






Secure robust carbon dioxide removal policy through credible certification

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Carbon Dioxide Removal (CDR) is a key element of any mitigation strategy aiming to achieve the long-term temperature goal of the Paris Agreement, as well as national net-zero and net-negative greenhouse gas emissions targets. For robust CDR policy, the credibility of certification schemes is essential.

Carbon Dioxide Removal (CDR) plays three distinct roles in future pathways in line with the Paris Agreement^{1,2}. First, if durability of carbon removal can be secured, CDR can help further reduce net emissions to meet interim emissions reduction targets in the short term. Second, at gigatonne scale by mid-century, CDR can assist in balancing residual emissions to achieve net-zero emissions, a necessary step to limit temperature increase. Third, after net-zero emissions have been achieved, CDR can be deployed to aim for and sustain net-negative emissions³. The levels of required CDR deployment will depend largely on policy decisions regarding the degree of temperature drawdown desired⁴ and the amount of residual emissions that need to be counterbalanced⁵.

The European Union's (EU) efforts to establish a CDR certification scheme is an important initiative in this regard—but it faces key challenges that should be resolved during the ongoing legislative processes. The Intergovernmental Panel on Climate Change (IPCC) defines CDR as: “Anthropogenic activities removing carbon dioxide (CO₂) from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical CO₂ sinks and Direct Air Carbon Dioxide Capture and Storage, but excludes natural CO₂ uptake not directly caused by human activities”¹. The IPCC definition allows for clear differentiation between activities that lead to net removal and those that result in emissions reductions or avoidance. Yet, the EU's ongoing efforts to certify carbon removal and operationalize it for European climate policy risk blurring this crucial difference. In addition to this, a credible understanding of ‘durability’ is another key challenge. Fully counterbalancing fossil CO₂ emissions would require storage of CO₂ for millennial timescales; however, existing CDR methods vary widely in their durability, ranging from decades to tens of millennia^{3,6}, a characteristic that would need to be reflected in a robust EU certification scheme.

Clear regulations and incentives for upscaling pathways

We are currently in the early stages of explicit CDR policy^{6,7}, laying the groundwork for a formative phase of CDR deployment^{8,9}. This early phase is critical for the establishment of a robust regulatory and governance regime, to nurture nascent markets, and to develop a CDR industry that will complement emission reductions and be capable of achieving the level of CDR

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envisioned by scenarios that limit warming to 1.5 and 2 °C (3.3–7.6 additional Gt per year by 2050 compared to 2020, interquartile range⁶).

A precondition for robust CDR policymaking and market uptake is a strong certification scheme, and the current lack of transparent and robust schemes is perceived as a barrier to scaling up CDR¹⁰. Removal credits with questionable additionality, questionable durability or other weaknesses could lead to a non-robust market and thus weaker deployment incentives for high-quality removals.

Similar issues have dogged past efforts, such as the Clean Development Mechanism¹¹, which saw the EU place limits on the use of international credits in the EU Emissions Trading System, in part due to environmental integrity concerns, leading to a drop in the market price for credits¹². Clean Development Mechanism credits representing removals from afforestation and reforestation activities (“temporary” and “long-term” certified emissions reductions, tCER and ICER) suffered from low uptake in part because these credits were required to be replaced before their expiration dates, rendering them not fully fungible with credits representing certified emission reductions (CERs) as a practical matter.

New rules for the Paris Agreement’s centralized crediting mechanism, established under Article 6.4 as a successor to the Clean Development Mechanism, have now been agreed (decisions 3/CMA.3 and 7/CMA.4). While these decisions address a range of environmental integrity concerns, detailed rules for removals have yet to be agreed. The Article 6.4 Supervisory Body is in the process of gathering public input on a range of detailed issues, including definitions, durability and the treatment of reversals, so that recommendations may be made to Paris Agreement Parties for adoption. The EU’s certification scheme, if well-designed, could have a beneficial impact on this evolution.

Carbon removal certification framework in the EU

The European Commission’s initiative to establish a Carbon Removal Certification Framework (CRC-F) is a key effort in integrating CDR into existing mitigation policy instruments and governance architectures. The EU is usually perceived (and perceives itself) as a leader in climate action. The Carbon Removal Certification Framework proposal directly refers to this leading role and implicitly assumes that such an EU initiative could be established and disseminated as a quality benchmark for future certification efforts.

