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Conditional fungibility: Sequencing permanent removals into Emissions Trading Systems

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Carbon dioxide removal (CDR) is a cornerstone of climate change mitigation strategies aiming for net-zero emissions targets, as emphasized in the IPCC AR6 (IPCC, 2023) and many national modelling studies (European Commission, 2024; He et al., 2022; Larson et al. 2021). However, a significant gap exists between the CDR required in climate scenarios and the current state of CDR in terms of public and private finance, policy instruments, and actual deployment (Smith et al. 2024). A broad portfolio of CDR policy instruments and CDR methods will be needed to address this gap in the coming years and decades.

The upscaling pathways of the individual methods differ significantly. In addition to technological readiness, costs, side effects, and other method-specific aspects, the upscaling dynamics will also be shaped by its embeddedness in existing policy architectures and sector- and country-specific politics. The role of specific CDR methods in climate policy should be fundamentally shaped by their permanence features. The positioning of methods on the continuum from decades to centuries, centuries to millennia, ten thousand years or more has important implications for the fungibility of emissions and removals, which in turn informs the emerging discussion on the potential integration of these methods into cap-and-trade systems.

In order to highlight the importance of permanence for designing CDR policies in general and deriving implications for policy discussion on possible ETS integration more specifically, this perspective is structured as follows: first, we present the policy context and a mapping and conceptual distinction of five groups of measures applicable to address varying levels of permanence in CDR policy. Second, we make the case for limiting the fungibility of different CDR methods with each other and with fossil CO_2 emissions. Third, and building on the identified measures and conditional fungibility, we present a sequencing strategy for integrating permanent removals into existing compliance carbon markets.

Policy context - the lack of comprehensive rules

Currently, there is a lack of comprehensive rules governing the permanence of CDR. The recent discussions at COP28 and reflections on Article 6 highlight the emerging recognition of this issue (Schulte et al., 2024; Kreibich 2024). Analysis of national CDR policies shows that some jurisdictions, such as the UK and the EU, have begun to address CDR proactively, yet they remain in the nascent stages of policy development (Schenuit et al. 2021; Lezaun et al., 2021). In the UK and the EU where emission trading systems are the cornerstones of climate policy architectures a debate among researchers and policymakers is rapidly evolving on whether and if so, how CDR should be integrated into these emission trading systems (ETS) (Rickels et al. 2021).

The reasoning behind this push towards integrating CDR in the ETS is at least twofold. First, integrating CDR into these markets is one strategy to tackle the "endgame" (Pahle et al. 2023) inscribed in these policy designs, i.e. running out of allowances despite still emitting hard-to-abate emissions, and thus putting high political pressure on the ETS. CDR could be a strategy to deal with the challenge. However, a key issue here would be to not reduce the pressure on conventional emission reduction through renewable energy, energy efficiency, electrification, and so on. Second, the integration of CDR into compliance markets could be an important step to establish effective incentive structures for scaling CDR and mobilise public and private funds for CDR deployment – a challenge all CDR policy instruments are facing (Hickey et al., 2023). However, integrating CDR into compliance markets should not be seen as a silver bullet solving both the "endgame" issue and need for deployment incentives. Given the central role of cap-and-trade systems in existing climate policy architectures, it is nevertheless important to explore policy design issues. In the early stages of the debate, addressing the issue of permanence is prerequisite for designing policy pathways (Burke/Schenuit 2023).

Five groups of measures for governing permanence and illustrative policy bundles

Mapping existing measures and conceptually grouping them based on their key objective serves as an entry-point for policymakers by highlighting promising approaches and guiding effective decision-making. Combining literature reviews of grey and academic literature with discussions with stakeholders we develop a conceptual distinction of 5 groups of measures to govern CDR permanence (see Table 1 and Figure 1, Supplementary Material).

