definition in Article 2 para. 1 lit. a CRCF explicitly includes emission reduction activities, which indicates that the drafters of the proposal regard emissions reductions and carbon removals as legally equivalent mitigation measures [24, 25, 86, 87]. As emission reductions and carbon removals are opposing concepts—with the former slowing down the release of GHGs into the atmosphere and the latter removing GHGs that have already been emitted—it is unclear whether classifying these mitigation activities as equivalent measures is legally permissible.

While emission reductions and carbon removals both fall under the umbrella category of mitigation measures [84, 88], they are not legally equivalent concepts. In the normative hierarchy of the various mitigation measures, emission reductions must be given priority [1, 3, 20, 21, 84, 89]. In contrast, carbon removals are only legally permissible for use as mitigation measures after priority mitigation measures, such as emission reductions, have been exhausted to the greatest extent possible. Several sources in EU law and international law support this normative hierarchy of mitigation measures, which we will review as follows.

With respect to EU law, Article 4 para. 1 ECL states that the EU's institutions and its member states "shall prioritise swift and predictable emission reductions", whereas the enhancement of removals by natural sinks is only mentioned as a complementary measure. It follows that EU law normatively differentiates between these two approaches. The exception is the LULUCF regulation, which accounts for net CO_2 additions and losses. Moreover, Article 191 para. 2 of the Treaty on the Functioning of the European Union (TFEU) stipulates that the EU's environmental policies "shall be based on the precautionary principle", which requires that appropriate measures should be taken to avoid long-term, cumulative, or uncertain environmental damage [30, 90, 91]. In practice, adherence to the precautionary principle means that when the EU is faced with a choice between different mitigation measures under uncertain circumstances, it must give priority to those measures that are most effective in achieving the relevant mitigation objectives and cause the least environmental damage in relative terms [1, 1]. Article 191 para. 2 TFEU thus indirectly mandates that emission reductions should be prioritised over carbon removals, as they are more effective and do not result in significant adverse environmental impacts.

Furthermore, Article 191 para. 2 TFEU also enshrines the polluter pays principle, which requires that those responsible for environmental damage should bear the costs of remedying that damage. Since emission reductions can be certified as carbon removal activities and thus generate revenue for operators, land managers could be paid for avoiding emissions, even though they—as polluters—are obliged to bear the costs themselves under Article 191 para. 2 TFEU. However, subsidies frequently have a similar effect, particularly when they are provided to enhance a public good, such as biodiversity.

In addition, according to the Charter of Fundamental Rights of the European Union (CFR), EU fundamental rights law—as well as human rights in national and international law—not only underline the precautionary and polluter pays principle; human rights also require that emission reductions must be given priority [2, 3, 20, 21, 36]. The CFR includes several fundamental rights that are considered to be elementary preconditions of freedom [30]—such as the right to life (Article 2 CFR), the right to respect for physical integrity (Article 3 para. 1 CFR), and the right to property (Article 17 CFR)—which are threatened by unmitigated climate change. Any EU policy that unduly prioritises relatively ineffective secondary mitigation measures, such as some carbon removal strategies, would likely infringe against the fundamental rights of present and future generations.

International agreements—in particular the relevant treaties on climate change—likewise establish a normative hierarchy between mitigation measures. They prioritise emission reductions over carbon removals [3, 21, 84, 89, 92–94]. As both the EU and its member states are contracting parties to the UNFCCC and the PA, they are legally bound by these agreements. Article 2 UNFCCC stipulates that the UNFCCC's ultimate objective of stabilising GHG concentrations in the atmosphere "should be achieved within a timeframe sufficient to allow ecosystems to adapt naturally to climate change". Similarly, Article 2 para. 1 lit. a PA sets the legally binding target of limiting global warming to 1.5 °C. Meeting these binding targets within the stipulated timeframe requires ambitious emission reductions across all relevant sectors [1–3, 30]. Complementary strategies for achieving negative emissions are also essential, with a primary emphasis on low-risk approaches that promote biodiversity conservation, including forest management and peatland rewetting [3, 20, 21, 27].

The difference between reducing emissions and removing GHGs is further supported by numerous scientific studies that show carbon removal is an inherently weaker form of climate change mitigation [95]. Notably, removing one tonne of CO_2 from the atmosphere does not have the same effect on the climate system as emitting one tonne—assuming that net negative emissions have been achieved [96–98]. Thus, there is an inherent asymmetry in how the carbon cycle reacts to emissions and removals. This asymmetry implies "that an extra amount of CO_2 removal is required to compensate for an emission of a given magnitude to attain the same atmospheric

CO_2 concentration" [96]. In other words, to have a positive impact on the global carbon cycle, it is necessary to remove a significantly greater proportion of GHGs than originally emitted [96, 99]. Moreover, even if emissions were removed on a large scale, NETs cannot entirely offset the climate impacts of global warming, such as rising sea levels and extreme weather events [99]. This finding is further underscored by the fact that no carbon removal approach (including engineered removals such as BECCS and DACCS) can fully achieve permanent sequestration, as some physical leakage is always expected [100–103]. Thus, emission reductions will always be more effective in mitigating climate change than carbon removals.

