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ARTICLE

Permanence and Liability: Legal Considerations on the Integration of Carbon Dioxide Removal into the EU Emissions Trading System

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Abstract
This article examines how carbon dioxide (CO_2) removal credits can be integrated into the European Union (EU) Emissions Trading System (ETS), focusing on questions of permanence and climate liability. It identifies challenges within the integration process and analyzes approaches from practice and literature to cultivate learning. These approaches apply different strategies to address the issue of permanence, including temporary credit issuance, granting credits once a certain number of carbon tonne-years have been accumulated, or issuing credits at the beginning of the project period and relying on liability instead. Drawing from the findings of this research, the article presents legal considerations that may inform a proposal for an EU legislative act on the integration of carbon removal credits into the EU ETS. It suggests that only credits issued for permanent CO_2 removal should be integrated to ensure the environmental integrity of the system. Furthermore, the liability of the project operator should transfer to the Member State under certain conditions to make liability risks more predictable.

Keywords: Carbon dioxide removal; Carbon removal credits; Climate change law; EU Emissions Trading System; Permanence; Liability

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC) has stressed that the 'deployment of carbon dioxide removal (CDR) to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 [carbon dioxide] or GHG [greenhouse gas] emissions are to be achieved'.[1] This would necessitate the large-scale deployment of activities to capture CO_2 from the atmosphere and store it durably in geological formations, terrestrial and marine ecosystems, or products.[2] Currently, the European Union

1 J. Skea et al., 'Summary for Policymakers', in IPCC (P.R. Shukkla et al. (eds), *Climate Change 2022: Mitigation of Climate Change. Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, 2022), pp. 1–48, at 36.

2 European Commission, 'Proposal for a Regulation of the European Parliament and of the Council Establishing a Union Certification Framework for Carbon Removals', 30 Nov. 2022,

(EU) is not on track to deliver the required levels of CDR deployment.[3] CDR in terrestrial ecosystems has declined in recent years, and no significant industrial CDR is currently operating in the EU.[4] Extensive investment is required, including from the private sector, to achieve CDR development and deployment on a large scale. One option discussed in policy and literature to provide sufficient financial resources is the integration of carbon removal credits (CRCs) into the EU Emissions Trading System (EU ETS).[5] Integrating CRCs into the EU ETS, one of the largest compliance markets globally, may provide the CDR sector in the EU with the necessary financial boost to scale up.

CDR refers to 'anthropogenic activities removing CO_2 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, geochemical or chemical CO_2 sinks, but excludes natural CO_2 uptake not directly caused by human activities'.[6] Numerous CDR technologies are available. The majority of current CDR efforts come from conventional land management, particularly afforestation and soil carbon sequestration.[7] Only a small fraction stems from novel CDR technologies, such as direct air capture with carbon storage (DACCS) or bioenergy with carbon capture and storage (BECCS), which store carbon in geological formations.[8]

This article investigates two concerns that need to be addressed during the process of integrating CRCs into the EU ETS: permanence and liability.[9] Available CDR technologies demonstrate different levels of permanence.[10] Permanence describes the duration for which atmospheric CO_2 has been removed through CDR and remains

COM(2022) 672 final, p. 1, available at: https://eur-lex.europa.eu/resource.html?uri=cellar:60d407c8-7164-11ed-9887-01aa75ed71a1.0001.02/DOC_1&format=PDF.

3 Ibid.

4 Ibid.; European Academies' Science Advisory Council (EASAC), 'Forest Bioenergy, Carbon Capture, and Storage, and Carbon Dioxide Removal: An Update', 19 Feb. 2019, pp. 1–2, available at: https://easac.eu/publications/details/forest-bioenergy-carbon-capture-and-storage-and-carbon-dioxide-removal-an-update.

5 See W. Rickels et al., 'Integrating Carbon Dioxide Removal into European Emissions Trading' (2021) 3 *Frontiers in Climate*, pp. 1–10, at 1; Vivid Economics, 'Greenhouse Gas Removal (GGR) Policy Options: Final Report', June 2019, p. 73, available at: https://assets.publishing.service.gov.uk/media/5d84ed3b40f0b61c9df67a3b/Greenhouse_Report_Gas_Removal_policy_options.pdf; E. Cox & N.R. Edwards, 'Beyond Carbon Pricing: Policy Levers for Negative Emissions Technologies' (2019) 19 *Climate Policy*, pp. 1144–56, at 1144; F. Schenuit, M. Böttcher & O. Geden, 'Carbon Dioxide Removal as an Integral Building Block of the European Green Deal', *Stiftung Wissenschaft und Politik*, SWP Comment No. 40, June 2022, p. 4, available at: https://www.swp-berlin.org/publications/products/comments/2022C40_CarbonDioxideRemoval.pdf; Netherlands, Norway, Denmark and Sweden, 'Non-Paper on Carbon Capture and Storage (CCS)', 2021, available at: https://www.ft.dk/samling/20201/almdel/KEF/bilag/87/2288136.pdf.

6 M. Pathak et al., 'Technical Summary', in IPCC, n. 1 above, pp. 49–147, at 114.

7 S.M. Smith et al., *The State of Carbon Dioxide Removal* (2023), p. 8, available at: https://static1.squarespace.com/static/633458017a1ae214f3772c76/t/64d2223cab34856349188e07/1691492940765/SoCDR-1st-edition-2023-V9.pdf.

8 Ibid.

9 The article does not make recommendations on the integration of specific CDR technologies into the EU ETS, as these are constantly being developed and the article is intended to provide information on permanence and liability that can be applied to all CDR technologies.

10 The Royal Society & Royal Academy of Engineering, 'Greenhouse Gas Removal', Sept. 2018, p. 74, available at: https://royalsociety.org/-/media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdf.

stored.[11] The level of permanence is determined by the timespan within which CO_2 is re-emitted (reversed).[12] The varying levels of permanence among CDR technologies pose major challenges for the integration of CRCs into the EU ETS. Firstly, more permanent CDR is more significant from a climate repair perspective than less permanent CDR, whereby short-term storage of carbon still entails benefits.[13] Secondly, it is important to establish some kind of equivalence between CRCs to achieve broad fungibility of carbon assets under the EU ETS.[14] Fungibility is important in promoting a liquid market that can provide sufficient funds for CDR deployment.[15] Lastly, if CRCs issued for CDR with low levels of permanence were integrated into the EU ETS, the environmental integrity of the EU ETS could be jeopardized. According to the understanding of this article, environmental integrity is safeguarded if the engagement in trading CRCs under the EU ETS leads to aggregated emissions covered by the EU ETS that are equal to or lower than those in a situation where the transfers did not occur.[16] The environmental integrity of the EU ETS would be undermined if carbon stored through CDR, for which CRCs were issued, were to be reversed without complete compensation for re-emissions. Considering these aspects collectively, the primary concern of the integration process would be to account for varying levels of permanence while ensuring wide fungibility and preserving the environmental integrity of the EU ETS.

Liability is a legal tool that can recognize and manage permanence issues and becomes relevant when CDR projects reverse. However, liability should not be seen as a general solution to the permanence issue but rather as a legal safeguard for exceptional circumstances. Situations in which liability becomes necessary ideally should be avoided, as liability itself poses many risks. These include enforcement challenges and the risk that the liability system could be overwhelmed if CDRs were to be reversed simultaneously on a large scale.[17] In the context of this article, 'liability' refers only to the narrow obligation of submitting emissions allowances or removal credits under the EU ETS to replace

11 Vivid Economics, n. 5 above, p. 42.

12 B.C. Murray & P. Kasibhatla, 'Equating Permanence of Emission Reductions and Carbon Sequestration: Scientific and Economic Foundations for Policy Options', *Duke Environmental and Energy Economics Working Paper*, 18 July 2014, p. 2, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2467567.

13 UK Government, 'Monitoring, Reporting and Verification of Greenhouse Gas Removals Task and Finish Group Report', 2021, p. 5, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1026994/mrv-ggrs-task-report.pdf.

14 J. Macinante & N.S. Ghaleigh, 'Regulating Removals: Bundling to Achieve Fungibility in GGR "Removal Units"', *Edinburgh School of Law*, Research Paper No. 2022/05, 24 Mar. 2022, pp. 20–2, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4064970.

15 Ibid., p. 17; International Swaps and Derivatives Association (ISDA), 'Legal Implications of Voluntary Carbon Credits', Dec. 2021, p. 7, available at: https://www.isda.org/a/38ngE/Legal-Implications-of-Voluntary-Carbon-Credits.pdf.

16 Note that there are other possible definitions of environmental integrity; see L. Schneider & S. La Hoz Theuer, 'Environmental Integrity of International Carbon Market Mechanisms under the Paris Agreement' (2019) 19(3) *Climate Policy*, pp. 386–400, at 388.

