



1. CONTEXT AND MOTIVATION

Why this question matters

The voluntary carbon market has faced intense scepticism because some offset projects may be non-additional, impermanent or risky.

Forest and nature-based offsets can fail through fire, disease, insecure property rights or land-use change. Even a successful project may store carbon only temporarily.

This paper asks: even if some offsets are impermanent and risky, are they worthless? Answer: No: Temporary storage still has value because it provides temporary cooling and climate damages reduction.



Impermanence

Carbon may be released back to the atmosphere.



Failure risk

Projects can end early or fail to meet their target.



Additionality

Credits count only if they deliver real additional benefits.

2. SCC AND SVO EXPLAINED

SCC and SVO are linked damage values

SOCIAL COST OF CARBON (SCC)

The SCC is the present value of future economic damages caused by one extra tonne of CO₂ emitted today. Equivalently, it is the benefit of permanently removing that tonne.

SOCIAL VALUE OF AN OFFSET (SVO)

The SVO is the present value of damages avoided while the offset keeps CO₂ out of the atmosphere.

The SVO is a well-defined proportion of the SCC.

$$\text{SVO} = z \times \text{SCC}_0$$

$$z = \text{SVO} / \text{SCC}_0$$

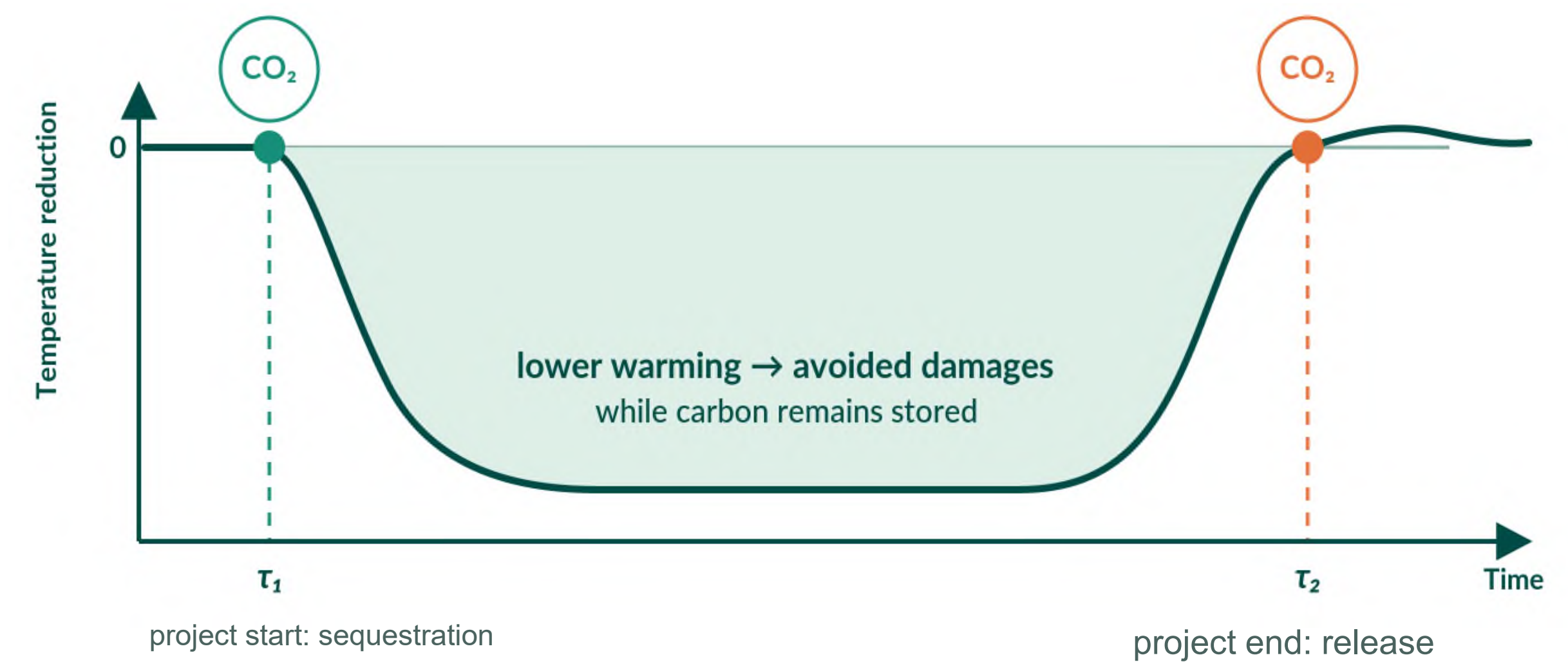
DAMAGE VALUE EQUIVALENCE

If $z = 0.40$, one temporary tonne delivers 40% of the damage value of one permanent removal. Equal expected damage value therefore requires 2.5 temporary offsets.

3. CENTRAL MECHANISM: HOW TEMPORARY STORAGE CREATES VALUE

Temporary storage delays climate damages

A temporary offset is a delayed emission



A temporary offset removes CO₂ now and releases it later. During the storage period, atmospheric carbon, warming and climate damages are lower than they would otherwise have been.