Despite the widespread acknowledgement of the limited effectiveness of CO_2 sequestration within the overall mitigation strategy, the Commission's proposal has only cautiously recognised the complementary role of carbon removals. According to the proposal's explanatory memorandum, the CRCF intends to "support physical and legal persons that are willing to make the extra effort, beyond reducing as much as possible their GHG emission" [10]. Furthermore, the proposal states that in order to meet the Union's climate objective, it is necessary "that GHG emissions are significantly reduced, and that the unavoidable emissions and removals should be balanced within the European Union at the latest by 2050, with the aim to achieve negative emissions thereafter." The proposal, however, does not include any provisions that set conditions for carbon removals relative to emission reductions. What exactly is meant by "unavoidable emissions" is also left unclear, thereby potentially opening the door for CO_2-intensive industries to change the interpretation of this concept so that it also applies to certain activities that are in fact avoidable. In contrast to the Commission's proposal, the European Parliament and its Committee on the Environment, Public Health and Food Safety (ENVI) have recognised the need to distinguish more clearly between emission reductions and removals. The European Parliament adopted a resolution in April 2023, in which it stressed that "the impact of natural and industrial carbon removal solutions on balancing GHG emissions is limited, and should not come at the expense of ambitious climate mitigation goals, which require a substantial reduction in emissions" [104].

Although treating emission reductions and removals as equivalent measures has attracted much criticism, the provisional political agreement reached by the European Parliament and the Council of the EU in 2024 maintains this misguided approach. At the time of writing, the published statement did not include a definition of what the institutions considered to be carbon removal activities, although it emphasised that the definition was more in line with that of the IPCC (see above) [26]. However, this statement is effectively contradicted by the fact that the agreement considers emission reduction activities, in particular soil emission reductions from carbon farming activities, as eligible carbon removal activities [26]. It follows that the 2024 provisional political agreement in its current form also conflicts with the above-mentioned principles of EU and international law.

Thus, in order to avoid for the CRCF to centrally rely on a concept that is inconsistent with EU and international law, it will be necessary for the proposed regulation to provide definitions of the legal terms "carbon removal" that are consistent with the normative hierarchy described above. To this end, the CRCF should be amended accordingly and exclude any emission reduction activities. This is particularly important as the EU is seen as a standard setter for other voluntary markets and the market mechanism under Article 6 para. 4 PA [86].

Temporary vs. permanent removals

Second, the current proposal legalises and largely equalises temporary and permanent removal activities. According to Article 2 para. 1 lit. b CRCF, three types of carbon removal activities should result in permanent carbon storage: "enhancing carbon capture in a biogenic carbon pool, reducing the release of carbon from a biogenic carbon pool to the atmosphere, or storing atmospheric or biogenic carbon in long-lasting products or materials." The proposal thus treats these three approaches as equivalent and exchangeable with all GHG emissions, even though they differ significantly in terms of their mitigation potential and storage permanence. Most significantly, the process of enhancing biogenic carbon pools cannot be depicted and accounted for as accurately as engineered removal approaches that are stored in long-lived materials.

The problem of depiction refers to the fact that certain sources of emissions and removals by sinks are much more difficult to identify and monitor than others [27, 30, 42, 105]. For example, GHG emissions from fossil fuel-intensive industries are easier to quantify than emissions generated and/or removed by land-use practices. As a result, the failure to accurately depict different types of removals under a uniform regulatory approach can lead to accounting inaccuracies, for instance, when carbon removal operators claim that their land removes more CO_2 than it actually does. In the context of the CRCF, the proposal thus runs the risk of incorrectly estimating actual removals by combining many different processes under a single heading of "removals" in order to achieve climate neutrality in name only.

In addition, pursuant to Article 2 para. 1 lit. g CRCF, the use of carbon farming or other enhancements of biogenic carbon pools cannot even be considered

"permanent carbon storage", as this requires storage for "several centuries" under normal circumstances. In theory, it follows that carbon farming activities should be ineligible under the CRCF, as they typically do not result in "permanent carbon storage". However, Article 6 para. 3 CRCF allows for such removals, provided that "the carbon stored by a carbon removal activity shall be considered released to the atmosphere at the end of the monitoring period." The proposal thus aims to establish some kind of framework for temporary removal certification, thereby enabling carbon farming to contribute to removal efforts [25]. Consequently, companies relying on temporary credits generated by such removals would need to purchase the equivalent amount of removals for the subsequent monitoring period [86]. However, the CRCF does not clarify which indicators are to be used to determine the length of a given monitoring period for specific removal activities, nor does it specify how temporary credits may be generated and managed.