The first group consists of Monitoring, Reporting and Verification (MRV) systems which assess the veracity of a carbon removal claim (Thorsdottir et al., 2024) and are fundamental quantifying the performance of CDR activities. However, significant oversight and methodological challenges remain for MRV. Many MRV protocols, particularly for novel CDR such as Direct Air Capture and Storage (DACCS), are proprietary and inaccessible, making it challenging to compare them with publicly available MRV protocols. Accounting approaches have non-standardised parameters, are inconsistent in their handling of measurement uncertainty, and verification processes typically only consider whether MRV criteria from the applied protocol were met, not whether the rules accurately reflect atmospheric outcomes (Powis et al., 2023; Brander et al., 2021). A further challenge within this current system is that, in some cases, a single actor can control several steps of the process, including developing the MRV protocol, and verifying and issuing credits, which raises questions about potential conflicts of interest and impartiality. The scale of the challenge should not be underestimated, both scientifically and politically. Indeed, the history of certified emissions reductions (CER) under the Kyoto Protocol, for example, including the differentiation between "longterm" and "temporary" CERs shows that many of these challenges are not new (Galinato et al., 2011).

Four further specific groups of measures are identified; 'liability measures', 'de-risking measures', 'durability measures', and 'fungibility measures' (for brief summary see Table 1, for details see Supplementary Material and Burke/Schenuit, 2023). To date, the application of fungibility measures remains largely theoretical. There are, however, some real-world applications of other permanence measures in public policy, of which liability measures and durability measures (buffer pools) are the most prevalent (Arcusa and Hagood, 2023). All measures should not be viewed as mutually exclusive but as complementary and interconnected, with a multiplicity of possible combinations.

Table 1: Overview of five groups measures to address permanence of CDR methods

MRV measures	Greenhouse gas quantification through crediting mechanisms and according to predefined standards
Liability measures	Mechanisms that stipulate the storage duration period and legally obligate to continually remove carbon in the event of a reversal or at the end of a project lifespan
De-risking measures	Financial carbon insurance and market discount rates/ratings agencies.
Durability measures	Measures to manage carbon that is re-released into the atmosphere due to extreme weather events, disease, site/facility maintenance or poor land use governance. The main measure is the use of buffer pools.
Fungibility measures	Attempts to quantitatively value CDR with different levels of permanence, from which equivalence ratios can be produced.

Source: from Burke and Schenuit, 2023

Most studies only focus on measures in isolation, for example, analysing the economic value of temporary CDR vis a vis permanent CDR (Groom and Venmans, 2023; Prado and McDowell, 2023; Parisa et al., 2022), the capitalisation of buffer pools (Badgley et al., 2022) and the potential of bundling multiple credits to create fungible units (Macinante and Ghaleigh, 2022). As such, the application of each measure and the combination of measures for different CDR methods is under studied in the literature. While foundational measures, (i.e., MRV) and liability measures apply to all CDR regardless of differing permanence and policy and market designs, the exact bundling of different measures should not be prescriptive, but adaptable and flexible as technologies mature and novel approaches emerge. For CDR methods storing CO_2 geologically, MRV and liability measures may be sufficient given their high permanence. For conventional CDR storing carbon in the biosphere, additional accompanying measures will be needed and the administrative burden is therefore likely to be higher (Burke/Schenuit, 2023).

