# Addressing non-permanence

## Key options for carbon credits and their implications for nature-based solutions

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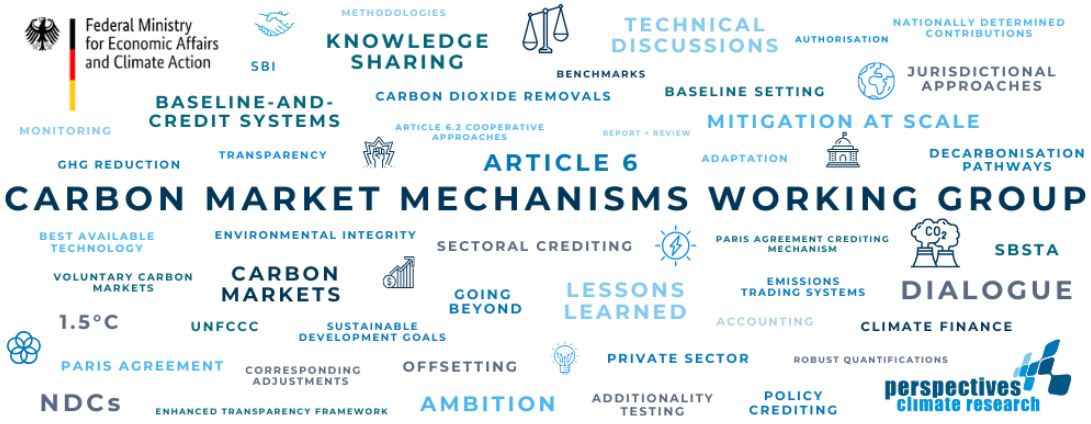


### Workshop paper

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## 1. Introduction

In the context of carbon credits, non-permanence refers to the risk that greenhouse gas (GHG) emission reductions or achieved net removals are reversed. Permanence is a key criterion for carbon credits and means that any reversals must be addressed. The Kyoto Protocol's Clean Development Mechanism (CDM) pioneered permanence requirements for carbon credits that were eligible for international compliance use. In parallel, various other carbon crediting programmes have developed permanence requirements for credits that were used voluntarily and for national or jurisdictional compliance. Permanence requirements for carbon credits have evolved over time and they continue to evolve, for example, under the Paris Agreement Crediting Mechanism (PACM), the Integrity Council for the Voluntary Carbon Market (ICVCM) and the EU Carbon Removals and Carbon Farming (CRCF) certification framework.

This paper aims to explore and stimulate discussion on key conceptual, methodological and policy issues relating to addressing non-permanence, and their policy implications to nature-based solutions (NBS), drawing on expert views and experience to date.

This paper explores the following questions:

- **What does permanence and non-permanence mean?** Are key concepts (e.g. "permanent removals") clearly defined and used consistently? Are there areas where further clarity is needed?
- **Why does addressing non-permanence matter?** Why and when is addressing non-permanence important for ensuring environmental integrity? Are there differences between use cases?
- **How should non-permanence be addressed?** What are the existing and emerging practices for addressing non-permanence?
- **What are the key options for addressing non-permanence in NBS?** Are there robust supply- and/or demand-side options for addressing non-permanence of NBS?

This paper served as input for a workshop on non-permanence in the context of carbon credits, organised under the Carbon Market Mechanisms Working Group (CMM WG). The workshop aimed at gathering insights on existing and emerging good practices for addressing non-permanence, including key options for NBS.

## 2. What does permanence and non-permanence mean?

The concept of permanence is consistently defined across the carbon credit market (see Box 1). The issue of permanence is closely related to the concept of durability. Although no official definition currently exists, practitioners commonly use durability to refer to the timeframe during which carbon is likely to be stored. In the context of carbon credits, the ICVCM describes permanence as the need to ensure that emission reductions and removals associated with carbon credits are "sustained over time periods that are meaningful for the purpose of mitigating climate change" (ICVCM, 2025). This includes adequately addressing and mitigating any risks that that carbon stored through a mitigation activity in, e.g., trees,

soils or geological formations, is (re)emitted into the atmosphere. Such a release is referred to as a reversal and it may occur at any time during or after the implementation of the mitigation activity.

Different storage options can have different durability and risk of reversal, which depend on their resilience to natural and human-made disturbances. At one end of the spectrum are emission reductions and removals with no or negligible reversal risk, and at the other end of the spectrum are emission reductions and removals involving carbon storage associated with a material reversal risk (Box 2).

**Box 1. Key terms: Permanence, durability and reversals**

According to the ICVCM, "the GHG emission reductions or removals from the mitigation activity shall be **permanent** or, where there is a **risk of reversal**, there shall be measures in place to **address** those **risks** and **compensate for reversals**" (ICVCM, 2024a). The ICVCM Assessment Framework requires certain categories of activities[1] to assess reversal risk and manage material risks, and certain categories of activities[2] to monitor and compensate for reversals.

The Science Based Targets initiative (SBTi) defines **permanence** / **durability** as "the longevity of a carbon pool and the stability of its stocks, given the management and disturbance environment in which it occurs" and notes that "storage duration can differ significantly, depending on the type of reservoir" (SBTi, 2024a).

The PACM's Removals Standard requires activity participants to address non-permanence by preventing and minimising the **risk of reversals** and **fully remediating the reversal** of removals for which A6.4ERs have been issued (UNFCCC, 2024). In the standard on addressing non-permanence and reversals (hereafter referred to as the Reversal Standard), a **reversal** is defined as "a net loss in the storage of a greenhouse gas or a precursor of a greenhouse gas for which A6.4ERs have been issued, calculated across all applicable greenhouse gas reservoir(s) over a period of time covered by a monitoring report" (UNFCCC, 2025a).