In the area of carbon removals, the EU could position itself as a facilitator and innovator as part of its regulatory export and global standard-setting efforts¹³, not only in relation to other countries but also to the United Nations Framework Convention on Climate Change (UNFCCC). During the Kyoto Protocol negotiations, the EU was critical of the inclusion of land use, land use change and forestry (LULUCF) removals in climate change mitigation efforts, pointing to the risk of undermining emission reduction efforts^{14,15}. With the European Green Deal, however, the EU is now pursuing an integration of CDR into climate policy. Given the risks of greenwashing and emissions reduction displacement associated with the issue of carbon removals, a robust and comprehensive certification policy that incentivises permanent removals by a first mover is essential.

The European Commission published its legal proposal for the Carbon Removal Certification Framework in late 2022, aiming at establishing a governance architecture and criteria for quantification, additionality and baselines, long-term storage, and sustainability for three different types of carbon removal: carbon farming, permanent storage, and carbon storage in long-lasting products and materials. The proposal to first establish a

framework for certifying CO₂ removal before fully integrating CDR into climate policy is a reasonable policy sequencing strategy - especially given the challenging interlinkages with agricultural policy and politics in the context of carbon farming. To serve as a basis for robust CDR policy, however, several problematic provisions should be addressed by decision makers. The following three, in our view, pose a risk to the credibility of the initial proposal:

Problem 1: Reductions are not ‘removal activities’

The definition of a ‘carbon removal activity’ in the Commission proposal is set as “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”¹⁶. Actions that reduce the release of carbon and thus can reduce gross positive emissions, like halting deforestation, peatland rewetting and marine ecosystem restoration, are necessary parts of an overall mitigation portfolio. However, these mitigation activities are fundamentally different from actions that increase gross negative fluxes, including afforestation or expanding seagrass meadows, which actively remove CO₂ from the atmosphere and store it in the biosphere.

In a regulatory regime which governs LULUCF and non-LULUCF forms of CDR, certifying both LULUCF reductions and removals as a ‘removal activity’ blurs the difference between emissions reduction and removals. A loss of this distinction risks providing lower incentives for more costly removal activities and saturating future markets with cheaper credits. While a clear definition of gross positive and negative LULUCF fluxes remains to be agreed upon^{17,18}, limiting the scope of the Carbon Removal Certification Framework to removals (i.e., negative LULUCF fluxes) will support robust policy designs and implementation of the integration of CDR into EU climate policymaking. Focusing on this scope is particularly important in the context of EU regulatory export and global standard-setting efforts, as the role of the LULUCF-based removals are a key element of many country pledges under the Paris Agreement^{19,20}.

Problem 2: Use cases for temporary and permanent removals are not separated

The Carbon Removal Certification Framework is intended to cover the full range of CDR methods with very different durability periods. To address this, the Commission included expiry dates for temporary removals (i.e., through carbon farming or in products). The proposal specifies that when certifying these methods, “the carbon stored by a carbon removal activity shall be considered released to the atmosphere at the end of the monitoring period”¹⁶ (CRC-F, Art. 6.3). In particular, non-permanent ‘carbon farming’ approaches in agriculture and forestry are usually associated with strong political stakes and significantly shape the political economy of CDR policy-making²¹.

The integration of Carbon Removal Certification Framework certificates into the three key pillars of EU climate policy, the EU Emissions Trading System, the Effort Sharing Regulation (ESR), and the LULUCF Regulation, may pose problems if use cases are not specified for different types of removals. For example, can CO₂ emissions that remain in the atmosphere be counterbalanced by non-permanent removals? While non-permanent removal certificates as such are not problematic, this fundamental question points to the fact that the new proposal does not address the use cases of Carbon Removal Certification Framework certificates. Allowing non-permanent removals to counterbalance residual emissions will result in poor policy outcomes, such as an infinite recurring debt on balance sheets requiring

sustained investment in future non-permanent credits, or carbon leakage if those credits are not renewed²². A prerequisite for addressing this issue is that the framework is able to distinguish between different types of certificates and their uses.

Problem 3: System boundaries are unclear

The current criteria proposed by the Commission include definitions for quantification of removals in Article 4 of the Regulation, which comprises three components: baseline removals, total removals from an activity, and the direct and indirect increase in greenhouse gas emissions due to the removal activity. When certifying removals based on Carbon Capture and Utilization (CCU) or Carbon Capture and Storage (CCS), both the origin of the CO₂ and the lifecycle emissions of specific process chains are key factors^{23,24}. How the system boundary is defined for a given removal activity is thus critical.