The Commission's proposal aims to address concerns related to temporary carbon storage by introducing the general requirement of long-term storage of all certified removals under Article 6 para. 1 CRCF. However, it should be noted that Article 6 para. 1 CRCF merely obliges carbon removal operators to "demonstrate that a carbon removal activity aims at ensuring the long-term storage of carbon." This provision does not constitute a legally binding obligation of result since operators must only "aim" to achieve such long-term storage [24]. As a result, there are technically no lower bounds for impermanent carbon removal activities, even if they only sequester the CO_2 for less than a year. Thus, the certification of extremely short-lived carbon farming measures is formally legalised under the CRCF, as long as the operators only aim to achieve some form of long-term storage.

The 2024 provisional political agreement adopted by the European Parliament and Council of the EU also aims to introduce a system for temporary carbon storage. To that end, it differentiates between four types of units: permanent carbon removals, temporary carbon storage in long-lasting products, temporary carbon storage from carbon farming, and soil emission reductions [26]. Permanent carbon removal requires storage for several centuries, and temporary carbon storage in long-lived products should last at least 35 years. In contrast, "[t]emporary carbon storage from carbon farming and soil emission reduction activities must last at least five years to be certified" [26]. However, temporary carbon storage of five or even 35 years has a significantly diminished climate mitigation benefit. This is particularly striking as the agreement indicates that there are no further restrictions on the use of temporary carbon sequestration units, thus treating them as otherwise legally equivalent to permanent removals.

Introducing a system of temporary carbon credits is also a questionable approach, as these credits have largely failed as a carbon crediting instrument under the Kyoto Protocol's Clean Development Mechanism (CDM) due to the risk of reversal of carbon pools and the subsequent need to acquire new carbon credits [106]. As there is currently no fully accurate way of accounting for temporary carbon pools—and given the difficulties of enforcing a temporary crediting system—operators should not be allowed to generate equivalent carbon removal units resulting from activities that are expected to be reversed in a few years. It is therefore essential that the option of certifying temporary carbon removals is explicitly excluded from the CRCF.

Usage of removal units

Third, the issue of not clearly delineating or excluding short-term removals is particularly salient because the Commission's proposal does not limit the use of carbon removal certificates once they are certified. In principle, there are currently three main use cases for CRCF credits: First, they could be used as contributions claims that enable buyers to formulate claims of positive environmental impacts. However, these claims could not count toward specific mitigation targets. Second, they could also be traded on voluntary carbon markets for offsetting purposes. Third, they could be used as counting towards the EU's nationally determined contribution (NDC) for removals that are not already covered by the EU ETS, the LULUCF Regulation or the Effort Sharing Regulation [24].

The second use case—the use of carbon removal units as offsets—is particularly worrying, given that the current proposal allows for the certification of temporary removal methods, such as carbon farming. As a result, a carbon removal certificate generated by temporary carbon removal approaches could be used to offset fossil fuel emissions, which persist in the atmosphere for centuries [24, 25, 86]. For instance, an energy company that emits a significant amount of CO_2 could buy removal certificates generated via temporary soil carbon removals and then ostensibly claim climate neutrality without reducing emissions. The voluntary carbon offset market is already plagued by numerous allegations of greenwashing and over-crediting [83, 107, 108], and the inclusion of temporary carbon removal methods as offsets under the CRCF would exacerbate these concerns.

At least some of the issues around greenwashing through offsets will be addressed by the EU's Empowering Consumers Directive [109], which is currently awaiting final adoption. The Directive prohibits companies

from promoting environmental claims that focus on offsetting GHG emissions for their products and services [109]. However, the current version of the Directive does not specifically define what is meant by "greenhouse gas offsetting"' leaving potential leeway for companies to circumvent the ban.

Moreover, the CRCF leaves open the door to the possibility of double claiming of emissions. A fundamental rule of carbon markets is that a credit can only be used once by one actor. The issue of double claiming contradicts this rule and "occurs when a single GHG emission reduction or removal, achieved through a mechanism issuing units, is counted more than once towards attaining mitigation pledges" [110]. The Commission's proposal does not address this issue and therefore allows carbon removal units generated through the CRCF process to be both traded on voluntary offset markets and counted towards the EU's NDCs. These removals would thus be counted twice. This is especially concerning if these units were generated by non-permanent removal methods, such as carbon farming. In a worst-case scenario, a carbon farming activity, that is reversed within less than a year and not renewed by the operator would count as equivalent to a permanent removal activity and can claimed by both the EU for its NDCs and on the voluntary carbon market. If the proposed framework were indeed to allow operators to certify temporary carbon removals, this would be difficult to reconcile with the PA's requirement for voluntary carbon markets to "achieve an overall reduction in global emissions" (Article 6 para. 4 lit. d PA). Whilst Article 6 PA does not directly apply to the Commission's proposal, it raises the question as to whether there is a valid reason for the EU's CRCF to potentially deviate from the global standards set by the PA.