Many carbon crediting programmes issue carbon credits also for emission reductions and removals that have material risks of reversal, provided that these risks are addressed and any reversals are compensated for in line with the programme's requirements. These requirements can differ across carbon crediting programmes, but initiatives such as the ICVCM – as well as the PACM, in its role as a global benchmark – are seeking to promote alignment across programmes. Section 4 provides an overview of existing and emerging good practices for addressing non-permanence.

The term "permanent removal" is not used consistently by carbon market actors. Durability is included in the definition of the Intergovernmental Panel on Climate Change (IPCC) of "Carbon Dioxide Removal" (CDR) and the PACM's definition for removals (Box 2). However, the terms "CDR" and "removals" are commonly used to refer also to removals that are not associated with durable storage. There is no consensus on the minimum durability required for storage to be considered permanent or durable (see Section 4).

[1] Biochar, carbon capture with geological storage or mineralisation, enhanced weathering, activities that displace non-renewable biomass, CO2 in concrete utilisation

[2] Conservation and avoided conversion, forestry and agriculture soil carbon sequestration, wetland and marine ecosystem restoration/management

**Box 2. Key terms: Permanent emission reductions and removals**

**Permanent / durable emission reductions and removals**

Emissions reductions from activities that **do not involve any $CO_2$ storage** are considered inherently permanent. This includes activities that reduce or displace fossil fuel use (e.g., renewable energy, energy efficiency and e-mobility) or destroy industrial gases or methane.

Emission reductions and/or removals from activities that **involve storing $CO_2$ and/or other GHGs durably** are considered to be permanent/durable if they have a "negligible" reversal risk. This includes, for example, activities that store $CO_2$ in geological formations. The capture and storage of $CO_2$ from fossil sources generates emission reductions while the capture and storage (CCS) of $CO_2$ from biogenic sources (bio-CCS) or directly from air (Direct Air Capture and Storage, DACS) generates removals. Bio-CCS and DACS are sometimes referred to as "technical", "engineered", "industrial", or "novel" removals.

The IPCC defines "**Carbon Dioxide Removal**" (CDR) as "anthropogenic activities removing [$CO_2$] from the atmosphere and **durably** storing it in geological, terrestrial, or ocean reservoirs, or in products", thus including durability in the definition of CDR (IPCC, 2022, p. 1796). The PACM's definition of removals also includes durability of storage: **removals** are "the outcomes of processes by which greenhouse gases are removed from the atmosphere as a result of deliberate human activities and are either destroyed or durably stored through anthropogenic activities" (UNFCCC, 2024, p. 4). The SBTi states that "in the context of carbon credits, mitigation outcomes are **permanent** if they are guaranteed in perpetuity" (SBTi, 2024a).

Emission reductions and removals with "material" reversal risks (see below) can also be considered "permanent" or "durable" if any reversals are adequately addressed.

**Emission reductions and removals with material reversal risks**

Emission reductions[3] and removals that are associated with land-based carbon storage can have a material reversal risk. Many **NBS** generate emission reductions by protecting land-based carbon storage (e.g., protecting existing forests from deforestation) and/or generate removals by enhancing land-based carbon storage (e.g., by planting new forests). These activities protect or enhance carbon storage in e.g., trees and soil, which are associated with a **"material" risk of reversal**, for example, due to natural disturbances (e.g., forest fires) and human mismanagement (e.g., illegal logging).

## 3. Why does addressing non-permanence matter?

Permanence has been a key criterion for carbon credits since their emergence in the mid-1990s, alongside additionality and robust quantification. These integrity criteria can be traced back to Activities Implemented Jointly (AIJ) and the Clean Development Mechanism (CDM) which aimed to bring about "real, measurable, and long-term" benefits related to the mitigation of climate change, that would not have occurred otherwise (UNFCCC, 1997, 1995). CDM introduced requirements for addressing non-permanence for afforestation/reforestation (A/R) and carbon capture and storage (CCS) activities (UNFCCC, 2001). The CDM criteria were designed for offsetting (Box 3), which was the original use case for carbon credits under the Kyoto Protocol.

[3] Some voluntary carbon market actors distinguish between "emission reductions" and "avoided emissions". However, in the context of carbon credits, there is no need for such a distinction. This is because emission reductions are defined and quantified against a crediting baseline, thereby including also any "avoided" emissions compared with this baseline.

**Box 3. Key terms: Offsetting**

Offsetting is generally understood to mean that carbon credits are used to counterbalance an equivalent amount of GHG emissions so that their combined impact on global net emissions is zero (Ahonen et al., 2022, p. 57). Note that the SBTi defines offsetting more narrowly than most other sources, as "purchasing carbon credits from activities outside of a company's value chain as a substitute for abating emissions within its value chain" (SBTi, 2024, p. 63).