17 UK Government, n. 13 above, p. 13; B.C. Murray, L.P. Olander & D.P. Kanak, 'Forging a Path for High-Quality Compliance REDD Credits', *Duke Nicholas Institute for Environmental Policy Solutions*, Dec. 2009, p. 11, available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/forging-a-path-for-high-quality-compliance-redd-credits-paper.pdf; Murray & Kasibhatla, n. 12 above, p. 19.

those affected by a reversal event (so-called 'climate liability'). The author acknowledges that other forms of liability are crucial in addressing potential harm and damage stemming from CDR technologies – in particular, liability related to environmental harm and liability under tort law. These are governed by distinct legal frameworks: liability under tort law is regulated under national legislation; liability in relation to environmental harm is regulated under the EU Environmental Liability Directive.[18] Both have no direct implications for the EU ETS as the EU ETS does not address these forms of liability. Therefore, they are beyond the scope of this article, which focuses on permanence and liability in the context of a possible integration of CRCs into the EU ETS.

The normative question of whether CRCs should be integrated into the EU ETS requires a broad assessment that exceeds the scope of this research. This study, therefore, is conducted on the assumption that integration of CRCs into the EU ETS will take place. The findings of this study on permanence and liability can be considered not only after integration has been chosen but also in the initial decision process to integrate CRCs into the EU ETS. Additional integration challenges that will be important for an overarching initial assessment have been addressed in dedicated literature, such as moral hazards and mitigation deterrence,[19] additionality,[20] monitoring reporting and verification processes,[21] carbon leakage,[22] and downward pressure on the overall carbon price.[23]

The article analyzes various approaches to the issues of permanence and liability. These are the Kyoto Protocol's Clean Development Mechanism (CDM),[24] voluntary carbon markets, and tonne-year accounting. Under the CDM, removal projects in developing countries could generate temporary carbon credits that developed state parties could buy and use towards compliance purposes of their emissions reduction commitments under the Kyoto Protocol.[25] These temporary credits had an expiration date and needed to be replaced to address concerns regarding the limited permanence of removal projects.[26]

[18] Directive 2004/35/EC on Environmental Liability with regard to the Prevention and Remedying of Environmental Damage [2004] OJ L 143/1 (Environmental Liability Directive).

[19] H. Shue, 'Climate Dreaming: Negative Emissions, Risk Transfer, and Irreversibility' (2017) 8(2) *Journal of Human Rights and the Environment*, pp. 203–16, at 203; N. Markusson, D. McLaren & D. Tyfield, 'Towards a Cultural Political Economy of Mitigation Deterrence by Negative Emissions Technologies (NETs)' (2018) 1 *Global Sustainability*, article e10; N. Grant et al., 'Confronting Mitigation Deterrence in Low-Carbon Scenarios' (2021) 16 *Environmental Research Letters*, article 064099; D. McLaren, 'Quantifying the Potential Scale of Mitigation Deterrence from Greenhouse Gas Removal Techniques' (2020) 162 *Climatic Change*, pp. 2411–28.

[20] J. Burke & A. Gambhir, 'Policy Incentives for Greenhouse Gas Removal Techniques: The Risks of Premature Inclusion in Carbon Markets and the Need for a Multi-Pronged Policy Framework' (2022) 3 *Energy and Climate Change*, article 100074, p. 5.

[21] UK Government, n. 13 above.

[22] B.C. Murray, B. Sohngen & M.T. Ross, 'Economic Consequences of Consideration of Permanence, Leakage and Additionality for Soil Carbon Sequestration Projects' (2007) 80(1–2) *Climatic Change*, pp. 127–43, at 127.

[23] See Burke & Gambhir, n. 20 above.

[24] Kyoto Protocol to the United Nations Framework Convention on Climate Change, Kyoto (Japan), 11 Dec. 1997, in force 16 Feb. 2005, Art. 12, available at: http://unfccc.int/resource/docs/convkp/kpeng.pdf.

[25] Ibid.

[26] Murray & Kasibhatla, n. 12 above, p. 8; European Commission, 'Analytical Support for the Operationalisation of an EU Carbon Farming Initiative: Lessons Learned from Existing Result-based Carbon Farming Schemes and Barriers and Solutions for Implementation within the EU', Task 1 and

Under voluntary carbon markets, a different approach is used. Participants generally conclude long-term project contracts, typically ranging from 3 to 100 years, to ensure some degree of permanence.[27] If the stored carbon or parts of it reverse before the project period ends, liability and risk-buffer accounts are intended to ensure that it is being compensated.[28] Tonne-year accounting is an approach to CDR accounting that involves issuing credits incrementally over the project period.[29] After a certain number of so-called 'carbon tonne-years' of storage have been accumulated, a certain number of permanent credits are issued, which cannot be revoked.[30] Based on the lessons learned from this analysis, the article formulates legal considerations on the challenges of permanence and liability that may guide a legislative proposal for an EU legislative act to integrate CRCs into the EU ETS.

Section 2 describes CDR technologies, their regulatory status quo in the EU, and the EU ETS. Challenges related to the integration of CRCs into the EU ETS are identified in Section 3, with a specific focus on permanence and liability. Section 4 analyzes the CDM, voluntary carbon markets, and tonne-year accounting to identify lessons for integration. Section 5 presents legal considerations to inform a potential legislative proposal for the integration of CRCs into the EU ETS, and Section 6 concludes.

2. Technical and Regulatory Context

To further delineate the scope of this article, this section will define CDR and differentiate it from related technologies. It will then explain the required scale of CDR deployment to fulfil global climate goals. Following that, it will outline the foundations of the EU ETS and the current regulation of CDR in the EU.

2.1. Distinguishing CDR from Related Technologies

Within the realm of 'greenhouse gas removal' or 'GHG removal', which refers to the 'withdrawal of a GHG and/or a precursor from the atmosphere by a sink',[31] CDR consists of those measures that target the removal and storage of CO_2.[32] GHG removal encompasses CDR measures but is broader in scope, referring to the set of technologies that

Task 2 Report CLIMA/C.3/ETU/2018/007, July 2020, p. 99, available at: https://ec.europa.eu/clima/system/files/2022-01/policy_forest_carbon_report_en.pdf.

[27] O. Miltenberger, C. Jospe & J. Pittman, 'The Good is Never Perfect: Why the Current Flaws of Voluntary Carbon Markets Are Services, Not Barriers to Successful Climate Change Action' (2021) 3 *Frontiers in Climate*, pp. 1–6, at 4; European Commission, n. 26 above, p. 100.

[28] Ibid.

[29] M. Amano et al., 'Implications of Different Definitions and Generic Issues', in IPCC (I. Noble et al. (eds)), *Land Use, Land-Use Change and Forestry* (Cambridge University Press, 2000), Ch. 2, para. 2.3.6.3; Murray & Kasibhatla, n. 12 above, p. 19.

[30] Murray & Kasibhatla, n. 12 above, p. 19.

[31] J.B.R. Matthews et al., 'Annex I: Glossary', in IPCC (V. Masson-Delmotte et al. (eds)), *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (Cambridge University Press, 2018), pp. 541–60, at 551.

[32] Please note that some references are using the broader term of 'greenhouse gas removal' or 'GHG removal' (GGR): The Royal Society & Royal Academy of Engineering, n. 10 above, p. 13.

remove and store any GHGs from the atmosphere.[33] This article will generally refer to CDR as distinct from GHG removal, in line with the practice of EU institutions.[34]

Carbon capture and storage (CCS) and carbon capture and utilization (CCU) can form an integral part of CDR technologies when they are applied to CO_2 that has been captured from the atmosphere.[35] The capture of CO_2 from the atmosphere can be achieved either indirectly through biomass or directly from the air.[36] CCS and CCU do not qualify as CDR technologies if they are applied to CO_2 from fossil fuel use, as no CO_2 is removed from the atmosphere.[37] CCS can be defined as a 'process in which a relatively pure stream of CO_2 from industrial and energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere'.[38] CCU is referred to as a 'process in which CO_2 is captured and then used to produce a new product'.[39] For example, CCS is an essential part of CDR when used in conjunction with bioenergy (BECCS). In contrast, CCS combined with a coal-fired power plant does not remove any CO_2 from the atmosphere and therefore cannot be considered as CDR. Only when CCS and CCU are components of CDR technologies, are they relevant to the scope of this article.

2.2. Required Levels of Carbon Dioxide Removal

Although GHG emissions reductions are the most important measure for climate change mitigation, GHG removal, of which CDR technologies are the most relevant, will be necessary to achieve the global temperature increase targets of the Paris Agreement:[40] specifically, if we intend to hold 'the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels'.[41] To reach this objective, the Paris Agreement stipulates that parties must aim to 'achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century'.[42] Emissions reductions alone are not sufficient to avoid catastrophic climate change, as scientific research indicates.[43] Of the scenarios

[33] Ibid.