Since the publication of the Commission's proposal, there have been several statements from EU institutions aimed at minimising double claiming, but at the time of writing, the issue still looms large. In November 2023, the European Parliament adopted its position on the CRCF and stated that "a certified unit shall not be used or claimed by more than one legal or natural person at any point in time" [111]. Likewise, the Council of the EU, in its position, posited that the CRCF "will be instrumental in meeting the Union climate change mitigation objectives set in international agreements and in the Union law legislation, while avoiding double counting" [112]. Although both institutions are therefore seeking to address the issue of double claiming, their 2024 provisional political agreement, does not show any attempt to operationalise this aspiration and therefore still allows for double claiming of removals in voluntary markets and under the EU's NDCs [26].

Furthermore, the absence of restrictions on using carbon removal units raises the issue of how carbon removals may relate to the current and future versions of the EU ETS. At present, Article 1 para. 2 Certification Proposal explicitly excludes the option that carbon removal units can be used on the EU ETS. Nevertheless, it is not unlikely that some more permanent carbon removal approaches, such as BECCS and DACCS, will eventually be used in some kind of emission trading scheme, as some researchers are already discussing (and advocating) [9, 113–117]. Is it therefore reasonable to assume that some carbon farming activities will at some point in the future also be taken into account in a (new) ETS scheme? The Commission is not currently considering such a policy, and with good reason. In this respect, the conclusions drawn from previous research on emissions trading schemes and forests and peatlands also apply to soils in general [3, 27, 118], with the exception of livestock farming [41]. While emission trading schemes can typically remedy several important governance problems, they are unable to adequately address the problem of depicting for peatlands, forests, and other areas of land-use governance—in the absence of easily identifiable governance units, such as fossil fuels or livestock products. In the case of carbon removals, biogenic carbon pools are inherently subject to carbon fluxes and lack such reliable governance units, thereby making them unsuitable for cap-and-trade schemes. It is therefore more appropriate to use command-and-control policies and targeted subsidy schemes for carbon farming policies, which include forest and peatland protection, in addition to emission trading for the drivers of land use.

Delegation of powers

Fourth, the delegation of powers conferred to the Commission by Article 16 para. 2 CRCF is particularly broad. According to Article 16 paras. 1 and 2 CRCF, the Commission may adopt non-legislative acts as specified by Articles 8 and 15 CRCF. Under Article 8 para. 2 CRCF, the Commission is "empowered to adopt delegated acts to establish the technical certification methodologies […] for activities related to permanent carbon storage, carbon farming and carbon storage in products." These certification methodologies should contain, at a minimum, the elements listed in Annex I—which include, but are not limited to, rules on storage duration, monitoring, and liability. Article 15 CRCF further empowers the Commission to adopt delegated acts "to amend Annex II in order to adapt the list of minimum information included in the [carbon removal] certificates." The certification proposal outlines the details of delegation powers in Article 16 paras. 3–5 CRCF. Notably, the European Parliament

or the Council may revoke the power to adopt delegated acts at any time.

It is questionable whether the delegation of powers conferred to the Commission under Article 16 para. 2 CRCF is in line with Article 290 para. 1 TFEU, as delegated acts are only allowed "to supplement or amend certain non-essential elements of the legislative act." For this reason, the "essential elements of an area shall be reserved for the legislative act and accordingly shall not be the subject of a delegation of power." The European Court of Justice (ECJ) has clarified that the essential elements of an area comprise "acts which are intended to give concrete shape to the fundamental guidelines of Community policy" (ECJ, C-240/90, R. 37). This in turn requires that "the conflicting interests at issue to be weighed up on the basis of a number of assessments" (ECJ, C-240/90, R. 65, 76). A modification of the temporal scope through the adoption of a delegated act would be likely to affect the essential elements of the legislation unless there are precise limitations [119]. Since the power to adopt delegated acts under Article 8 para. 2 CRCF concerns, inter alia, the issue of the permanence of storage, the temporal scope of the proposed regulation could be modified by delegated acts—which would be incompatible with Article 290 para. 1 TFEU [120]. In the following, we will outline how the issue of storage permanence as minimum elements of the certification methodologies under Annex I likely touches upon the "essential elements" of the legislative act. It should be noted, however, that other issues covered by the delegation of powers in the proposal, such as liability and validity of removal credits, may also have to be regulated by legislative acts [120].