The rationale for offsetting is that emission reductions or removals have the same impact on global net emissions regardless of where they occur. Thus, an entity can achieve the same impact by reducing its own emissions or using carbon credits that represent an equivalent amount of emission reductions or removals achieved elsewhere. For carbon credits to truly counterbalance an equivalent number of emissions, they need to represent emission reductions or removals that are additional to what would otherwise have happened, robustly quantified and equivalent in terms of the duration of the climate impact, and that are not double counted. If carbon credits that do not meet these criteria are used for offsetting, environmental integrity would be undermined. In the context of compliance offsetting, this would mean that global emissions would increase as a result of carbon credit use, compared to situation where mitigation targets would have been achieved with internal mitigation instead of carbon credits (Ahonen et al., 2022; Cullenward, 2023). In the context of voluntary offsetting, this would be mean that the carbon credit user's emissions have not been counterbalanced as a result of carbon credit use and any related claims would be considered greenwashing.[4]

While the AIJ was a pilot phase that did not generate tradable units, the CDM issued Certified Emission Reductions (CERs) that could be bought and used by countries with national emissions quotas under the Kyoto Protocol, to offset their excess emissions. Under the Paris Agreement, countries can use internationally transferred mitigation outcomes (ITMOs) to comply with their Nationally Determined Contributions (NDCs). Participating countries must ensure environmental integrity, including minimising the risk of non-permanence of mitigation across several NDC periods and, when reversals of emission reductions or removals occur, ensuring that these are addressed in full. The ICVCM's Core Carbon Principles (CCPs) and their Assessment Framework are developed for "offset-grade" carbon credits, and permanence is thus a key criterion.

At the jurisdictional level, some emissions trading systems have allowed companies to use carbon credits, including those associated with reversal risks, to comply with their obligations, while others have not. For example, under the European Union Emissions Trading System (EU ETS), companies used to be allowed to offset a limited share of their emissions with CERs, with the notable exception of CERs from A/R activities. By contrast, under the Californian cap-and-trade scheme, companies are allowed to use carbon credits also from A/R activities for offsetting a share of their emissions, provided that they are locally sourced and meet other relevant requirements of the Californian authorities.

[4] Offsetting is generally understood to be a zero-sum game for the global atmosphere. This applies to compliance offsetting – an entity with mitigation obligations can meet them either by reducing its own emissions or buying an equivalent amount of carbon credits. In either case, the overall impact on global net emissions should be the same. If carbon credits do not represent the mitigation they are supposed to, their use instead of internal reductions would lead to higher global emissions. Voluntary offsetting, however, is not necessarily a zero-sum game for global net emissions: entities may use carbon credits to offset emissions that they are not obliged to reduce and that they would emit regardless of whether they buy carbon credits. In this case, if carbon credits do not represent the mitigation they are supposed to, they would not lead to higher emissions (as would be the case for compliance offsetting), but they would undermine the entity's claim that its emissions have been offset as a result of carbon credits use when that is actually not the case. For more information, see Ahonen et al. (2022, p. 29-30).

Experts, too, are divided on whether and how to use carbon credits that are associated with reversal risks. Some argue that, if reversal risks are minimised and reversals are addressed over sufficiently long timeframes, such carbon credits should be considered permanent, and their climate mitigation benefits equivalent to those without reversal risks. Others, however, advocate for a like-for-like approach (Box 4), which includes using only carbon credits that represent permanent mitigation to offset permanent emissions (e.g., from fossil fuel use).

**Box 4. Key terms: Like-for-like principle**

The like-for-like principle requires the emission reductions or removals associated with the carbon credits to be equivalent not only in terms of volume but also in terms of durability to the emission reductions or removals that they are counterbalancing (offsetting). For example, emissions from fossil sources that remain in the atmosphere for centuries or even millennia should be offset with either a reduction of an equivalent amount of reductions in fossil emissions, or the removal of an equivalent amount of GHGs from the atmosphere and their storage for an equivalent duration (Streck et al., 2025). Short-lived emissions (e.g., of methane) could be offset with emission reductions or removals that are associated with shorter-term durability, such as from forest conservation or soil carbon sequestration.

The authors as not aware of any universal definition of the like-for-like principle. According to the Oeko-Institut "flexibility should only be allowed on a 'like-for-like' basis, i.e. not mix uncertain reductions or removals from land-use sectors with permanent $CO_2$ emissions" (Graichen et al., 2025) and "they do not ensure equivalence in the duration of emission reductions or removals compared to carbon credits without reversal risks. Therefore, carbon credits subject to reversal risks should not be used to offset permanent emissions. This would pose considerable integrity risks, particularly as some ecosystems are shifting from a sink to a source of emissions. It would also raise equity issues, as the partner countries would ultimately bear responsibility for any future reversals" (Schneider et al., 2025).

In the context of carbon credits, the like-for-like principle is sometimes (mis)understood or (misre)presented as meaning that fossil emissions can be offset **only** with permanent (technical) **removals** ("Do Not Rule Out Nature from Climate Action," 2025; Höglund et al., 2023). There is no science-based rationale for excluding the option of offsetting fossil emissions with reductions in fossil emissions, since, at the sub-global level, both permanent emission reductions and permanent removals have an equivalent impact on global net emissions (Möllersten et al., 2024).

An alternative view on the science-aligned use of permanent removals is that it should be limited to hard-to-abate emissions, so not just any fossil emissions: "We will never be able to scale enough high-quality carbon removals to offset like-for-like currently avoidable fossil fuel emissions. The use of finite carbon removals needs to be preserved for hard-to-abate emissions and then bringing us back to safe levels after we almost certainly overshoot 1.5 degrees, and not sustaining existing fossil fuel interests" (University of Oxford, 2024).

The like-for-like principle is not exclusive to carbon credits – it is also applied to e.g. biodiversity offset schemes, such as the one in New South Wales, Australia (NSW Government, 2024).