[34] Regulation (EU) 2021/1119 Establishing the Framework for Achieving Climate Neutrality and Amending Regulations (EC) No 401/2009 and (EU) 2018/1999 [2021] OJ L 243/1 (European Climate Law), Recital 22; European Commission, n. 2 above, Recital 2.

[35] M. Babiker et al., 'Cross-Sectoral Perspectives', in IPCC (P.R. Shukkla et al. (eds)), n. 1 above, pp. 1245–354, at 1261.

[36] Ibid.

[37] Ibid.

[38] J.B.R. Matthews et al., IPCC, n. 31 above, p. 544.

[39] Ibid.

[40] The Royal Society & Royal Academy of Engineering, n. 10 above, pp. 10–3.

[41] Paris Agreement, Paris (France), 12 Dec. 2015, in force 4 Nov. 2016, Art. 2(1)(a), available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

[42] Ibid., Art. 4(1).

[43] The Royal Society & Royal Academy of Engineering, n. 10 above, p. 13; J. Rogelj et al., 'Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development', in IPCC, n. 31 above, pp. 93–174, at 118–25.

in integrated assessment models considered at the time of the Paris Agreement, 87% of those that aim to achieve 2°C, and all those that expect 1.5°C, relied partly on GHG removal to reach the temperature targets of the Paris Agreement.[44] Without GHG removal, very drastic emissions reductions would be necessary to reach 2°C, while 1.5°C would remain out of reach.[45] According to a report from the National Academies of Sciences, CDR efforts must annually remove 10 gigatons (Gt) CO_2 by the late 2050s and 20 Gt CO_2 by the late 2090s globally to limit global warming to below 2°C.[46] For comparison, global net anthropogenic GHG emissions amounted to 59 Gt CO_2-eq in 2019.[47] The need to scale up CDR was also emphasized in the Paris Agreement's first global stocktake concluded in the United Arab Emirates in 2023. The document 'calls on Parties' to contribute to the global efforts to accelerate removal technologies such as CCS and CCU, particularly in hard-to-abate sectors.[48]

CDR technologies are not only essential in helping to reach net zero emissions but also for maintaining a net zero status by removing residual hard-to-abate emissions, including those from sectors such as agriculture and aviation. After complete decarbonization, CDR could deliver genuine removal by drawing down 'legacy carbon' remaining in the atmosphere from past emissions.[49]

The Report on the State of Carbon Dioxide Removal by Smith and co-authors finds a 'yawning gap' between the extent to which countries are planning CDR deployment and what will be required to achieve the global temperature increase targets of the Paris Agreement.[50] This also holds for the EU, which is currently not on track to deliver the required level of CDR deployment.[51]

2.3. The European Union Emissions Trading System

The EU ETS was set up in 2005 as the world's first international emissions trading system. It operates in all EU Member States, as well as Liechtenstein, Iceland, and Norway. The EU ETS currently covers installations in the power sector and manufacturing industry, and airlines operating between the participating countries, which make up for approximately 40% of the EU's GHG emissions.[52] It is one of the largest emissions trading systems worldwide.[53] The EU agreed in 2023 to expand the EU ETS to other

44 The Royal Society & Royal Academy of Engineering, n. 10 above, p. 13.
45 Ibid.
46 National Academies of Sciences, Engineering, and Medicine, *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda* (The National Academies Press, 2019), p. 361, available at: https://nap.nationalacademies.org/catalog/25259/negative-emissions-technologies-and-reliable-sequestration-a-research-agenda.
47 59 ± 6.6 $GtCO_2$-eq in 2019: J. Skea et al., IPCC, n. 1 above, p. 10.
48 Draft Decision -/CMA.5, 'Outcome of the First Global Stocktake, of the Paris Agreement', 13 Dec. 2023, UN Doc. FCCC/PA/CMA/2023/L.17, para. 28(e).
49 UK Government, n. 13 above, p. 12; D.R. Morrow et al., 'Principles for Thinking About Carbon Dioxide Removal in Just Climate Policy' (2020) 3(3) *One Earth*, pp. 150–3, at 150.
50 Smith et al., n. 7 above, p. 8.
51 European Commission, n. 2 above, p. 1; Smith et al., n. 7 above, p. 8.
52 European Commission, 'EU Emissions Trading System (EU-ETS)', available at: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en.
53 Rickels et al., n. 5 above, p. 2.

sectors, such as international aviation and maritime transport, and to create a separate emissions trading system for fuel combustion in buildings, road transport, and additional sectors (so-called 'EU ETS II'), which will become operational from 2027 onwards.[54] The European Commission referred to the EU ETS as a 'cornerstone' of the EU's strategy to reduce GHG emissions.[55] The EU ETS regulatory framework is set out in the EU ETS Directive, which has been updated over time.

The EU ETS is a 'cap and trade' system, which sets a cap on the absolute quantity of certain GHG emissions from entities covered by the system.[56] Entities covered by the system must annually surrender sufficient emissions allowances to cover their emissions. Failure to do so may result in heavy penalties. The number of allowances available corresponds with the cap.[57] The cap, and consequently, the total number of allowances, is reduced over time to decrease overall emissions. As a result of supply and demand, the price of emissions allowances is likely to rise, providing an incentive to reduce emissions and invest in low-carbon technologies.[58] Entities covered by the system buy allowances at auctions or, in certain cases, receive them for free.[59] Moreover, allowances can be traded among participants. The market approach is intended to ensure that emissions are reduced in the most cost-effective way.[60] Participants in the EU ETS were able to use international credits from the Kyoto Protocol's CDM to fulfil part of their obligations under the EU ETS until 2020.[61] This was achieved by linking the EU ETS and the Kyoto project-based mechanism.[62]

Eventually, the cap will reach zero, putting an end to the supply of emissions allowances.[63] Entities covered by the system could no longer purchase allowances to cover their GHG emissions. This could become problematic as some GHG emissions will be difficult or even impossible to mitigate.[64] Integrating CRCs into the EU ETS emerges as a solution to cover GHG emissions from these so-called hard-to-abate sectors.[65]

54 Directive (EU) 2023/958 amending Directive 2003/87/EC as regards Aviation's Contribution to the Union's Economy-Wide Emission Reduction Target and the Appropriate Implementation of a Global Market-Based Measure [2023] OJ L 130/115; Directive (EU) 2023/959 amending Directive 2003/87/EC Establishing a System for Greenhouse Gas Emission Allowance Trading within the Union and Decision (EU) 2015/1814 concerning the Establishment and Operation of a Market Stability Reserve for the Union Greenhouse Gas Emission Trading System [2023] OJ L 130/134.

55 European Commission, 'Report from the Commission to the European Parliament and the Council on the Functioning of the European Carbon Market in 2022 pursuant to Articles 10(5) and 21(2) of Directive 2003/87/EC', 31 Oct. 2023, COM(2023) 654 final, p. 3.

56 European Commission, *EU ETS Handbook* (European Union, 2015), p. 4, available at: https://ec.europa.eu/clima/system/files/2017-03/ets_handbook_en.pdf.

57 European Commission, n. 55 above, p. 6.

58 European Commission, n. 52 above.

59 These are, among others, aircraft operators and manufacturing industries: ibid.

60 Ibid.

61 European Commission, n. 55 above, p. 22.

62 Directive 2004/101/EC amending Directive 2003/87/EC Establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community, in respect of the Kyoto Protocol's Project Mechanisms [2004] OJ L 338/18.

63 See M. Pahle et al., 'The Emerging Endgame: The EU ETS on the Road Towards Climate Neutrality', 7 Mar. 2023, p. 2, available at: http://dx.doi.org/10.2139/ssrn.4373443.

64 European Commission, n. 2 above, p. 8.

65 Pahle et al., n. 63 above, p. 2.

2.4. The Current Regulatory Framework of CDR in the EU

At present, the EU ETS does not include a mechanism for the creation of additional allowances or credits through CO_2 removal.[66] Article 2(1) of the EU ETS Directive limits the scope of the directive to positive emissions, excluding negative emissions technologies.