The main issue regarding the delegation of powers is that the proposal leaves several ambiguities when it comes to permanent and temporary carbon storage. As highlighted above, a carbon removal activity is only eligible for certification under Article 3 lit. a in conjunction with Article 6 para. 1 CRCF if the operator "aims at ensuring the long-term storage of carbon." Irrespective of the fact that this provision is highly problematic as it does not establish an obligation of result but only one of conduct [24, 25, 86], the proposal fails to define the concept of long-term carbon storage. The definition of "carbon removal activity" under Article 2 para. 1 lit. b CRCF refers only to the objective of "permanent carbon storage" and (erroneously) stipulates that this can also be achieved via temporary removal activities, such as carbon farming. The concept of "permanent carbon storage" under Article 2 para. 1 lit. g CRCF in turn means that "under normal circumstances" carbon is stored for "several centuries". Since the proposal does not specify what is meant by "several centuries", this could theoretically mean a period of 300 to 3000 years—or even longer. It is further left unclear whether the storage of CO_2 for several centuries automatically qualifies as "long-term storage" in accordance with Article 6 para. 1 CRCF.

Article 6 para. 2 CRCF—which is intended to ensure that operators demonstrate long-term storage—fails to define the concept precisely. The provision sets out several criteria that an operator must meet in order to demonstrate long-term carbon storage. Among other things, the operator must "monitor and mitigate any risk of release of the stored carbon occurring during the monitoring period". As stated in recital 13 of the proposal, the length of the monitoring period depends "on the expected duration of the storage and the different risks of reversal associated with the given carbon removal activity". It follows that the expected length of monitoring periods will vary depending on the particular removal activity. However, it is unclear how the different concepts relate to each other. The length of a monitoring period may refer to "long-term storage of carbon" under Article 6 para. 1 CRCF or to the expected duration and the risks of reversal for the respective removal activity, as specified in recital 13 [120].

Moreover, as noted above, Article 6 para. 3 CRCF implicitly establishes the possibility of temporary carbon removals for carbon farming and carbon storage in products. Pursuant to recital 13, the certificates generated by these temporary removal activities "should be subject to an expiry date matching with the end of the relevant monitoring period." After this expiry date, it is presumed that the carbon has been fully released. Again, the proposal does not specify how monitoring periods are to be determined for temporary carbon removals. This is not surprising, given the difficulties in accurately depicting carbon fluxes from natural carbon sinks (see above). However, in its current form, the proposal gives the Commission too much leeway in determining the duration of temporary removals. This could lead to a situation where carbon farming activities are potentially overestimated but still counted as an equivalent carbon removal unit.

In sum, the uncertainties regarding the storage length required for a carbon removal activity to be eligible for certification under Article 6 CRCF substantially modify the temporal scope of the proposal. As this concerns the essential elements of the legislative act, the delegation of powers under Article 16 para. 2 CRCF is likely incompatible with Article 290 para. 1 TFEU [120, 121]. It follows that legislative acts are necessary to address the issues raised above. In this respect, it is not sufficient to require the Commission to consult the Expert Group on Carbon Removals before adopting a delegated act on methodologies, as proposed by ENVI [104]. Moreover, the objection rules provided in Article 16 para. 5 CRCF, which allow

the European Parliament or the Council to object to delegated acts within two months, are also not suitable to remedy the infringement of Article 290 para. 1 TFEU either [121].

Shifting effects

Fifth, the proposal will likely cause shifting effects, and it lacks effective measures to prevent such outcomes. Research has shown that, in addition to accounting difficulties, carbon certification schemes are prone to cause shifting effects [16, 122–124]. These effects occur when a government attempts to regulate a particular behaviour and, as a result, relevant actors shift their use of resources to countries/regions with less stringent environmental rules [30]. Consequently, while one location improves due to the shift, adverse environmental effects are caused in other locations [125], although there may also be some positive technological spillover effects [126]. In the context of carbon farming, shifting effects often occur when a carbon farming practice reduces the yield in a country or region (while at the same time increasing the rate of carbon removal). This may lead to agricultural intensification or land-use change in another country or region, thereby causing increased GHG emissions and biodiversity degradation (also known as "negative spillovers" or "carbon leakage") [127–131]. In contrast, carbon farming activities show co-benefits to nutrient management (see below). However, the introduction of carbon farming activities supported by a certification scheme may not always provide a net carbon benefit—regardless of whether agricultural output remains constant or declines. In any case, if the Commission's proposed certification framework were to incentivise shifting effects, thereby inducing an increase in GHG emissions and biodiversity degradation, this would likely be incompatible with the objectives of the PA and the CBD. While such a carbon leakage scenario is most pronounced in the case where carbon credits under the CRCF are used as offsets in compliance markets, the current lack of restrictions on the potential use of carbon credits in such markets (see above) underscores the importance of the issue.