The rationale for the like-for-like approach is linked to the use of carbon credits for offsetting - addressing non-permanence is one precondition for credible offsetting. However, offsetting is not the only use case for carbon credits. Already in the Kyoto era, some countries, such as Sweden, purchased and used CERs for delivering results-based climate finance to developing countries, rather than for offsetting Swedish emissions to comply with Sweden's Kyoto target (Ahonen et al., 2023, p. 11). In the Paris era, the use of carbon credits for contributing to global mitigation, rather than for offsetting own emissions to comply with national targets, has emerged as an explicit option under the PACM (through "mitigation contribution units"), as well as in the context of voluntary corporate climate action and funding be-

yond value chain mitigation. While the like-to-like principle (including addressing non-permanence) is important for the credibility of offsetting, it is not a necessary condition for the credibility of mitigation contributions (Cullenward, 2023). Although there has been limited demand for contributions to date, this could change in the future, if contributions were recognised as valuable for achieving global mitigation (and other, e.g. biodiversity) goals.

## 4. How should non-permanence be addressed?

Addressing non-permanence consists of assessing the risk of reversals, managing these risks, monitoring the GHGs stored in the activity-specific GHG reservoirs, reporting of and compensating for reversals. In the following, we provide an overview of existing and emerging approaches to address non-permanence across carbon crediting programmes.

**Reversal risk assessment and management**

*Reversal risk assessment*

Carbon crediting programmes typically apply distinct requirements or guidelines to assess reversal risks in activities with land/nature-based carbon storage versus activities with geological carbon storage. In categorising reversal risks, existing programmes take different approaches, though many distinguish between the two broad categories of natural and human-induced risks and determine thresholds for "negligible" or "material" risks of reversal.

**Box 5. Key term: Negligible risk of reversal**

According to the **PACM Reversal Standard** (UNFCCC, 2025a), a negligible risk is "a risk of reversal that would result in a loss of no more than a maximum percentage to be specified in methodologies on the basis of guidance to be developed in the reversal risk assessment tool of all the A6.4ERs issued with respect to the total emission reductions and/or net removals achieved by the activity during its active crediting period, calculated over a 100-year timeframe starting from no earlier than the end of the last crediting period". The Article 6.4 Methodological Expert Panel (MEP) had proposed a specific percentage to the Supervisory Body of the Article 6.4 mechanism (SBM), recognising thought that this is a normative policy decision in the end. The percentage proposed was a value between 0.5 to 2.5%. Generally, higher percentages cause the buffer pool to bear a larger share of the remaining risk.

Programmes quantify reversal risks by either setting a fixed rate (e.g., Gold Standard for Global Goals (GS4GG) for AFOLU activities) or through a dedicated risk assessment. Because these risk assessment approaches rely on fundamentally different types of assessments, it is difficult to determine which is preferable, or to conclude that fixed rates are inherently less effective than the outcomes of dedicated assessments. An existing practice across programmes is the regular update of these risk assessments, i.e. at least every five years. Reassessments should also take place in case reversals occur.

**Box 6. Reversal risk assessment: Examples**

**PACM**: The PACM Removals Standard specifies that reversal risk assessments must consider the nature, magnitude, likelihood and duration of risks. Also, the risk assessment is to be updated every five years. The standard requires activity participants to use the Reversal Risk Assessment Tool to determine the activity's extent of reversal risk, including whether this risk is considered negligible. The tool is used to calculate a percentage-based risk rating which, in turn, is used to determine the total number of A6.4ERs to be contributed to a Reversal Risk Buffer Pool Account to manage the

reversal risk and compensate for any reversals if these occur (UNFCCC, 2024). While the draft tool has not yet been published, the MEP had discussed to develop standardised tools for each GHG reservoir type (UNFCCC, 2025b).

**ICVCM**: The Assessment Framework requires carbon crediting programmes to either apply a fixed rate (at least 20% of all carbon credits issued) or ensure contributions to the pooled buffer reserve that are proportional to the reversal risk (ICVCM, 2024b).

**EU CRCF**: The CRCF Regulation requires that appropriate liability mechanisms are in place to address reversals, including that methodologies should account for the risk of failure of these mechanisms (EU, 2024).

*Risk mitigation*

Common practice among carbon crediting programmes is to require the implementation of risk reduction strategies based on a comprehensive plan or report. This includes evaluating proposed risk mitigation measures during the activity's validation or design approval stage. The implementation of risk reduction measures usually results in a lower risk rating.

**Box 7. Risk mitigation: Examples**

**PACM:** The PACM Removals Standard requires the inclusion of a risk mitigation plan into the risk assessment.

**ICVCM:** The Assessment Framework requires activity proponents to implement measures to mitigate potential reversal risks (ICVCM, 2024b).

**EU CRCF:** The CRCF Regulation requires that the activity is subject to the mitigation of any identified risks of reversals (EU, 2024).

*Exclusion of high-risk activities*

Some carbon crediting programmes (e.g., GS4GGand Verified Carbon Standard (VCS)) have introduced reversal risk thresholds for activities. Activities that exceed this threshold are not eligible to generate carbon credits under the programme, unless they can successfully lower the score below the threshold through risk reduction measures. Such thresholds are not, however, common practice among carbon crediting programmes.

**Box 8. Exclusion of high-risk activities: Examples**

**PACM:** The draft Reversal Risk Assessment Tool is not yet publicly available. Thus, it remains unclear whether the PACM will include upper limits for the risk rating for excluding such activities.