The European Commission published a legislative proposal for a regulation on a carbon removals certification framework in November 2022.[67] The proposed regulation aims to establish a voluntary Union certification framework for carbon removals, with the objective of incentivizing the uptake of high-quality carbon removals.[68] It lays down quality criteria, rules for verification and certification, and rules for the functioning and recognition of certification schemes.[69] This framework intends to form a foundation that policymakers can draw upon to incentivize and govern CDR technologies. It does not currently facilitate the integration of CRCs into the EU ETS. Nevertheless, it could potentially serve as a regulatory foundation for another legislative proposal aimed at integrating CRCs into the EU ETS that were certified under an EU carbon removals certification framework. Participants in the EU ETS would be able to purchase CRCs and use them towards fulfilling their obligations under the EU ETS, or at least parts of it. This option is already foreseen in the EU ETS Directive.[70] Article 30(5)(a) of the EU ETS Directive mandates the EU Commission to report by 31 July 2026 'how negative emissions resulting from greenhouse gases that are removed from the atmosphere and safely and permanently stored could be accounted for and how those negative emissions could be covered by emissions trading'.[71]

In contrast, CCS is already subject to a detailed regulatory framework. The EU ETS Directive provides incentives for the deployment of CCS because the obligation to surrender allowances does not arise for emissions that are verified as captured and transported to an authorized facility for permanent storage.[72] The CCS Directive stipulates, inter alia, provisions for permits and obligations for the operation, closure and post-closure of sites.[73] In the case of carbon leakage, the operator must notify the competent authority and must take corrective measures.[74] Moreover, the operator must surrender EU ETS allowances as CO_2 capture, transport, and storage facilities are covered by the EU ETS.[75] Further liability rules for operators are stipulated in the Environmental

66 Rickels et al., n. 5 above, p. 7.
67 European Commission, n. 2 above.
68 Ibid., Art. 1.
69 Ibid.
70 Art. 30(5)(a) of Directive (EU) 2003/87/EC Establishing a System for Greenhouse Gas Emission Allowance Trading within the Union and amending Council Directive 96/61/EC [2003] OJ L 275/32 (EU ETS Directive).
71 Ibid.
72 Ibid., Art. 12(3a).
73 Directive (EU) 2009/31/EC on the Geological Storage of Carbon Dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] OJ L 140/114 (CCS Directive).
74 Ibid., Art. 16.
75 EU ETS Directive, n. 70 above, Annex I; see CCS Directive, n. 73 above, Recital 30.

Liability Directive and at the Member State level.[76] Most liabilities arising in relation to the storage site are transferred to the competent authority after the storage site has been closed and certain conditions apply so-called risk transfer.[77] These conditions are (i) that all available evidence indicates that the stored CO_2 will be completely and permanently contained, and (ii) that a minimum period has passed (not less than 20 years), which is to be determined by the competent authority.[78] The operator can be held liable, even though the risk transfer has taken place, if the clawback provision pursuant to Article 18(7) applies. This provision allows for the post-transfer recovery of costs if the operator has been at fault, which includes cases of deficient data, wilful deceit, or a failure to exercise due diligence.[79] Before the risk transfer has taken place, the CCS operator is exclusively liable for any CO_2 leakage. For CCS projects under the CDM, a transfer of liability from the project operator to the host state would take place under similar conditions.[80]

3. Challenges for Integrating CRCs into the EU ETS

There are several aspects to consider when integrating CRCs into the EU ETS with regard to permanence and liability, such as the fungibility of CRCs, the benefits of more permanent CDR, the environmental integrity of the EU ETS, and reversal risk management. The following section attempts to identify these aspects and draw conclusions to guide a legislative proposal.

3.1. Why Permanence Matters

Public policy needs to define parameters to determine equivalence between CRCs stemming from different CDR technologies and emissions allowances.[81] Broad fungibility is important for promoting a liquid market that provides sufficient investments to scale up CDR at a high rate.[82] The only common parameter that seems to apply to these units is one metric tonne of CO_2 equivalent.[83] However, it is difficult to define scientifically the equivalence between CO_2 captured and stored through different CDR technologies and avoided CO_2 emissions.[84] This is because the various CDR technologies available differ significantly regarding their levels of permanence.[85] For instance, carbon theoretically

76 A. Pop, 'The EU Legal Liability Framework for Carbon Capture and Storage: Managing the Risk of Leakage While Encouraging Investment' (2015) 6 *Aberdeen Student Law Review*, pp. 32–56, at 43.

77 CCS Directive, n. 73 above, Art. 18(1).

78 Ibid., Art. 18(1)(a)–(b).

79 Ibid., Art. 18(7).

80 Decision 10/CMP.7, 'Modalities and Procedures for Carbon Dioxide Capture and Storage in Geological Formations as Clean Development Mechanism Project Activities, of the Kyoto Protocol', 9 Dec. 2011, UN Doc. FCCC/KP/CMP/2011/10/Add.2, App. B para. 25.

81 Macinante & Ghaleigh, n. 14 above, pp. 20–2.

82 Ibid., p. 17; ISDA, n. 15 above, p. 7.

83 J. Macinante & N.S. Ghaleigh, 'Déjà Vu All Over Again: Greenhouse Gas (GHG) Removals and Legal Liability', *Edinburgh School of Law*, Research Paper No. 2022/14, 7 July 2022, p. 22, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4155563.

84 See Burke & Gambhir, n. 20 above, p. 5.

85 UK Government, n. 13 above, p. 8.

can be stored indefinitely in terrestrial ecosystems, such as forests, peatlands, and soils.[86] However, the risk of reversal as a result of human action – such as deforestation, or natural disturbances, including fire and drought – is relatively high.[87] Carbon stored in biochar in soil, on the other hand, will reverse after a certain period.[88] Some works suggest it can persist on a centennial scale.[89] CO_2 stored in well-selected and well-managed geological formations through BECCS or DACCS can be stored for a thousand years or longer.[90] Under these conditions, reversal is much less likely to occur, although it remains a concern.[91] The quantity of CO_2 escaping from appropriately selected and managed geological formations will 'very likely' remain below 1% over the first 100 years.[92]

Generally, more permanent CDR technologies are more significant from a climate repair perspective than less permanent technologies.[93] This is because, in the event of a reversal, the original benefits of the CDR project are reversed to some extent, depending on when the reversal occurs.[94] However, the value of temporary removal of CO_2 is not zero.[95] A CDR project does not have to remove a tonne of CO_2 indefinitely to effectively offset a tonne of CO_2 emitted. This is because the bulk of the original emission does not stay in the atmosphere eternally, as atmospheric CO_2 is being sequestered through natural processes over time. Only a fraction of the CO_2 emitted remains in the atmosphere essentially forever.[96] Even if the removed CO_2 reverses before the original emission has fully decayed, a certain percentage of CO_2 has already been taken from the atmosphere, thus reducing the global net atmospheric CO_2 concentration. For instance, a CDR project that reverses after 100 years has the net effect of a 39% reduction relative to no CDR. This increases to 66% after 1,000 years.[97] Moreover, temporary removal of CO_2 can buy humanity time to develop methods to permanently remove CO_2.[98] Therefore, CDR technologies with low levels of permanence entail benefits.[99]

86 The Royal Society & Royal Academy of Engineering, n. 10 above, p. 26.
87 IPCC, n. 29 above, para. 2.3.6.2.
88 The Royal Society & Royal Academy of Engineering, n. 10 above, p. 74.
89 Ibid.
90 N. Bey et al., *Certification of Carbon Removals Part 1: Synoptic Review of Carbon Removal Solutions*, REP-0795 (Environment Agency Austria, 2021), p. 19, available at: https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0795.pdf; The Royal Society & Royal Academy of Engineering, n. 10 above, p. 75.
91 Ibid.
92 E. Rubin et al., 'Technical Summary', in IPCC (B. Metz et al. (eds)), *Special Report on Carbon Dioxide Capture and Storage* (Cambridge University Press, 2005), pp. 17–50, at 34.
93 J.C. Abanades et al., 'Summary for Policymakers', in IPCC, *Special Report on Carbon Dioxide Capture and Storage*, ibid., pp. 1–16, at 5.
94 Murray, Sohngen & Ross, n. 22 above, p. 129.
95 IPCC, n. 29 above, para. 2.3.6.3.
96 Murray & Kasibhatla, n. 12 above, p. 5; H. Riebeek, 'The Carbon Cycle', *NASA Earth Observatory*, 16 June 2011, available at: https://earthobservatory.nasa.gov/features/CarbonCycle.
97 UK Government, n. 13 above, p. 12.
98 Taskforce on Scaling Voluntary Carbon Markets, 'Phase II Report', *The Institute of International Finance*, 8 July 2021, p. 75, available at: https://www.iif.com/Portals/1/Files/TSVCM_Phase_2_Report.pdf.
99 IPCC, n. 29 above, para. 2.3.6.3; Murray & Kasibhatla, n. 12 above, p. 3.

In other words, CDR technologies with high levels of permanence are more valuable than those with low levels of permanence, but CDR technologies with low levels of permanence still provide benefits.