Although the proposal by the Commission requires accounting for emissions resulting from shifting effects, it is uncertain whether these regulations will prove effective. Article 4 para. 1 CRCF establishes the formula for quantifying the respective carbon removal activity, which should result in a net carbon benefit. This is done by establishing a carbon removal baseline and subtracting the total carbon removals of the activity and the supply chain emissions associated with the removal approach, as mentioned earlier. These GHG emissions "which are due to the implementation of carbon removal activity" also include emissions caused by carbon leakage, i.e. shifting effects. Recital 9 of the Commission's proposal underscores this notion by stating that "[i]n the case of carbon farming, the carbon captured by an afforestation activity or the carbon kept in the ground by a peatland rewetting activity should outweigh the emissions from the machinery used to carry out the carbon removal activity or the indirect land-use change emissions that can be caused by carbon leakage."

As a result, by fully considering the emissions resulting from the effects of potential shifting effects, carbon leakage could theoretically be avoided. For instance, if the GHG emissions related to the shifting effects are accurately estimated, it is doubtful that a hypothetical carbon farming activity would be eligible under Article 4 para. 1 CRCF due to the lack of a net carbon benefit. The operator would therefore refrain from engaging in carbon farming, thereby reducing the likelihood of a shifting effect occurring in the first place. In practice, however, this is unlikely to happen for two reasons. Firstly, the precise GHG emissions caused by shifting effects are difficult to depict (see above), as they typically occur in multiple locations and not simultaneously. Secondly, neither the EU nor the intended certification bodies have an incentive to accurately account for all emissions that are "due to the implementation of carbon removal activity". The accurate depiction and quantification of emissions caused by shifting effects might potentially render carbon farming activities far less attractive to operators, potentially undermining the objective of the proposal. This example illustrates that a certification scheme that is limited to a specific jurisdiction will always be vulnerable to shifting effects [28, 30, 124]. Nevertheless, to counteract these negative effects, policy instruments at the EU level appear to be more effective than those at the national or regional level, which is indeed the approach taken in the Commission's proposal. Furthermore, while the CRCF, as currently proposed, will only apply to disposal activities taking place in the EU, the 2024 provisional political agreement has mandated the Commission to at least reconsider the possibility of storage in neighbouring third countries [26], thereby alleviating some of the concerns related to shifting effects.

Alignment with the CAP

Sixth, the CRCF contains elements that are not seamlessly aligned with the EU's CAP framework. Under the Commission's proposal, carbon farming certificates reward land managers for removing carbon from the atmosphere or reducing the release of CO_2 into the atmosphere. As stated in recital 16, the CRCF considers sources of both private and public funding, which would also include the CAP, to compensate farmers for carbon removal efforts. In this context, the proposal aims to take

into account carbon farming practices which are listed in the Commission's Communication on Sustainable Carbon Cycles:

- Afforestation and reforestation;
- Agroforestry and other forms of mixed farming combining woody vegetation with crop and/or animal production systems on the same land;
- Use of catch crops, cover crops, conservation tillage and increasing landscape features;
- Conversion of cropland to fallow or of set-aside areas to permanent grassland; and
- Restoration of peatlands and wetlands [7].

Several of these practices are mandatory requirements for CAP income support, including conservation tillage, use of cover crops, having land lying fallow, and protection of wetlands and peatlands (Annex III Regulation (EU) 2021/2115). It is questionable why these practices should be eligible for remuneration under a certification scheme when they are currently treated as mandatory requirements for CAP income support. While the combination of CAP subsidies and the advantages of carbon farming certification may be crucial in driving significant shifts towards sustainable farming practices in some cases, concerns about deadweight effects are pertinent—especially in offset market settings. Recent evidence suggests that a carbon certification system that certifies units used for offsets will primarily benefit farmers who have already adopted environmentally beneficial practices [132]. This raises concerns about the ability of the CRCF to ensure additionality in this particular context.

In order to ensure that a carbon removal activity is additional, a clear distinction between CAP requirements and carbon farming measures is needed [25, 86, 121]. According to Article 5 para. 1 CRCF, a removal activity can only be considered additional if it meets the following two criteria: "(a) it goes beyond Union and national statutory requirements; (b) it takes place due to the incentive effect of the certification." As the rules on CAP income support are EU requirements, the activity in question would not be considered additional and therefore could not be certified under the proposed regulation. This could result in less stringent environmental standards for the 2024–2027 CAP period, as policymakers may intend to ensure that carbon removal activities remain eligible under the certification scheme [86]. Furthermore, several assessments of the CAP have found that the CAP's mandatory requirements have so far failed to achieve positive environmental outcomes [133–136]. Hence, clarifications and potential revisions of the mandatory requirements and/or the proposal are needed to differentiate between the mandatory requirements and "certificate-worthy" practices, thereby ensuring that environmental effects, i.e. carbon sequestration and humus accumulation, are actually achieved. Additionally, it is still crucial to prevent the potential for double-funding of carbon farming measures, such as afforestation and agroforestry, which are currently eligible for support under CAP eco-schemes and second pillar programs [16, 122].