**ICVCM:** The Assessment Framework does not include thresholds for excluding activities that have high reversal risk.

**EU CRCF:** The CRCF Regulation does not include thresholds for excluding activities that have high reversal risk.

**Monitoring frequency and implications of cessation**

Carbon crediting programmes set different schedules for monitoring reports (Michaelowa et al., 2025). In the case of GS4GG, developers must submit both monitoring reports – for each verification within the five-year certification cycle – and annual reports summarising data gathered throughout the year. CAR and Puro.earth require annual submission of monitoring reports. ACR requires a monitoring report every five years. Existing practice among programmes is thus to require a monitoring report annually or at least every five years.

Regarding the cessation of monitoring report submissions, good market practice entails the declaration of a full reversal of all affected mitigation outcomes and full compensation (FAO, 2024).

**Box 9. Monitoring frequency and implications of cessation: Examples**

**PACM:** The Reversal Standard (UNFCCC, 2025a) requires mechanism methodologies to determine the minimum frequency at which monitoring reports must be submitted during the crediting period and afterwards. Thereby, the minimum frequency must be between one and five years, with the exact frequency being guided by the nature, type and reversal risk. The standard further specifies that less frequent reporting might be appropriate where the quantification of emission reductions or net removals entails considerable costs, or where long time periods are required to observe such outcomes.

**ICVCM:** The Assessment Framework does not specify a report frequency, but requires the programme to treat cessation of monitoring as an avoidable reversal (ICVCM, 2024b).

**EU CRCF:** For permanent carbon removals, the CRCF Regulation specifies that monitoring reports are to be submitted at last once a year (EU, 2024). For carbon farming and carbon storage products, the frequency of monitoring reports will be specified in certification methodologies (Article 8).

**Duration of post-crediting monitoring and reporting**

There is no consensus on the minimum durability required for storage to be considered permanent. For activities with material risk of reversal, the ICVCM's Assessment Framework requires a 40-year minimum commitment for monitoring, reporting and compensation of avoidable reversals, from the start date of the activity, with the exception of jurisdictional REDD+ programmes that have specific provisions (ICVCM, 2024a). All CCP-eligible carbon crediting programmes, such as the ACR, CAR, GS4GG, Isometric and VCS, must adhere to ICVCM's minimum requirements. Some programmes apply more stringent approaches to permanence. For example, Isometric requires monitoring for 40 years from the end of the crediting period for reforestation activities, and some CAR methodologies require monitoring for 100 years after the final issuance of credits. In its next iteration of the Assessment Framework, the ICVCM will consider longer monitoring and compensation periods (ICVCM, 2025). Microsoft, a major voluntary buyer of removal credits, considers low, medium and high durability storage to be up to 100 years, between 100 and 1000 years, and over 1000 years, respectively (Microsoft, n.d.). According to Microsoft, forests and soil-based projects are typically durable for up to 100 years, biochar has medium durability of up to 1000 years, and geologic storage and mineralisation have high durability of more than 1000 years. For geological storage activities, post-monitoring requirements also vary widely, ranging from a minimum of 7 years (VCS) to demonstration of $CO_2$ plume stabilisation (ACR, Puro.earth) to 50 years (Isometric).

**Box 10. Duration of post-crediting monitoring and reporting: Examples**

**PACM:** The Information Note (UNFCCC, 2025c) that was adopted jointly with the Reversal Standard specifies that the post-crediting monitoring period is to start on the first day after the end of the last active crediting period. The Reversal Standard stipulates that mechanism methodologies must determine a minimum monitoring period during the post-crediting period, after which monitoring may be terminated if the activity participant demonstrates that the risk of reversal is negligible

(UNFCCC, 2025a). The minimum period must be determined based on the mitigation activity type and its associated risks (UNFCCC, 2025a). Mechanism methodologies must also lay out the conditions or criteria to be fulfilled to demonstrate a negligible risk of reversal. Post-crediting monitoring obligations for activity participants shall continue unless a third party, nominated by the participants and approved by the SBM, assumes that responsibility. The post-crediting monitoring period can be terminated if the following conditions are met (UNFCCC, 2025c):

- All potential reversals for all A6.4ERs issued to the Article 6.4 activity are mitigated by cancelling an equivalent number of A6.4ERs in the mechanism registry, using authorised units where applicable.
- A – by an independent third-party – justified demonstration of sufficient insurance policy, comparable guarantee products or third-party guarantee that cover the reversal risk including a plan to monitor and detect reversals for a minimum period is submitted. The provided demonstration must be approved by the SBM. If approved, monitoring, reporting and remediation obligations are passed on to the third parties, insurers or guarantors.
- At any time after the minimum post-crediting period: A verification is submitted that the stored GHGs are at a negligible risk demonstrating that through: Modelling or other methodical evidence about long-term stability of stored GHGs, application of conservativeness in reversal risk assessments and quantification, consideration of all causes of uncertainty including use of the higher or lower bound (as appropriate) and applying a sensitivity analysis to the demonstration.

**EU CRCF:** The CRCF Regulation does not specify requirements for post-crediting monitoring and reporting but states that "permanent carbon removals provide enough certainties as to the very long-term duration of storage, namely a duration of several centuries" (EU, 2024, preamble, para 22).

**Reversal-related notifications, reports and consequences**

Most carbon crediting programmes require developers to report reversals promptly, though timelines vary (Michaelowa et al., 2025). GS4GG and VCS require notification by email within 30 days of identifying a reversal or loss, while ACR sets a tighter deadline of 10 business days. Puro.earth requires notice within 5 days, and Isometric is expecting same-day reporting or, at most, within 3 days.