Economically, the project delays an emission. Its value is the present value of the damages avoided between sequestration and release — not zero merely because storage is finite.

The green cooling area generates the stream of avoided damages valued by the equation below.

THE VALUATION EQUATION: FROM TEMPORARY COOLING TO DAMAGE VALUE

The SVO is the SCC corrected for timing, duration and risk

$$\text{SVO}_{\tau_1, \tau_2}^{\phi} = \text{SCC}_0 \underbrace{e^{(x_1 - r)\tau_1}}_{\text{Delayed start}} \underbrace{\left(1 - e^{(x_2 - r - \phi)(\tau_2 - \tau_1)}\right)}_{\text{Impermanence}} \underbrace{\frac{r - x_2}{r + \phi - x_2}}_{\text{Failure risk}}$$

DELAYED START

Value is discounted at rate r from the date the project begins (τ_1), not simply valued as if it started today.

IMPERMANENCE

Only damages avoided before carbon is re-released at τ_2 count. Longer storage raises damage value equivalence.

FAILURE AND NON-ADDITIONALITY RISK

Expected value falls with the chance that the project ends early. ϕ contains failure and non-additionality risks.

4. RESULTS: DAMAGE VALUE EQUIVALENCE

Damage value equivalence: illustrative calibration

$z = \text{SVO} / \text{SCC}_0$ in RCP2.6

Annual failure / non-additionality risk

	25 years	50 years	100 years
0%	24%	44%	70%
0.5%	22%	39%	57%
1.0%	21%	34%	47%

Illustration: low start-risk additionality; values from Table 1.

Longer storage raises value; higher annual failure or non-additionality risk lowers it.

RULE OF THUMB

2–3 × 50-year offsets ≈ 1 permanent tonne

This corresponds to $z \approx 0.33$ – 0.50 .

Project-specific estimates should replace the rule where reliable data exist.

5. IMPLICATIONS FOR MARKET DESIGN

What this implies for carbon markets

The framework replaces a binary judgement — “permanent or worthless” — with a transparent quality adjustment.

- CREDIT BY DAMAGE VALUE, NOT ONE-FOR-ONE**
Recognise that a temporary offset delivers a proportion of the damage value of a permanent removal.
- COMPARE BENEFIT–COST RATIOS**
Evaluate projects using benefit–cost analysis and compare temporary storage with abatement or permanent removal.
- USE FINITE, MONITORED CONTRACTS**
Set contract duration, monitor outcomes and renew only if additionality and performance remain credible.
- FILTER OUT LOW-QUALITY PROJECTS**
Exclude projects with high failure risk or weak additionality that undermine market credibility.

THE DATA REQUIREMENT

Duration, failure and additionality must be measured, reported and audited. The SVO makes those assumptions visible rather than hiding them inside a one-for-one claim.

6. CONCLUSION

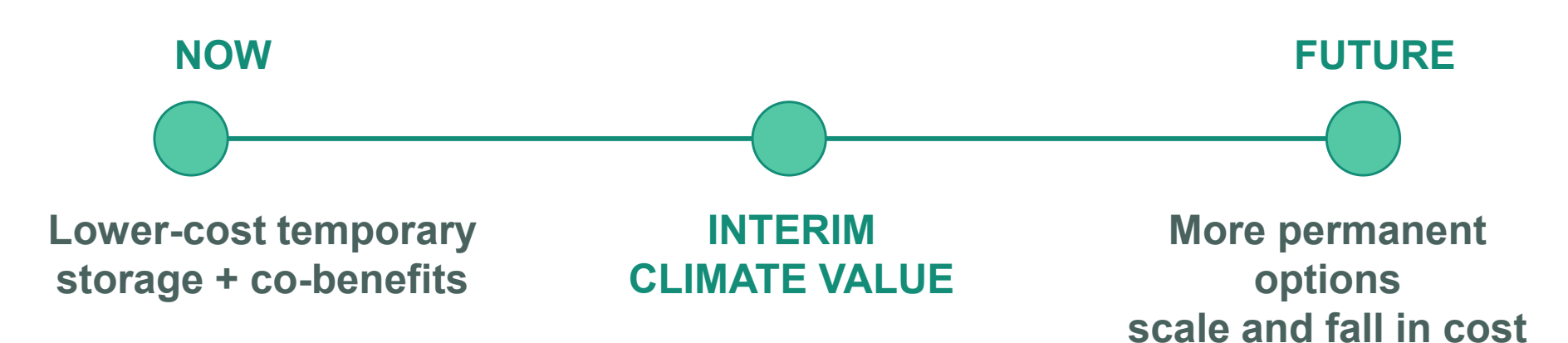
Temporary is not permanent — but it is not worthless

Temporary storage can be cheaper today.

Nature-based projects may also provide biodiversity and ecosystem-service co-benefits alongside their carbon value.

Temporary offsets can provide an interim or bridge solution while more permanent removals scale up and become cheaper in the future.

But this is not a licence to weaken mitigation. Offsets should complement, not postpone, deep emissions reductions.



VALUE CARBON HONESTLY • REWARD CO-BENEFITS SEPARATELY • DO NOT WEAKEN MITIGATION