Conditional fungibility

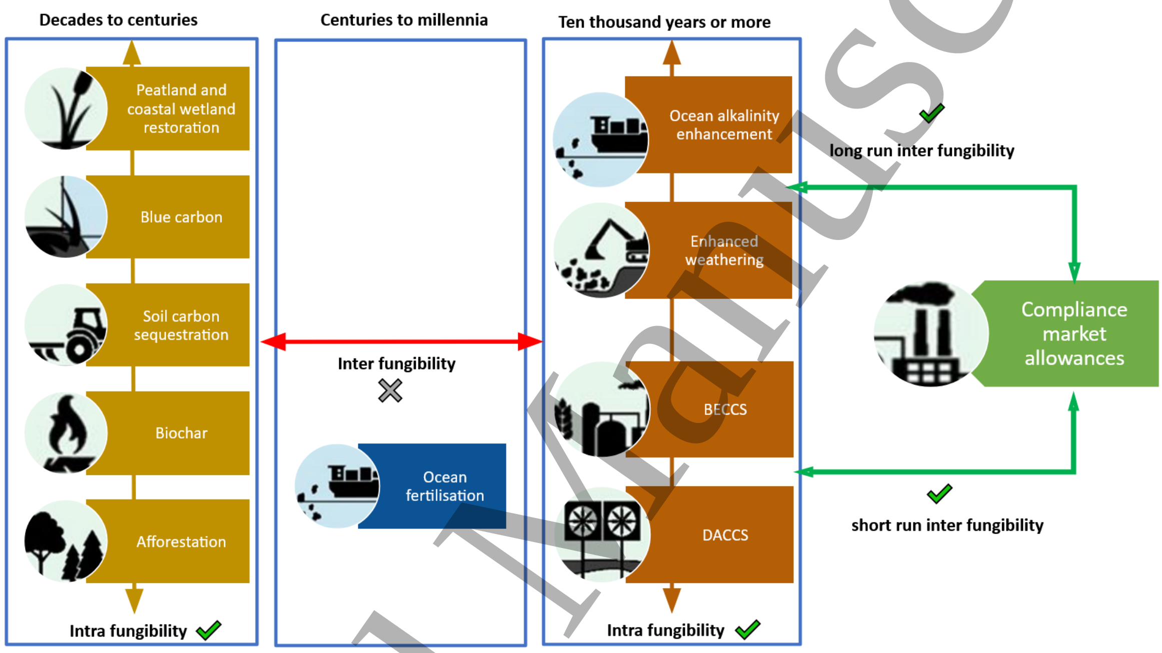
The integration of CDR into compliance carbon markets will necessitate the homogenization of the differences between CDR methods. The measures and policy bundles combining them described above represent a critical step in this direction. While they technically could provide tools to establish fungibility of certificates from all CDR methods with greenhouse gas emissions, we argue that this should not lead to the integration of all CDR methods.

There are two major risks: First, the integration of CDR into existing compliance markets could result into a certified ton of removed carbon substituting fossil emissions. If removals used for these credits are generated through non-permanent removals, they would have to be renewed continuously (Kalkuhl et al. 2022) since fossil CO2 emissions have to be considered 'permanent'. In addition to the potentially high costs linked to this liability, the administrative burden in a compliance regime tracking could overload emissions trading systems. Second, in the short-term, one key objective of integrating CDR into the ETS is to create demand and incentives innovation and upscaling for novel CDR methods currently too expensive to be deployed at large scale. If all methods were to be integrated into the ETS, it is to be expected that cheaper and less permanent removal crowd-out more permanent and expensive methods. With the objective of having a broad portfolio of methods available in the future, limiting the integration is therefore also a strategic choice for supporting more permanent methods.

Some scholars argue for complete non-fungibility of CDR methods both within carbon markets and mitigation targets (e.g. Carton et al. 2021). However, this could be reconsidered if specific criteria are satisfied. Instead of viewing fungibility as a binary concept, it is more precise to understand it as a continuum (see Figure 1). We argue that if CDR methods are at the highest end of this continuum, they qualify for an integration into compliance markets. The framework differentiates between intra- and inter-fungibility. *Intra-fungibility* (or vertical fungibility) refers to the fungibility across CDR methods with similar levels of permanence. This dimension of fungibility helps to cluster different groups of CDR methods, a critical step in CDR policy given the rapidly expanding portfolio of methods. These clusters defined by a vertical fungibility of different CDR methods are positioned differently on the continuum of permanence. For reasons described above, we argue that only the cluster with the highest permanence (ten thousand years or longer) qualify for *interfungibility* (or horizontal fungibility), i.e. the fungibility of CDR credits with emissions allowances.