Following a reversal event, programmes impose consequences: GS4GG freezes affected registry accounts; CAR suspends transactions pending verification; and VCS restricts issuance of new credits, holds or cancels buffer credits depending on reporting delays, and mandates third-party verification (Michaelowa et al., 2025). As a next step, detailed reporting is required. Thereby, reporting deadlines vary: GS4GG requires an assessment within three months, CAR within one year, and VCS within two years (or earlier if discovered during verification). Established practice across private carbon crediting programmes includes suspending operations, promptly recording reversals, revising risk ratings, and ensuring remediation before resuming activities.

**Box 11. Reversal-related notifications, reports and consequences: Examples**

**PACM**: Under PACM, developers must inform the SBM of any observed release of stored GHGs within 30 days (UNFCCC, 2025c). The Information Note specifies that activity participants must submit annual reversal reports by 31 March each year (UNFCCC, 2025c). It refers to the previous calendar year and must clarify whether any observed event might have led to a reversal. The reports must be verified, either before submission or as part of the verification of monitoring reports. If an annual report is submitted late, activity-specific operations are suspended).

**ICVCM**: Beyond the requirement to report reversals, no further provisions are specified.

**EU CRCF**: The CRCF Regulation does not specify requirements for reporting reversals.

**Remediation of unavoidable and avoidable reversals**

*Reversal remediation tools*

The most common practice among carbon crediting programmes is to use buffer pools to manage the risks of reversals and remediate (especially "unavoidable", Box 14) reversals. With this tool, some of the credits generated are withheld in a shared reserve rather than placed on the market.

For the remediation of reversals, insurance products are rarely used (FAO, 2024). Insurance premiums are determined based on how providers evaluate the underlying risks, with some high-risk activities potentially considered uninsurable. Coverage must ensure that substitute credits are provided immediately once a reversal takes place. There is ongoing debate over what types of replacement credits should be permitted – ranging from strict like-for-like substitution to allowing any credits that satisfy the programme's eligibility rules. An important design question for such insurance schemes is how long the coverage must remain in place under programme requirements. ACR allows insurance products to replace buffer pool contributions, provided they are based on an actuarial analysis of project-specific risks, whereas Isometric permits external insurance without reducing buffer pool requirements.

Regarding buffer pool management, it is established practice that the buffer pool is fully replenished by the number of carbon credits used to compensate for avoidable reversals. Good practice includes ensuring replenishment of the buffer pool also for covering unavoidable reversals, if the number of credits used to compensate for unavoidable reversals exceeds the original contributions. This approach is applied by some programmes (e.g., ACR, VCS), but not all.

Another good practice (exercised by, e.g., CAR) is for the programme to step in and address avoidable reversals if the activity owner does not meet their remediation obligations by for example retiring credits from the pool to cover the loss. Under the CDM, if CCS activity participants fail to remedy the reversals in full (by cancelling an equivalent amount of CERs issued for the activity from a reserve account), the liability falls within the host Party or, if the host Party has not accepted the obligation to address the net reversals, to the buyer Party (UNFCCC, 2012).

**Box 12. Reversal remediation tools: Examples**

**PACM**: The PACM allows the use of "Buffer A6.4ERs" to remediate avoidable and unavoidable reversals (UNFCCC, 2025c). If unavoidable or avoidable reversals occur, an equal number of A6.4ERs from the buffer pool is to be cancelled of the same proportional authorisation type and of the same activity, if possible. Regarding avoidable reversals, the standard obliges activity participants to replenish the pool with an equivalent quantity of A6.4ERs of matching quality (i.e., same authorisation status). The Removals Standard also stipulates that the buffer pool must be subjected to stress-testing at a minimum of once every three years (UNFCCC, 2024). It also specifies that activity participants should "obtain and maintain coverage under an insurance policy or comparable guarantee products" to address risks of avoidable reversals.

**ICVCM**: For biogenic reservoirs, the Assessment Framework requires programmes to implement a pooled buffer reserve to compensate for reversals (ICVCM, 2024b). The initiative has established a work programme on insurance products and mechanisms and other approaches to be considered for the next framework.

**EU CRCF**: The CRCF Regulation requires having liability mechanisms such as collective buffers or up-front insurance mechanisms in place to address cases of reversals with the last resort option

being direct cancellation of units (EU, 2024, Article 6, 8). The rules for monitoring and liability will be included in the applicable certification methodologies. For activity types based on temporary removals, the regulation requires setting an expiry date at the end of the monitoring period, with the option of extending the monitoring period and the validity of the unit (see below).

*Differentiated treatment of avoidable and unavoidable reversals*

An existing practice has been to apply differentiated treatment to avoidable and unavoidable reversals (Box 14). Under differentiated treatment, good practice – applied by ACR, CAR and GS4GG – reserves buffer pool credits for the compensation of unavoidable reversals and does not allow their use to compensate for avoidable reversals. Rather, the activity developer is required to provide additional compensations (e.g., non-buffer credit cancellations) for such reversals. Buffer pool credits are consequently reserved for remediating unavoidable reversals. Where no differentiated treatment exists, good practice provides that any buffer credits used to compensate for avoidable reversals should be replenished in equivalent measure.

**Box 13. Differentiated treatment of avoidable and unavoidable reversals: Examples**

**PACM**: The Reversal Standard requires equal forwarding of same type A6.4ERs (i.e., mitigation contribution of authorised A6.4ERs) to the buffer pool for avoidable reversals (UNFCCC, 2025c).