3.2. Risks of Low Levels of Permanence for Integration

Integrating CRCs issued for CDR technologies with low levels of permanence into the EU ETS could pose two main challenges.

Firstly, by compensating for emissions with CDR that have low levels of permanence, the environmental integrity of the EU ETS could be jeopardized. For instance, if CRCs can be used for compliance under the EU ETS, one tonne of CO_2 can be emitted by submitting a CRC. This would be acceptable from a climate perspective because the tonne of CO_2 emitted is offset by the removal. However, this calculation holds only if the removal is sufficiently permanent. If the captured and stored tonne of CO_2 reverses after a certain period, a certain net amount of CO_2 is added to the atmosphere.[100] The transfers of CRCs would then lead to an increase in aggregated global emissions and undermine the environmental integrity of the system. This result could be addressed through regulations on liability. However, liability presents its own set of challenges and should not be the primary mechanism to manage permanence issues, as further discussed in the next section.

Secondly, an EU legislative act that does not consider the different levels of permanence would create economic incentives to deploy currently cheaper and less permanent CDR technologies.[101] Therefore, permanent CDR technologies would not be scaled up and the goal of reaching carbon neutrality in the long term would be threatened. Less permanent CDR technologies, such as afforestation, are generally cheaper, whereas most engineering-based approaches that show high levels of permanence, such as BECCS and DACCS, are currently relatively expensive.[102] This is problematic, as sufficient investments in engineering-based CDR are critical for reaching net zero emissions and maintaining it.[103]

Therefore, an EU legislative act must consider the different levels of permanence of the CDR technologies when integrating CRCs into the EU ETS.

3.3. Liability as a Risk Management System

A common approach under the CCS Directive,[104] and under many voluntary carbon schemes,[105] is to hold the project operator liable for any re-emissions. There are several mechanisms available to hedge reversal risks. In many voluntary carbon schemes,

[100] IPCC, n. 29 above, para. 2.3.6.2.

[101] See Macinante & Ghaleigh, n. 83 above, p. 21.

[102] UK Government, n. 13 above, p. 7; S. Fuss et al., 'Negative Emissions – Part 2: Costs, Potentials and Side Effects' (2018) 13(6) *Environmental Research Letters*, pp. 1–47, at 36.

[103] The Taskforce on Scaling Voluntary Carbon Markets, 'Final Report', *The Institute of International Finance*, Jan. 2021, p. 10, available at: https://www.iif.com/Portals/1/Files/TSVCM_Report.pdf.

[104] EU ETS Directive, Annex I; see CCS Directive, Recital 30.

[105] These are not limited to the EU but operate worldwide: Murray & Kasibhatla, n. 12 above, p. 8.

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project operators have to retain a certain portion of the received credits in a risk buffer account, often ranging from 10 to 40%.[106] Under some schemes, the portion relies on the project's *ex ante* risk rating.[107] This portion cannot be sold for a predetermined period and should be used to compensate for reversals.[108] Risk pooling is a variant of risk buffer accounts, where multiple CDR projects keep a common buffer account. An advantage of this pooled approach is that individual contributions may be less than those for individual buffer accounts.[109] Moreover, there are non-permanence insurances that cover a portfolio of different CDR projects.[110] A combination of these approaches is also possible.

Situations where liability becomes necessary should be avoided in the first place as liability itself entails many risks. For instance, it can be very challenging to identify the relevant emitter and enforce the liability against them, depending on with whom the liability lies and the time frame.[111] Companies may be insolvent, untraceable, or no longer exist.[112]

Moreover, if CDR were to reverse simultaneously on a large scale, exacerbated by extreme weather events caused by climate change in the future, the liability system could be at risk of collapsing.[113] For instance, in the event of catastrophic forest fires, many CDR projects for which CRCs have been issued could be reversed. The liable entities, most likely the project operators, would have to compensate for the climate damage by surrendering CRCs or emissions allowances. If such reversal events were sufficiently large, the demand for CRCs and emissions allowances would soar, most likely driving up prices significantly and potentially pushing many project operators into bankruptcy. This will become even more problematic as the number of emissions allowances in the market will continue to decline. Once there are no more emissions allowances left in the EU ETS, CRCs issued for failed CDR can be replaced only with other CRCs. Depending on the availability of CRCs and demand at the time, this could be a costly undertaking. Risk buffer accounts and non-permanent insurance can increase the resilience of the system, but they too have limitations. The question then becomes, who is going to ensure that the reversed CO_2 is compensated for if the project operator fails? Most likely, this will be the responsibility of the Member States. In the event that the reversals are not fully offset, the environmental integrity of the EU ETS would be undermined, as more CO_2 would have been emitted than in a situation where there was no trading of CRCs. This is because integrating CRCs

[106] E.g., 20% under the Gold Standard for forestry projects: 'Gold Standard: Land Use Activities + Nature Based Solutions', available at: https://www.goldstandard.org/our-story/sector-land-use-activities-nature-based-solutions (Gold Standard).

[107] Murray & Kasibhatla, n. 12 above, p. 10.

[108] The discounts range from 5 to 60%: European Commission, n. 26 above, pp. 101–4.

[109] A. Angelsen (ed.), *Moving Ahead with REDD: Issues, Options and Implications* (Center for International Forestry Research, 2008), p. 81, available at: https://www.cifor.org/publications/pdf_files/Books/BAngelsen0801.pdf.

[110] Ibid.

[111] UK Government, n. 13 above, p. 13.

[112] Macinante & Ghaleigh, n. 83 above, p. 30.

[113] Murray, Olander & Kanak, n. 17 above, p. 11; Murray & Kasibhatla, n. 12 above, p. 19.

would expand the total gross GHG emissions permissible under the EU ETS. This expansion would be acceptable as the additional GHG emissions would be offset by CDR, leaving the net GHG emissions trajectory unaffected. Nonetheless, this reasoning remains valid only if the CO_2 is stored permanently. Should the stored CO_2 reverse prematurely, the original emission is no longer (fully) offset. In this scenario, more GHG emissions would have occurred than in a scenario where no CRCs were traded under the EU ETS and the environmental integrity of the system would be disrupted.

For these reasons, liability should be seen as a legal safeguard for exceptional circumstances and not as a general solution for the permanence problem. Situations that give rise to liability need to be prevented from the outset to avoid the above issues in advance.[114]

4. Analysis of Approaches to Integration from Practice and Literature

There are various approaches considered to address the permanence issue. This article analyzes the Clean Development Mechanism, voluntary carbon markets, and tonne-year accounting to identify lessons for the EU ETS.

4.1. Clean Development Mechanism

Under the former Clean Development Mechanism of the Kyoto Protocol, removal projects in developing countries (non-Annex I parties) could generate temporary carbon credits.[115] Each temporary credit would represent a tonne of CO_2-equivalent removed. Developed state parties (Annex I parties) could buy and use these temporary credits to meet part of their emissions reduction commitments under the Kyoto Protocol. These temporary credits would expire after a certain time because of concerns regarding the limited permanence of removal projects. Eventually, the temporary credits had to be replaced by the purchaser with permanent credits at a one-to-one ratio.[116]

Only a limited range of CDR technologies, primarily afforestation and reforestation, were eligible under the CDM.[117] An important reason to make credits temporary was concern about the potential reversibility of the stored carbon. Afforestation and reforestation were considered temporary solutions to gain time in which to develop the technologies to effectively mitigate climate change.[118] They were not regarded as long-term solutions that could generate credits equivalent to credits from emissions reduction projects. This practice ensured the environmental integrity of the CDM regarding removal projects, as no emissions could be offset by CDR in the long term. This does not pertain

[114] The 'tonne-year accounting' and temporary credits under the CDM address the permanence issue at the credit issuance stage, rather than at the liability stage. They do not oblige the project operator to repay for reversals. They are discussed further below.
[115] Kyoto Protocol, n. 24 above, Art. 12.
[116] Murray & Kasibhatla, n. 12 above, p. 8; European Commission, n. 26 above, p. 99.
[117] Murray & Kasibhatla, n. 12 above, p. 8.
[118] Z. Salinas et al., '*BioCarbon Fund Experience: Insights from Afforestation and Reforestation Clean Development Mechanism Projects* (World Bank, 2011), pp. 46–7, available at: https://openknowledge.worldbank.org/server/api/core/bitstreams/da9a4b7a-bfa0-5d4a-89a5-c41b401fa9b4/content.

to problems regarding the accuracy of monitoring and additionality of removal projects as they are outside the scope of this study.