A prime example of unclear system boundaries is the use of carbon removed from the atmosphere for further fossil extraction. With Enhanced Oil Recovery, CO₂ is pumped underground to increase the recovery of crude oil from almost depleted fields. If Enhanced Oil Recovery is performed with biogenic or atmospheric CO₂ it could (depending on how indirect emissions are defined) qualify as “carbon removal” under the current Carbon Removal Certification Framework proposal. However, robust CDR-specific certification frameworks and policy more generally must avoid introducing new indirect fossil fuel subsidies. To do so, it should proactively exclude removal practices which result in additional fossil fuel extraction. In the US, for example, monitoring, reporting and verification associated with Enhanced Oil Recovery is delineated from other CCS process chains, and the IRA differentiates the tax credit: for Direct Air Carbon Dioxide Capture and Storage it is \$180/t, for use through e.g., Enhanced Oil Recovery it is \$130/t²⁵. A novel certification scheme aimed at credible CDR should focus on methods and process chains that result in net negative emissions; certifying the use of biogenic or atmospheric CO₂ for oil extraction as CDR would blur these boundaries.

Other examples where system boundaries are key include bioenergy plus CCS (BECCS), with regards to emissions linked to unsustainable biomass growth and emissions when linked to long-distance import of biomass feedstock. Methods like terrestrial enhanced weathering or ocean alkalinity enhancement, which both require large-scale mining, grinding and transportation of rock, also raise questions about system boundaries in emissions accounting. The Carbon Removal Certification Framework and other certification frameworks will need to be able to address lifecycle emissions that are more challenging to quantify.

Secure robust removal policy

Robust CDR policy designs must tackle the issues of heterogeneous ecosystem-based carbon fluxes and non-permanent removals, as well as the full system consideration of how removal credits are utilized. Certification frameworks which conflate short-term removal activities with durable activities risk weakening the incentive structures necessary for supporting niche markets for novel carbon removal during their critical formative innovation phase. Matching the durability of a removal activity with the permanence of an emission activity provides more equal footing to value activities in a like-for-like manner. For instance, an alternative might be to limit use cases for short-term CDR activities. LULUCF-based CDR could be limited to balancing LULUCF-based carbon emissions, and non-durable storage could be considered only to balance emissions of short-lived greenhouse gases that have an atmospheric lifetime comparable to the timescale of this temporary storage.

In the case of the EU Carbon Removal Certification Framework, the following options exist to address the identified weaknesses: The co-legislators in the European Parliament (EP) and the Member States could use their influence on the dossier to change the definition and add elements on use cases in different pillars of EU climate policy. Some details of future use cases can not be specified at this stage, e.g., because information about durability of methods and accounting methodologies are not yet available. However, in our view, the Carbon Removal Certification Framework Regulation should both specify broader categories of certificates and exclude certain use cases for non-permanent certificates to address the three problems laid out here. Furthermore, the Regulation could signal that follow-up legislation for climate policy in the period 2031–2040, including the economy-wide headline target for 2040, should include specific rules on which type of certificate can be used for what purpose in accounting systems.

The upcoming negotiations of the overall EU 2040 target will define what role CDR is supposed to play in EU climate policy. However, the Carbon Removal Certification Framework is the central process to legislate that ambiguities in definitions, monitoring, reporting and verification practices, and use cases must not be exploited to weaken decarbonization efforts. Furthermore, the Carbon Removal Certification Framework provides the opportunity to set standards for aligning CDR certification practices with sustainable development goals. Tons of carbon removed can only be one dimension of the emerging certification framework—protection of terrestrial and marine ecosystems, biodiversity, impacts on local communities, among other factors, should also be considered.

A strong certification framework within the EU is likely to provide a strong signal and reference point to other national and multilateral processes, and serve as a best-practice example for future enhancement of Nationally Determined Contributions (NDCs) and Long-term Strategies (LT-LEDs). Furthermore, it can serve as valuable input to the work on removals under Article 6 of the Paris Agreement, as well as removal certification across both compliance and nascent voluntary markets. Balancing the need for streamlined regulation to enable innovation with a strong first-mover removal framework is critical for a successful EU CDR policy which supports overall global mitigation toward net-zero CO₂ emissions and beyond.

Received: 18 May 2023; Accepted: 19 September 2023;
Published online: 03 October 2023

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Acknowledgements

FS and OG acknowledge the financial support by the project CDRSynTra, funded by the German Federal Ministry of Education and Research (BMBF), grant number: 01LS2101A; MG, KR, WL, and JM acknowledge the European Union's ERC-2020-SyG "GENIE" grant, grant ID 951542. MB and OG acknowledge financial support from the ASMAYS project, funded by the German Federal Ministry of Education and Research (BMBF), grant number: 03F0898E.

Author contributions

FS and MG developed the idea for the paper and drafted the paper. MB, EB, CF, TG, OG, WL, MM, JM, KR contributed to paper writing and revision.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s43247-023-01014-x>.

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Peer review information *Communications Earth and Environment* thanks David Reiner and the other, anonymous, reviewer(s) for their contribution to the peer review of this work. Primary Handling Editor: Heike Langenberg. A peer review file is available.

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