**ICVCM**: ICVCM does not specify any requirements for differentiated treatment.

**Box 14. Key terms: Avoidable/unavoidable risks vs. intentional/unintentional risks**

The PACM and ICVCM use the terms *avoidable* and *unavoidable* reversals, while some carbon crediting programmes instead refer to *intentional* and *unintentional* reversals. In substance, both sets of terms describe the same distinction. For example:

- Under the **PACM**, avoidable reversals refer to "reversals caused by factors over which the activity participants have influence or control" (UNFCCC, 2025a). Consequently, unavoidable reversals are those over which the activity participants have not influence or control. The Reversal Standard lists the following types under each category:

| **Avoidable Reversals** | **Unavoidable Reversals** |
|---|---|
| • Activity management and other wilful actions by participants<br>• Mismanagement, neglect or illegal actions incl. as a consequence of bankruptcy, insolvency or default<br>• Intentional use of a product or material, in which a GHG was stored<br>• Failure to implement the risk mitigation plan<br>• Annual reversal report is missing | • Natural disturbances and extreme events<br>• Declared war, undeclared war, acts of terrorism<br>• Changes in policies or legal requirements that prevent participants from implementing risk mitigation plans<br>• Illegal action by third parties out of control or management using legal means by activity participants |

- Under the **American Carbon Registry (ACR)**, in the context of terrestrial sequestration, an intentional reversal is the result of an intentional, wilful activity (e.g., harvesting, forest conversion, wilful withdrawal of a parcel) (ACR, 2023). An unintentional reversal is the decrease of carbon stock in the project due to natural disturbances.

### Temporary crediting

Temporary crediting is one option for addressing the non-permanence of carbon credits. Under this approach, carbon credits expire after a certain period, after which they must be renewed or replaced with other carbon credits (FAO, 2024). This approach was pioneered by the CDM for A/R activities. The EU CRCF Regulation introduces certified units based on temporary removals (through carbon farming or carbon storage in products) alongside units based on permanent removals and soil emission reductions.

**Box 15. Temporary crediting: Examples**

**CDM:** Under the CDM, A/R activities could choose between generating temporary or long-term Certified Emission Reductions (tCERs or lCERs). Contrary to normal CERs, tCERs and lCERs had expiry dates, by which the host Party had to replace tCERs and lCERs with other units. Unlike normal CERs, tCERs and lCERs could only be used for compliance within the commitment period that they had been issued in, and could not be carried over to subsequent commitment periods (UNFCCC, 2006).

**EU CRCF:** The CRCF Regulation introduces an expiry date for units that are based on temporary removals – namely carbon farming sequestration units and the carbon storage in product units. This expiry date coincides with the end of the relevant monitoring period, after which the carbon captured and stored should be considered released into the atmosphere, unless the activity participant commits to prolonging the monitoring period. The certification methodologies should incentivise the prolongation of the monitoring period of the relevant carbon farming activities, with the aim to store captured carbon for at least several decades in soils or biomass (EU, 2024).

### Tonne-year accounting

A different way of tackling reversal risks, without relying on compensation measures, is the use of tonne-year accounting. Under this method, mitigation is credited on an annual basis, reflecting the idea that stored carbon could be fully released at any time. The fraction of credits issued gradually rises for every year that the reduced or removed carbon remains in storage, so that a full credit per tonne is only granted once the specified duration has elapsed (FAO, 2024). If a reversal takes place, the issuance of credits is halted, and it is assumed that the fraction of credits already issued continues to reflect a share of permanent mitigation. CAR is using tonne-year accounting in some of its methodologies (FAO, 2024). The SBM decided to not consider this approach under PACM.

## 5. What are the key options for nature-based solutions?

### Consensus on importance of nature, debate on role of carbon credits

There is global consensus that NBS have an important role in achieving global climate change mitigation and biodiversity goals, as well as other global sustainable development goals, alongside other types of mitigation activities. According to Article 5 of the Paris Agreement, “Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs” of GHGs, including forests. Parties are also encouraged to incentivise activities relating to reducing emissions from deforestation and forest degradation in developing countries (REDD+), including through conserving and sustainably managing forests and enhancing forest carbon stocks, and incentivise also non-carbon benefits of these approaches (UNFCCC, 2015).

While there is also broad agreement that carbon credits can be one – albeit by no means the only – tool for mobilising (results-based) funding for NBS, there are divergent view on the use of nature-based carbon credits, especially whether they are appropriate for offset use, given their material reversal risks.

**Debate on the eligibility of nature-based activities under PACM**

To date, carbon credits have been an important source of funding for NBS activities. Nature-based carbon credits have been supplied by carbon crediting programmes that cater for the voluntary carbon markets and compliance schemes that accept nature-based credits (e.g. Californian cap-and-trade and the Carbon Offset and Reduction Scheme for International Aviation).[5] Although A/R activities were eligible to generate carbon credits (tCERs and lCERs) under the CDM, the demand – and consequently also the supply – for such credits was limited, not least because a major source of CER demand – the EU ETS – excluded tCERs and lCERs.

Looking forward, the NBS community is hoping that NBS activities could earn carbon credits under the PACM. During public consultations on the draft Reversal Standard, the NBS community had raised concerns that its stringent requirements, including for infinite monitoring and liability for reversals, would effectively exclude NBS from generating carbon credits under the PACM. They called for considering co-benefits alongside the aim of counterbalancing, and argued that the proposed requirements are excessive from the perspective of ensuring environmental integrity and unfairly deprive NBS of must-needed finance, to the detriment of global climate and nature goals ("Do Not Rule Out Nature from Climate Action," 2025; Streck and Minoli, 2025).