Temporary credits represented only a marginal piece of the CDM carbon market. They were excluded from most emissions trading schemes, such as the EU ETS, particularly because of concerns about permanence, the accuracy of monitoring, and liability.[119] For example, temporary credits would have created liability risks under the EU ETS because a company that wanted to cease operations could sell its permanent credits and replace them with cheaper temporary credits. If the company ceased to exist, it could no longer replace the temporary credits with permanent credits. Consequently, the Member State in which the company operated had to cover the expired credits.[120]

Investments in CDR projects under the CDM were very weak;[121] this was mainly as a result of the restrictive regulatory approach under the CDM.[122] Temporary credits were complex and not fungible with other carbon assets.[123] They were not admitted under the EU ETS, which was the largest market for CDM credits.[124] They were difficult to manage and transfer because of the obligation to replace them.[125] Perhaps most importantly, temporary carbon sequestration was not valued as the replacement ratio with permanent credits was one-to-one.[126]

4.2. Voluntary Carbon Markets

Many companies purchase carbon credits on voluntary carbon markets to offset their emissions.[127] Voluntary carbon credits are issued by carbon standards[128] for the reduction or removal of GHG emissions.[129] Each carbon standard sets its own rules with which CDR projects must comply to be certified. The quality and price of the credits can consequently vary significantly, as each project uses a specific technology and shows disparate levels of permanence.[130] In 2021, the value of voluntary carbon market transactions exceeded US$ 1 billion, more than doubling since 2020.[131] Currently,

[119] Ibid., p. 53.

[120] European Commission, 'Commission Staff Working Document: Accompanying Document to the Proposal for a Directive of the European Parliament and of the Council Amending Directive 2003/87/EC so as to Improve and Extend the EU Greenhouse Gas Emission Allowance Trading System: Impact Assessment', 23 Jan. 2008, SEC(2008) 52, p. 58.

[121] Murray & Kasibhatla, n. 12 above, p. 18.

[122] European Commission, n. 26 above, p. 99.

[123] Salinas et al., n. 118 above, p. 55.

[124] H. McDonald et al., *Certification of Carbon Removals Part 2: A Review of Carbon Removal Certification Mechanisms and Methodologies*, REP-0796 (Environment Agency Austria, 2021), p. 85, available at: https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0796.pdf.

[125] Salinas et al., n. 118 above, p. 47.

[126] Murray & Kasibhatla, n. 12 above, p. 11.

[127] ISDA, n. 15 above, p. 26.

[128] E.g., Verified Carbon Standard (Verra) or Gold Standard (n. 106 above).

[129] ISDA, n. 15 above, p. 25.

[130] Ibid., p. 26.

[131] R. Macquarie, 'Searching for Trust in the Voluntary Carbon Markets', Grantham Research Institute on Climate Change and the Environment at LSE, 16 Feb. 2022, available at: https://www.lse.ac.uk/granthaminstitute/news/searching-for-trust-in-the-voluntary-carbon-markets.

they mainly finance nature-based solutions such as afforestation or soil carbon sequestration in the removal sector.[132]

A typical approach taken by participants in voluntary carbon markets to ensure some degree of permanence is through long-term project contracts, typically ranging from 3 to 100 years.[133] The length of these contract periods is based on contractual realities rather than any notional definition of permanence or atmospheric residence of CO_2.[134] Contractual realities in this sense refer to the period deemed appropriate to require private parties to ensure the safe storage of carbon. The carbon credits are typically issued at the beginning of a project and the carbon must remain stored during the contract period.

If any part of the carbon reverses before the project period ends, liability and risk-buffer accounts are intended to ensure the environmental integrity of the system. Many standards distinguish between intentional and unintentional reversal.[135] In the case of unintentional reversal, such as wildfires, the credits from the (pooled) risk buffer are generally used to replace the loss. If the reversal was caused intentionally, such as through the resumption of deforestation by the project operator, all previously issued credits must generally be replaced by the project operator. Thus, the project operator loses all the benefits it has received.[136]

The approach of voluntary carbon markets does not ensure that carbon is removed and stored for a significant period in atmospheric terms. Most project contracts stipulate project lengths of up to 100 years, yet many contract periods are significantly shorter.[137] From an atmospheric perspective, 100 years is a relatively short period because CO_2 resides in the atmosphere for much longer.[138] As mentioned above, the storage of CO_2 for 100 years has the effect of reducing atmospheric carbon stock by just 39% compared with no CDR.[139] However, from a contractual perspective, 100 years is a long period of time as many project operators are not willing to or are not capable of committing further into the future.

The practice of many voluntary carbon standards to issue credits at the beginning of the project period could jeopardize the stability of the system. Large-scale simultaneous reversals could push the risk management system of liability and risk buffer accounts to its limits. The possibility of such a scenario, coupled with relatively short contract periods, forges a vulnerability that questions the environmental integrity of the system.

132 L. Singleton, 'Nature-Based Solutions Can Mitigate Impact of Climate Change on Agriculture', *Imperial College London*, 2 Dec. 2021, available at: https://www.imperial.ac.uk/news/232336/nature-based-solutions-mitigate-impact-climate-change; World Bank, 'State and Trends of Carbon Pricing 2022', 24 May 2022, p. 44, available at: https://openknowledge.worldbank.org/handle/10986/37455.

133 Miltenberger, Jospe & Pittman, n. 27 above, p. 4; European Commission, n. 26 above, p. 100.

134 Murray & Kasibhatla, n. 12 above, p. 19; European Commission, n. 26 above, p. 102.

135 Murray & Kasibhatla, n. 12 above, p. 19; European Commission, n. 26 above, pp. 188–9.

136 Murray & Kasibhatla, n. 12 above, p. 8.

137 European Commission, n. 26 above, p. 100; A. Kollmuss, H. Zink & C. Polycarp, 'Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards', World Wildlife Fund & Stockholm Environment Institute, Mar. 2008, pp. 28–9, available at: https://wwfint.awsassets.panda.org/downloads/vcm_report_final.pdf.

138 Murray & Kasibhatla, n. 12 above, p. 19.

139 UK Government, n. 13 above, p. 12.

Furthermore, most voluntary carbon schemes do not reward temporary carbon storage if it is reversed intentionally before the end of the contract period. In this case, temporary carbon storage is worthless even though the project did create some climate benefits and investments were made. Consider, for example, a reforestation project with a contract period of 100 years. The project reverses fully after 90 years as a result of the resumption of deforestation by the project operator. The project operator must then replace all the credits it has received for this project and the investments that it has made are lost. One could argue that this result is justified to prevent project operators from intentionally undoing CO_2 storage. However, the project operator might have substantial impending reasons, including a financial crisis, and has already created some benefits by storing CO_2 for 90 years. This 'all-or-nothing approach' may deter the deployment of CDR projects at the forefront.

4.3. Tonne-Year Accounting

Another approach, referred to in the literature as 'tonne-year accounting', involves issuing credits incrementally over the project period. Permanent credits are issued after a certain number of carbon tonne-years of storage have been achieved.[140] This way, storage periods with varying lengths can be put in equivalent and fungible units. Murray and Kasibhatla describe this approach as 'less conservative than temporary crediting', which was practised under the CDM, and 'more conservative than prepaid credits and buffer provisions', which are typically used in voluntary carbon markets.[141]

Murray and Kasibhatla suggest that policymakers should stipulate a time period, such as 100 years, for carbon storage after which full permanence is earned. This period must not represent a permanent emissions reduction in atmospheric terms but should serve as a 'policy-relevant target for de facto permanence'.[142] Once a certain number of carbon tonne-years have been accumulated, a certain degree of permanence has been achieved and cannot be reversed. The more carbon that is stored for longer periods, the more permanence is gained. Hence, the level of permanence and therefore the value of the project accumulate exponentially over time.

This approach tries to pursue a middle ground between 'prepaid credits' that are given out at the beginning of a project, such as in voluntary carbon markets, and the option to receive the credits at the end of the project period. In this case, operators earn credits incrementally over the course of the project. Murray and Kasibhatla claim that this approach 'seems to reduce vulnerability of the entire system to reversal risk'.[143] It builds on the rationale that short-term removal of CO_2 still entails some benefits and should be rewarded, which is reflected in an incrementally increasing value of the CO_2 storage. It seeks to ensure the environmental integrity of the system by allowing no more emissions than have been 'earned' through the accumulation of carbon tonne-years. Contrary to voluntary carbon schemes, this approach does not rely on liability.

140 IPCC, n. 29 above, para. 2.3.6.3; Murray & Kasibhatla, n. 12 above, p. 19.
141 Murray & Kasibhatla, n. 12 above, p. 19.
142 Ibid.
143 Ibid.

The credits are irrevocable, even though a CDR project might reverse in the future.[144] Therefore, the system is resilient and challenges relating to liability are being avoided.

It is important to carefully define the period that is considered permanent, after which the full credits are received. If it were too short, the environmental integrity of the system would be low, and it would incentivize the deployment of currently cheaper low permanent CDR technologies. For instance, if the period were to be 100 years, this threshold could be reached through afforestation. CO_2 storage beyond this point would not be rewarded, as full credits are earned after 100 years and no liability arises in the event of reversal after that time.