Co-benefits of carbon farming, nature restoration and soil health

Although the problems outlined above indicate that attempts to link carbon farming and carbon certification schemes are fraught with difficulties, the importance of this approach—especially for biodiversity—should not be underestimated. Carbon farming has been shown to have many synergies with nature restoration and biodiversity conservation, if managed appropriately [137–140]. Indeed, the CRCF is closely linked to the EU's newly adopted Nature Restoration Law, which aims to protect 20% of the EU's land and sea areas through restoration measures by 2030 [141]. To achieve this, the stock of organic carbon in forest ecosystems and agricultural soil, including drained peatlands, should be increased. This will be reinforced by carbon farming activities. The same is true for the EU Forest Strategy, which aims to preserve biodiversity and increase removals through natural sinks [142]. Hence, the CRCF and the Nature Restoration Law, as well as the EU Forest Strategy, can be mutually reinforcing [10]. As they contribute both to climate and biodiversity protection, they should not be addressed as separate but rather intertwined issues [143].

Furthermore, some carbon removal activities in the agricultural sector can also have nutrient management benefits. In general, enhancing soil health constitutes a significant component of sustainable nutrient management and sustainable agriculture [16, 17]. Soil management practices that enhance the capacity to filter and retain water and nutrients, mitigate nutrient losses, while simultaneously improving carbon sequestration. These practices include building up humus, incorporating organic matter through manure, compost, or biochar, adopting conservation tillage, and implementing crop rotations that include legumes. Improving soil carbon through the addition of organic matter to agricultural soil is likely to enhance the turnover of phosphorus and nitrogen due to the increased microbial activity and optimised soil structure [144]. In addition, increased humus content and optimised soil structure help to reduce soil erosion and improve nutrient retention. Cover crops, catch crops, and flower strips are equally beneficial for managing nutrients and storing carbon [16, 17, 145].

How these biodiversity and soil health co-benefits will be achieved, however, is currently unclear. While

a previous draft of the CRCF required that a carbon removal activity must "ensure a positive contribution" to "the protection and restoration of biodiversity and ecosystems", the Commission's proposal does not include such an obligation. Instead, Article 7 para. 1 CRCF merely requires that a "carbon removal activity shall have a neutral impact on or generate co-benefits for […] sustainability objectives". The generation of biodiversity co-benefits is therefore only a voluntary requirement. Moreover, what exactly constitutes a "neutral impact" remains to be determined, although recital 15 makes reference to the "Do No Significant Harm" principle as laid down in the Commission Delegated Regulation (EU) 2021/2139, which therefore serves a minimum requirement. In contrast, the 2024 provisional political agreement indicates "that a carbon farming activity must always generate at least a biodiversity co-benefit (including soil health and avoidance of land degradation)." It follows that the requirements for demonstrating biodiversity co-benefits are likely to be tightened in the forthcoming negotiations.

Conclusions

The EU plans for carbon farming practices to become a vital component of its strategy to offset residual emissions in hard-to-abate sectors. This strategy is sensible, as land sinks, primarily agricultural soil, capture a significant portion of global emissions. Overall, the LULUCF sector has provided net CO_2 removals since 1990, but forest carbon sinks have recently been declining [146, 147], highlighting the need to effectively protect existing carbon stocks. Carbon farming not only faces the risk of reversibility, but it is also probable that the estimated carbon sequestration potential of diverse carbon farming methods is overestimated due to the inadequate depiction of the intricate and delicate nature of the ecosystems involved and their vulnerability to the long-term impacts of climate change [27, 118]. Despite the fact that reliance on carbon farming activities is inevitable to some degree to meet the requirements under the PA, its impact on mitigating climate change remains uncertain and is a subject of debate.