In response, the PACM's SBM and MEP had highlighted that the Reversal Standard is being developed within the mandate of the (already adopted) Removals Standard, for the specific context of offsetting (i.e., counterbalancing), and as part of a larger package of work. Differences of opinion among SBM members ultimately led to the decision not to adopt standard-level provisions on key elements such as the duration of the post-crediting monitoring period or the definition of a negligible risk of reversal. Instead, it agreed to an activity type–specific approach, under which these elements are to be proposed and determined at the methodology level. Accordingly, the MEP and the SBM will assess activity-specific requirements on the basis of proposals submitted by methodology proponents. Discussions on how to operationalise the PACM's detailed requirements for addressing reversals will therefore continue at the activity type level as methodologies are brought forward. Further guidance is expected from the reversal risk assessment tool currently under development, which will inform the determination of buffer pool contributions, the maximum threshold for defining negligible reversal risk, and the consideration of remediation measures. It is highly likely that this debate will continue once the first draft of the tool is released for public consultation. Also, the adopted Reversal Standard put more emphasis on alternative tools such as the insurance policy, comparable guarantee products and third-party guarantee.

[5] E.g. Verified Carbon Standard, The REDD+ Environmental Excellence Standard, the Climate Action Reserve and the American Carbon Standard.

Such tools could reduce the burden of individual activity developers and facilitate the feasibility of NBS activities under the PACM.

**Supply-side options for nature-based activities**

The NBS community's proposals have focused on the supply side. Key proposals include relaxing the requirements for addressing non-permanence and reversals for all carbon credits, including increasing the threshold for negligible reversal risk and reducing reporting requirements. Proposals point to existing options to manage reversal risk, such as the use of buffer pools, and call for pragmatic approaches, including a less rigid application of the like-for-like principle, that work also for nature-based solutions ("Do Not Rule Out Nature from Climate Action," 2025).

**Demand-side options for nature-based activities**

Thus far, the debate has largely by-passed demand-side options for incentivising investments into nature. Key options could include differentiated use cases for nature-based credits for funding beyond value chain mitigation and/or meeting separate nature targets, using contribution models rather than offsetting (Cullenward, 2023; Hewlett et al., 2024). Policies that incentivise the near-term deployment of NBS and the replacement of reversals with engineered removals in the longer term may be associated with lower temperature overshoot and related damages, compared with waiting until engineered removals are ready for deployment at scale after 2050 (Streck et al., 2025; Streck and Minoli, 2025). These proposals deserve further attention.

Voluntary nature frameworks are already emerging (Box 16), potentially paving way for governments and companies for introducing nature goals alongside their climate goals and driving demand and funding for nature-based solutions.

**Box 16. Corporate frameworks for funding for nature-based solutions**

The SBTi and Gold Standard strongly encourage companies to fund beyond value chain mitigation, including through nature-based solutions, to complement reductions in their value chain emissions. Although SBTi's Corporate Net-Zero Standard is a major driver for corporate demand for "permanent" removals, SBTi identifies nature-based solutions as a priority area in the context of funding beyond value chain mitigation (SBTi, 2024b). The Gold Standard, too, makes a special case for nature-based solutions in the context of beyond value chain mitigation and organisational contributions to global net zero (Hewlett et al., 2024).

Corporate nature frameworks have been developed by the Science Based Targets Network (SBTN), Gold Standard and the World Wide Fund for Nature (WWF) had developed (Hewlett et al., 2025; Petersen et al., 2025; Science Based Targets Network (SBTN), 2024).

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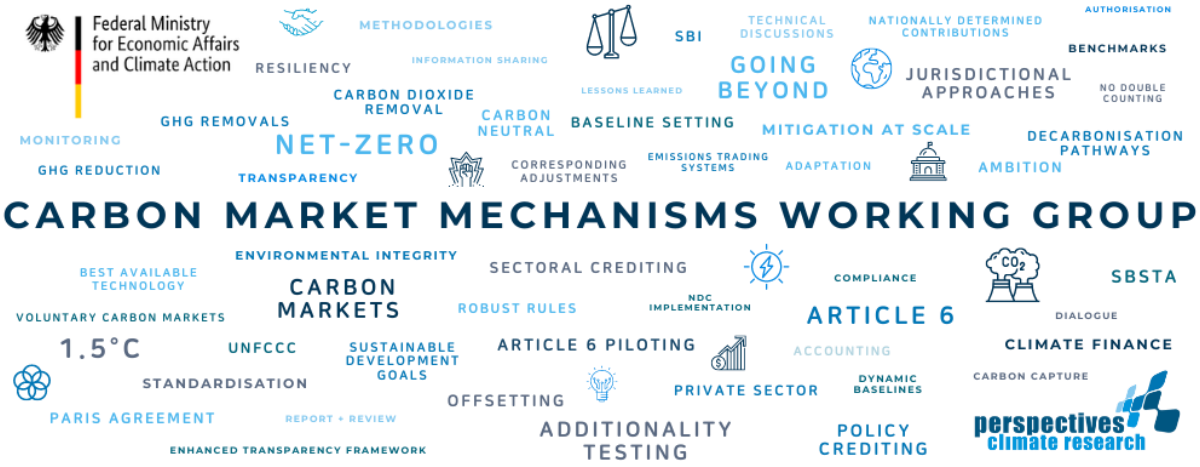


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