This approach has been criticized on the basis that it is questionable that the delayed revenue stream would provide sufficient financial incentives to scale up CDR rapidly and significantly.[145] For many CDR technologies, costs are incurred at the beginning of the project, while payment would be made after permanence has been earned. This might deter investors. An EU report on carbon farming flagged a practice in voluntary carbon schemes as problematic from a cash-flow perspective, which issued credits after the carbon has been sequestered.[146] The report states that the 'associated lagging stream of revenues is the main structural barrier that has led to the limited uptake of reforestation activities'.[147] This criticism applies *a fortiori* to tonne-year accounting as carbon sequestration occurs before a certain degree of permanence has been earned. Moreover, the final report of the Taskforce on Scaling Voluntary Carbon Markets identified the 'long lag times between investment and return' and the accompanying 'lack of financial attractiveness' as a significant mobilization challenge.[148] This issue of scattered financial flows could be addressed by reducing the level of liability in proportion to the reduction in the global warming potential of the original emission, as opposed to earning credits once carbon tonne-years have been accumulated. In other words, instead of issuing credits incrementally, the level of liability is decreasing according to the accumulation of carbon tonne-years. In this way, the full number of credits can be issued at the beginning of the project period. CDR deployment, therefore, is made more financially attractive. In the case of a reversal, only the remaining global warming potential of the original emissions at the time of the reversal must be compensated, rather than demanding the submission of all the credits that were originally issued for the project.

However, there are more fundamental criticisms of tonne-year accounting in the scientific community. It has been criticized for the use of subjective economic discount rates and arbitrary time horizons to assess the costs of emissions and the benefits of temporary storage.[149] Others have argued that equivalence claims between temporary car-

144 Ibid., p. 17.
145 Angelsen, n. 109 above, p. 81.
146 European Commission, n. 26 above, p. 91.
147 Ibid.
148 Taskforce on Scaling Voluntary Carbon Markets, n. 103 above, p. 51.
149 M.D. Hurteau, B.A. Hungate & G.W. Koch, 'Accounting for Risk in Valuing Forest Carbon Offsets' (2009) 4 *Carbon Balance and Management*, article 1, pp. 1–2.

bon storage and avoided emissions or permanent storage are flawed.[150] The Article 6.4 Mechanism Supervisory Body stated that it will 'focus on measures that address reversals on a tonne-for-tonne basis, and not on a tonne-year basis' because of concerns 'within the scientific community, regarding its underpinning methods and assumptions, and ecological implications, and insufficient confidence in its suitability for international applications and effectiveness at addressing reversals'.[151]

4.4. Lessons Learned

The restrictive approach to CDR taken under the CDM did ensure that no emissions were permanently offset by non-permanent carbon removal, thereby ensuring the environmental integrity of the system in this respect. However, the CDM failed to encourage extensive investments in CDR. CDR were not sufficiently valued, as temporary credits had eventually to be replaced with permanent credits on a one-to-one ratio. Such an approach might have been satisfactory at this time because afforestation and reforestation were perceived as temporary solutions. However, it will not be sufficient to achieve the current goal of scaling up CDR rapidly and significantly.

The approach of voluntary carbon schemes has the potential to drive investment, as evidenced by high demand and growth rates. However, the contract periods that guarantee safe storage of CO_2 are relatively short and the system relies heavily on liability and risk buffer accounts. This approach does not seem to offer the best solution to ensure environmental integrity.

The tonne-year approach does not rely on liability and risk buffer accounts, which avoids challenges regarding execution, and which bolsters the system's resilience. Short-term CDR technologies are valued based on the benefits they provide. However, concerns about the underlying methods and assumptions, as well as the environmental impacts, make this approach less favourable. In addition, the dispersed financial flow would most likely not encourage sufficient investment in CDR.

From the analysis of these approaches, it appears that a right balance must be struck, particularly between encouraging investments and ensuring environmental integrity. Too stringent rules on permanence and liability can present barriers to participation while loose rules can jeopardize environmental integrity.[152]

5. Legal Considerations to Guide a Legislative Proposal

This section aims to inform a potential legislative proposal for the integration of CRCs into the EU ETS.[153]

[150] F. Chay et al., 'Unpacking Ton-Year Accounting', *CarbonPlan*, 31 Jan. 2022, available at: https://carbonplan.org/research/ton-year-explainer.

[151] UNFCCC, Article 6.4 Mechanism Supervisory Body, 'Meeting Report: Fifth Meeting of the Article 6.4 Mechanism Supervisory Body', 31 May–3 June 2023, p. 8, available at: https://unfccc.int/sites/default/files/resource/a64-sb005.pdf.

[152] See T. Ruseva et al., 'Additionality and Permanence Standards in California's Forest Offset Protocol: A Review of Project and Program Level Implications' (2017) 198(1) *Journal of Environmental Management*, pp. 277–88, at 277.

[153] The integration of CDR into the EU ETS II would pose equivalent challenges regarding permanence and liability and will therefore not be addressed separately.

5.1. Permanence

The EU intends to create a certification framework for all types of carbon removal, not all of which will be eligible for integration into the EU ETS because of their varying levels of permanence. Therefore, the article argues that the EU should create a distinct, more stringent definition of permanence, specifically for the purpose of integrating CRCs into the EU ETS.

The Commission's proposal for a carbon removals certification framework defines permanent carbon storage as 'a carbon removal activity that, under normal circumstances and using appropriate management practices, stores atmospheric or biogenic carbon for several centuries'.[154] This definition must be further elaborated. The EU should explicitly define a time frame that it deems permanent. Currently, it is not specified what exactly is meant by 'several centuries'. This could lead to uncertainties about whether specific CRCs are eligible for integration into the EU ETS, and therefore hinder investment and deployment.

This article proposes to define permanent CDR as technologies that have a relatively low risk of significant CO_2 reversals prior to the end of the period considered permanent. This definition uses three variables to determine the permanence of CDR technologies: (i) what storage period is deemed permanent; (ii) what constitutes a significant reversal of the stored CO_2; and (iii) what constitutes a low reversal risk. Depending on the exact definition of these variables, many nature-based solutions could be considered non-permanent, whereas engineered CDR technologies (such as BECCS and DACCS) could be regarded as permanent.

Firstly, the EU must determine the permanent storage period. Defining the permanent storage period is about finding the right balance between ensuring the environmental integrity of the EU ETS and scaling as many CDR activities as possible. If the permanent storage period is too long, many CDR technologies would be excluded from the market, which otherwise could provide valuable (temporary) storage. If it is too short, the level of environmental integrity of the EU ETS would diminish. There is no uniform definition of permanence.[155] Murray and Kasibhatla define permanence 'as the point in time at which stored carbon has essentially fulfilled its role as offsetting the global warming potential of the original emission'.[156] This definition should guide the determination of the permanent storage period. The stored carbon must offset a significant percentage of the global warming potential of the original emission, rather than fully offset it. This approach does not guarantee complete environmental integrity as a certain percentage of the original emission will remain in the atmosphere. However, it is necessary to draw a line because a certain percentage of the original emission will inevitably remain in the atmosphere nearly forever, making it almost impossible for it to be fully offset. In addition, the temporary removal offers other benefits, such as buying humanity time in which to develop more permanent CDR technologies.

154 European Commission, n. 2 above, Art. 2(1)(g).
155 Vivid Economics, n. 5 above, p. 42.
156 Murray & Kasibhatla, n. 12 above, p. 3.

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Secondly, the EU must stipulate what constitutes a significant reversal of the stored CO_2 in addition to what is considered a high *versus* low reversal risk. A possible problem in that respect is the lack of information regarding the reversal risks of certain CDR technologies.[157] To address this knowledge gap, the precautionary principle[158] should apply. When the reversal risk is not sufficiently clear, a CDR technology shall be deemed non-permanent in order to ensure the environmental integrity of the system. Further research is required to better understand the reversal risks of CDR technologies.