The CRCF proposal by the Commission underscores the EU's recognition of both the promise and the risks inherent in carbon farming policies. Despite acknowledging these complexities, the EU has made a strategic decision to support such efforts through a voluntary carbon removal scheme. This initiative reflects the EU's ambition to fulfil the mandates set out in Article 2 para. 1 and Article 4 para. 1 PA [10]. To that end, the framework sets out standards that apply across the EU, as well as verification and certification rules and guidelines for certification schemes. While the proposal outlines quality criteria, certification methodologies, and the roles of certification bodies and schemes, many crucial details are deferred to delegated and implementing acts. In addition, the current text of the proposal raises several issues that need to be addressed in a future revision of the proposed framework, as it currently is incompatible with specific rules of EU and international law and may even counteract some objectives set by the PA and CBD:

- First, the proposal does not sufficiently take into account the normative hierarchy between different mitigation measures mandated by EU and international law, in particular that emission reductions take legal precedence over carbon removal activities [3, 20, 21]. The current proposal includes emission reductions as a carbon removal activity under Article 2 para. 1 lit. a CRCF, effectively putting the two activities on the same legal footing, even though they are significantly different in terms of mitigation effectiveness. Accordingly, the proposed rules are inconsistent with EU and international law.
- Second, while the CRCF ideally aims for long-term carbon storage, it also allows for temporary carbon approaches, such as carbon farming, without providing a clear floor for short-term storage limits. In addition, the concept of temporary carbon credits has failed in the past, as demonstrated by the experience with the CDM, and therefore raises questions about the effectiveness and integrity of the CRCF proposal.
- Third, the CRCF does not set any limits on the use of carbon credits certified under the CRCF, thus theoretically allowing temporary removals to offset fossil fuel emissions. In addition, the issue of double claiming remains relevant, as the EU insists that credits count towards its NDCs but can also be used for other purposes.
- Fourth, the delegation of powers granted to the Commission under Article 16 para. 2 CRCF is quite extensive, allowing them to adopt non-legislative acts for various aspects of carbon removal certification. It is highly questionable whether this delegation of powers is compatible with Article 290 para. 1 TFEU, as it involves "essential elements" of a legislative act—specifically due to the lack of clear definitions regarding permanent and long-term carbon storage and the potential for modification of the regulation's temporal scope through delegated acts.
- Fifth, the Commission's proposal inadequately addresses the issue of shifting effects. Carbon certification schemes may inadvertently lead to increased GHG emissions and biodiversity degradation in other regions due to land-use change. Although the proposal makes efforts to account

for emissions resulting from shifting effects, it is doubtful that these provisions will be effectively enforced, given the difficulty of accurately quantifying such emissions.

– Sixth, the proposal is not currently aligned with the EU's CAP policy. Some carbon farming practices may be eligible for certification while simultaneously qualifying as mandatory requirements for CAP income support. This raises concerns regarding doubling funding for carbon farming measures and highlights the necessity for distinguishing between CAP requirements and practices suitable for certification under the proposal to ensure favourable environmental outcomes.

Nevertheless, some of these shortcomings can and should be addressed, as we have outlined above. Furthermore, when correctly handled, carbon farming can contribute significantly to biodiversity conservation and nature restoration [148], offering significant co-benefits to climate and biodiversity policy, as it is well-aligned with the EU's Nature Restoration Law and Forest Strategy. Moreover, implementing carbon farming techniques that boost soil health may enhance nutrient management in agriculture by reducing nutrient loss and enhancing soil structure [149].

In summary, our analysis of carbon farming practices and the Commission's proposal reveals that the suggested approach may undermine international climate and biodiversity goals. While an EU certification scheme for voluntary carbon removals is undoubtedly necessary, the current proposal may inadvertently incentivise temporary carbon removal activities that could also be subject to double claiming. Furthermore, the lack of synchronisation with other EU policy instruments and strategies indicates a need for a more streamlined approach.

To prevent further delays in achieving effective climate action, it is crucial to deviate from the current path of carbon farming activities being incentivised by voluntary carbon credits, as highlighted by concerns over their effectiveness [150, 151]. While both carbon farming and carbon crediting schemes will have their roles in mitigation portfolios, excessive reliance on (temporary) carbon credits could heighten the risk of postponing necessary emission reductions. Such delays would, in turn, amplify the anticipated societal and economic costs associated with climate mitigation efforts [152]. As the EU and its member states deliberate on the future course of actions concerning carbon credits, it is therefore imperative that policymakers strike a balance between incentives for more permanent carbon removals and the need for emissions reductions via phasing out fossil fuels and minimising livestock farming.

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Author contributions
P.G. provided the legal analysis of the Certification Proposal (Section "Discussion and critical assessment"), conclusions, references, proofreading, and formatting. B.G. provided the summary on the Certification Proposal (Section "Results: The Commission's proposal for a regulation on a certification framework for carbon removals") and some aspects for the introduction and the discussion. K.H. authored the chapter on the natural scientific background, contributed to the discussion section, and designed Fig. 1. F.E. supervised the project, provided the overall theses and the underlying methodology, and made amendments to the legal analysis, discussion, and conclusions. All authors have read and agreed to the published version of the manuscript.

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