Even though CDR that stores carbon for ten thousand years or more might theoretically be considered fungible with compliance market allowances, in practice this is currently not the case for all methods within this classification. This is due to the differing levels of technical maturity and vastly different levels of MRV readiness between closed system methods such as bioenergy carbon capture and storage (BECCS) and DACCS compared to open system methods such enhanced weathering (EW) and ocean alkalinity enhancement (OAE) (Burke and Mercer, 2023, Schulte et al., 2024). For example, MRV for BECCS and DACCS is relatively well advanced with fewer methodological concerns. Thus, Figure 1 illustrates that these methods have the potential for short run fungibility, meaning that the timeline for compliance carbon market integration is a near to medium term option. In contrast, EW and OAE have the potential for long run fungibility due to their high levels of permanence, but this remains a long term ambition due to gaps in foundational science that mean the MRV protocols are still nascent and under developed.

Figure 1: The permanence continuum and intra- vs. inter-fungibility



Source: adapted from Burke/Schenuit 2023, categorization based on IPCC 2022

Sequencing strategy to integrate CDR into compliance markets

Policy sequencing is a key strategy in climate policymaking and has successfully addressed political challenges in other areas of decarbonization strategies (e.g., Meckling et al., 2017). Sequencing strategies may be employed with the objective of increasing the stringency of a policy over time. However, they may also be employed with the objective of implementing experimental governance designs and capacity-building initiatives, both within the administration and among relevant stakeholders (Sabel/Victor 2022).

In order to facilitate the eventual inclusion of permanent methods in compliance markets, a sequencing strategy is required. Based on the considerations on permanence measures and conditional fungibility, we propose the following three steps:

First, establishing credible certification through the implementation of robust MRV systems. Such systems ensure transparent and accurate accounting of removal activities, taking into account the different permanence characteristics and system boundaries. This first phase should provide sufficient time for capacity building and the establishment of the policy ecosystem and capacities to secure robust certification and risk assessments. The second stage of a sequencing strategy should address the challenge of the managing reversal risks. This is achieved through the introduction of liability measures, which are designed to address the risks of carbon re-release and a prerequisite for instruments. These measures are of the utmost importance for ensuring the reliability of CDR methods, and a prerequisite for any CDR policies, including non-carbon market based instruments. These measures are neither optional nor theoretical and future policy initiatives can build on existing public policy for managing reversal risks (e.g. CCS regulations). As part of the second phase, non-carbon market-based policy instruments such as result-based subsidies can contribute to lower prices for permanent CDR. The final and third stage involves the integration of CDR into carbon market-based instruments by enabling the tradeability of CDR certificates with ETS allowances. In this final stage, the crediting of CDR transforms the removed carbon into a tangible commodity that project developers can seek to trade in a compliance market (Schulte et al., 2024) and position the ETS as a significant driver of demand for CDR. In particular, the design of policy instruments for integrating credits into the market requires careful consideration to avoid the emergence of moral hazards. Together, these stages constitute a structured approach to govern the permanence through conditional fungibility of CDR, thereby enhancing its credibility and facilitating its adoption in compliance markets.

Conclusion

The recent momentum for CDR as a key element of mitigation strategies to achieve net-zero targets has led to the question of how the existing compliance markets can play a role in facilitating demand for CDR without reducing the level of abatement ambition. In order to develop policy design to address this question, two essential questions must be answered: which methods should qualify to provide CDR considered fungible with fossil emissions, and what are the next steps in preparing the integration? Based on the mapping of existing measures and the conceptualization of intra- and inter-fungibility, we propose the introduction of conditional fungibility for permanent CDR in compliance markets. This would be best achieved through a sequencing strategy that allows for sufficient time for capacity building, the establishment of non-market-based policies to lower the costs of permanent CDR, and the signalling of the ETS's eventual role as a tool for creating demand for CDR.

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