The Commission's proposal suggests that the 'validity of the certified carbon removals should depend on the expected duration of the storage and the different risks of reversal associated with the given carbon removal activity'.[159] CDR technologies that store carbon in geological formations should not be subject to an expiry date as they provide enough certainty on the long-term duration of the stored carbon. The validity of the certified carbon removals from carbon farming or carbon storage in products, conversely, should be subject to an expiry date as they are more exposed to the risk of re-emission. After the expiration date, the carbon should be considered as re-emitted unless the operator demonstrates the maintenance of carbon storage through continuous monitoring activities. This article argues that CRCs with an expiration date should not be integrated into the EU ETS, as the experiences with temporary credits under the Kyoto Protocol have demonstrated.[160] The expiry of certain credits would make them not fungible with indefinite CRCs and emissions allowances, thus increasing complexity and administrative work. Therefore, CRCs with an expiration date are likely to be unattractive to market participants. Instead, this article proposes a clear cut between permanent and non-permanent CDR technologies. Only CRCs issued for permanent CDR technologies should be integrated into the EU ETS. Non-permanent CDR technologies, particularly those with strong co-benefits, should be promoted through other mechanisms such as the Innovation Fund,[161] the Common Agricultural Policy,[162] the Regional Development Fund,[163] or by means of a distinct market for non-permanent

157 UK Government, n. 13 above, p. 13; European Commission, n. 26 above, p. 101; The Royal Society & Royal Academy of Engineering, n. 10 above, p. 74.

158 The precautionary principle is an approach to risk management which demands that if there is a possibility that a particular policy or action could cause harm to the public or the environment, and there is not yet scientific consensus on the issue, the policy or action in question should not be undertaken; the policy or action may be reviewed as more scientific information becomes available. This principle is enshrined in Art. 191 of the Treaty on the Functioning of the European Union, Lisbon (Portugal), 13 Dec. 2007, in force 1 Dec. 2009 [2012] OJ C 326/47, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2012:326:FULL:EN:PDF.

159 European Commission, n. 2 above, Recital 13.

160 See Murray & Kasibhatla, n. 12 above, p. 18; Salinas et al., n. 118 above, p. 55; McDonald et al., n. 124 above, p. 85.

161 The Innovation Fund is the largest EU funding programme for the deployment of net zero and innovative technologies: European Commission, 'What is the Innovation Fund?', available at: https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/what-innovation-fund_en.

162 The Common Agricultural Policy is the EU's central agricultural policy that implements subsidies and other programmes: European Commission, 'The Common Agricultural Policy at a Glance', available at: https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en.

163 The European Regional Development Fund finances programmes in shared responsibility between the European Commission and national and regional authorities in Member States to strengthen economic,

CRCs. This is because the benefits of short-term removal and storage of CO_2 cannot outweigh the risks that their inclusion would pose for the environmental integrity of the EU ETS as a result of potential large-scale reversal events. It is crucial to remember that the EU ETS is a cornerstone, if not the leading mechanism, in the EU ambition to reduce its emissions. Therefore, the standard of environmental integrity must be high.

5.2. Liability

The Commission's proposal for a carbon removals certification framework does not specify what a liability system could look like. It only calls for 'appropriate liability mechanisms', which could include discounting of carbon removal units, collective buffers, or up-front insurance mechanisms.[164] With regard to the geological storage of CO_2, the liability mechanisms and corrective measures of the EU ETS Directive and the CCS Directive should apply to avoid double regulation.[165] The Commission's proposal makes it clear that the project operator or a group of operators should be liable for any re-emission of a CDR project.[166] This is compelling as the project operator is the best place to address any reversal, both with regard to knowledge of the project and access to the site.[167] Passing the liability risk to the purchaser of the removal unit would provide a 'perverse incentive' to the project operator not to bear responsibility for safe storage.[168]

One way of establishing a liability regime is to include CDR technologies in Annex I of the EU ETS Directive, which lists the activities covered by the EU ETS. In the event of a reversal, allowances or CRCs would have to be submitted as for any other source of GHG emissions. This approach has been taken for CCS activities.[169] This liability regime would be robust if only CRCs issued for permanent CDR technologies were integrated into the EU ETS. Large-scale, simultaneous reversals that overwhelm the system would then be unlikely. Liability should become relevant only when a CDR project reverses before the permanent storage period ends. It should not apply after that period, as a significant percentage of the original emission will have decayed by that time.

This article distinguishes between two reversal scenarios: disastrous and non-disastrous. A 'disastrous reversal' should be defined as a kind of reversal caused by catastrophes beyond the control of the project operator, such as drought, wildfires, flooding, earthquakes, storms, tornados, or human-induced events. A 'non-disastrous reversal' could be defined as a reversal that does not fall within the category of disastrous reversals, particularly because the project operator had been at fault. This applies, for instance, in situations where the project operator acted intentionally or failed to exercise due diligence. The distinction between these scenarios is practised widely in

social, and territorial cohesion in the European Union: European Commission, 'The European Regional Development Fund', available at: https://ec.europa.eu/regional_policy/funding/erdf_en.

164 European Commission, n. 2 above, Art. 6.2(b).

165 Ibid., Recital 14.

166 Ibid., Art. 6.2 (b).

167 Macinante & Ghaleigh, n. 83 above, pp. 13–4.

168 Ibid.

169 Annex I EU ETS Directive.

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voluntary carbon schemes.[170] The clawback provision of Article 18(7) of the CCS Directive introduces a similar differentiation.

This article proposes that the project operator should be liable in the event of a non-disastrous reversal until the end of the permanent storage period. In the case of a disastrous reversal, the liability risk should be transferred from the project operator to the competent authority when certain conditions apply. Lessons can be drawn from the CCS liability regime because both CCS and permanent CDR demonstrate high levels of permanence. BECCS and DACCS, which most likely fall within the category of permanent CDR, rely on CCS for the storage of removed CO_2. Under the CCS Directive, a transfer of liability risk from the operator to the competent authority takes place.[171] For CDR, a risk transfer should apply under similar conditions because liability periods that are too long are unpredictable and uninsurable, and therefore are likely to discourage the deployment of and investment in CDR.[172] The conditions for a risk transfer should be, alongside other possible requirements, that (i) all information available must indicate that the bulk of the stored CO_2 will be safely contained until the end of the permanent storage period, and (ii) that a minimum period has passed. The allocation of part of the liability to the Member State would be justified by the public interest in the widespread application of CDR to tackle climate change.[173] Moreover, large reversals that force the Member State to make payments under the liability scheme are unlikely to occur when only CRCs issued for CDR technologies with high levels of permanence are integrated.

6. Conclusion

Permanence and liability will be pivotal elements in discussions surrounding the potential integration of CRCs into the EU ETS. This article has highlighted several key challenges to these discussions, including the necessity of achieving fungibility among CRCs derived from diverse CDR technologies and emissions allowances to create a liquid market that provides sufficient investments to scale up CDR. Achieving fungibility currently faces difficulties as the various CDR technologies available demonstrate different levels of permanence. Accounting for these differences is essential because CDR with high levels of permanence holds greater climate value compared with CDR with low levels of permanence, albeit that the latter still yields benefits. Integrating non-permanent CRCs into the EU ETS could also compromise the environmental integrity of the EU ETS as large-scale reversal events could overwhelm the liability system, particularly once the supply of emissions allowances ends.

The CDM, voluntary carbon markets, and tonne-year accounting provide mechanisms to address these issues, but are found to be insufficient. The CDM failed to

[170] Murray & Kasibhatla, n. 12 above, p. 19; European Commission, n. 26 above, pp. 188–9. The Verified Carbon Standard refers to these as avoidable and unavoidable reversals: 'Program Definitions', v4.4, 29 Aug. 2023, available at: https://verra.org/wp-content/uploads/2023/08/VCS-Program-Definitions-v4.4.pdf.

[171] CCS Directive, n. 73 above, Art. 18(1).

[172] For the CCS liability regime see Pop, n. 76 above, p. 52.

[173] Ibid., p. 56.

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stimulate investments in CDR as credits were issued temporarily and not sufficiently valued. The approach adopted under many voluntary carbon markets does not appear to offer optimal solutions to ensure environmental integrity. The contract periods that guarantee safe storage of CO_2 are relatively short and the system relies extensively on liability and risk buffer accounts for managing reversals. With regard to the tonne-year approach, the dispersed financial flow would most likely not encourage sufficient investment in CDR, and the underlying methods and assumptions are questionable.

Integrating CRCs into the EU ETS revolves around accommodating the requirements, needs, and interests involved, despite being seemingly contradictory at times. These factors encompass, among many others, environmental integrity, the interests of project operators and investors, and the imperative to rapidly and substantially scale up CDR. An EU legislative act must strike a balance that considers all of these to the greatest extent possible. Based on these insights, the article formulates legal considerations that may guide a proposal for a future EU legislative act. It argues that only CRCs issued for permanent CDR technologies should be integrated into the EU ETS to ensure its environmental integrity. The project operator's liability should transfer to the Member State under certain conditions to encourage CDR investments by making liability risks more predictable and insurable. If the EU were to integrate CRCs into the EU ETS, this could influence climate policies around the world and ultimately lead to the establishment of a global standard. If the international trade of CRCs is to be a way forward in scaling CDR technologies globally, the consideration of permanence and liability could determine its success.

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