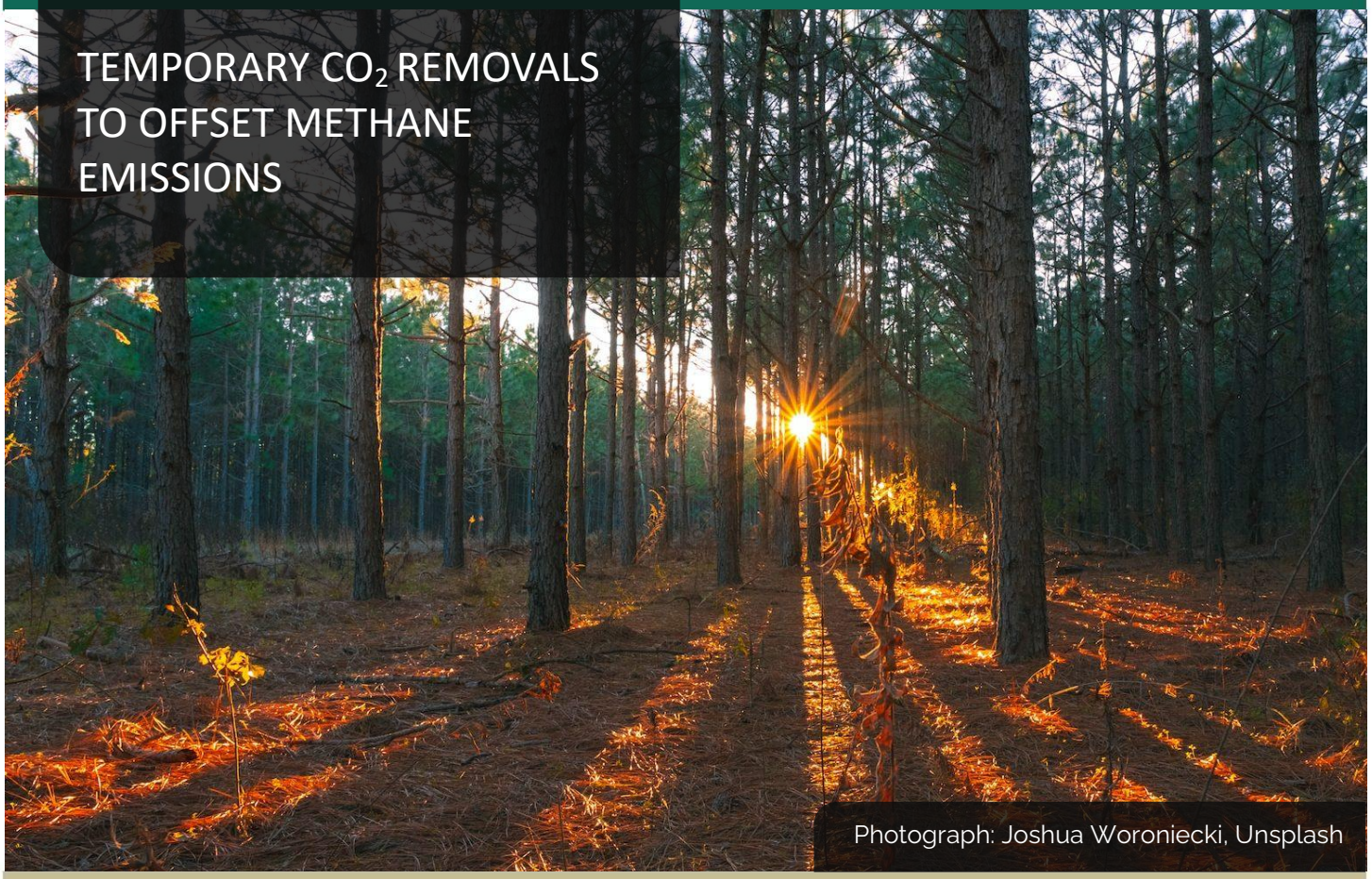
Dragon Capital Chair

REPORT

TEMPORARY CO_2 REMOVALS TO OFFSET METHANE EMISSIONS



Photograph: Joshua Woroniecki, Unsplash

The paper addresses how residual methane (CH_4) emissions should be offset in climate policy and carbon markets. Methane has a strong but short-lived warming effect, whereas carbon dioxide (CO_2) accumulates and affects temperatures over centuries.

Authored by:

Summary of Venmans, Rickels & Groom (2025)

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Temporary CO_2 Removals to Offset Methane Emissions

Research and policy question

The paper addresses how residual methane (CH_4) emissions should be offset in climate policy and carbon markets. Methane has a strong but short-lived warming effect, whereas carbon dioxide (CO_2) accumulates and affects temperatures over centuries. The central policy question is whether it is appropriate—and efficient—to offset methane emissions using permanent CO_2 removals, or whether temporary CO_2 removals that better match the time profile of methane-induced warming provide a more credible and welfare-consistent approach. This question is particularly relevant for agriculture and land-use sectors, where residual methane emissions are difficult to eliminate and nature-based CO_2 removal projects tend to provide only temporary storage.

Methodological approach

The authors compare methane emissions and CO_2 removals using a welfare-based framework rather than conventional global warming potential (GWP) metrics. They model the temperature impulse response of a pulse of methane emissions and of temporary CO_2 removals, and value their impacts using avoided economic damages. Welfare impacts are measured using the social cost of methane (SCM), the social cost of carbon (SCC), and the social value of offsets (SVO), which captures the value of temporary CO_2 storage as a fraction of the SCC. By comparing the ratio SCM/SVO, the paper derives the number of temporary CO_2 removal projects that are welfare-equivalent to one tonne of methane emitted. The approach explicitly accounts for storage duration, failure risk, discounting, and future climate scenarios.

Findings

The analysis shows that offsetting methane emissions with permanent CO_2 removals creates large intertemporal welfare transfers: it overcompensates future generations while failing to adequately mitigate near-term warming. By contrast, temporary CO_2 removals that coincide with methane's short-lived temperature effect better smooth temperature paths and associated damages over time. Across a wide range of assumptions about discount rates, climate scenarios, and failure risks, the results indicate that approximately 78–117 temporary CO_2 removals lasting around 30 years are welfare-equivalent to one tonne of methane emissions, with a central estimate of about 87. Importantly, equivalence for 30-year projects is relatively insensitive to controversial parameters, making it more robust than equivalence based on permanent removals.

Policy implications

The findings support a shift in how methane offsets are designed and regulated. Rather than relying on permanent CO_2 removals, climate policy could explicitly allow temporary, time-matched CO_2 removals to offset residual methane emissions. Such an approach improves climate effectiveness in the near term, reduces intergenerational welfare transfers, and aligns better with

the characteristics of many nature-based solutions. Shorter monitoring periods of 20–30 years are also more credible and enforceable than perpetual commitments, and they allow projects to be reassessed and re-certified over time. More broadly, the paper argues for disaggregated carbon accounting, where temporary and permanent removals serve different policy purposes within net-zero strategies.

Links and materials

Venmans, F., Rickels, W. & Groom, B. Temporary carbon dioxide removals to offset methane emissions. *Nat. Clim. Chang.* **16**, 37–42 (2026). https://doi.org/10.1038/s41558-025-02487-8

Data and code repository:
https://doi.org/10.5281/zenodo.17228030

Venmans, F., Rickels, W. & Groom, B. Reducing the large short-lived impact of methane emissions with temporary carbon removals. *Nat. Clim. Chang.* **16**, 19–20 (2026).
https://doi.org/10.1038/s41558-025-02511-x.

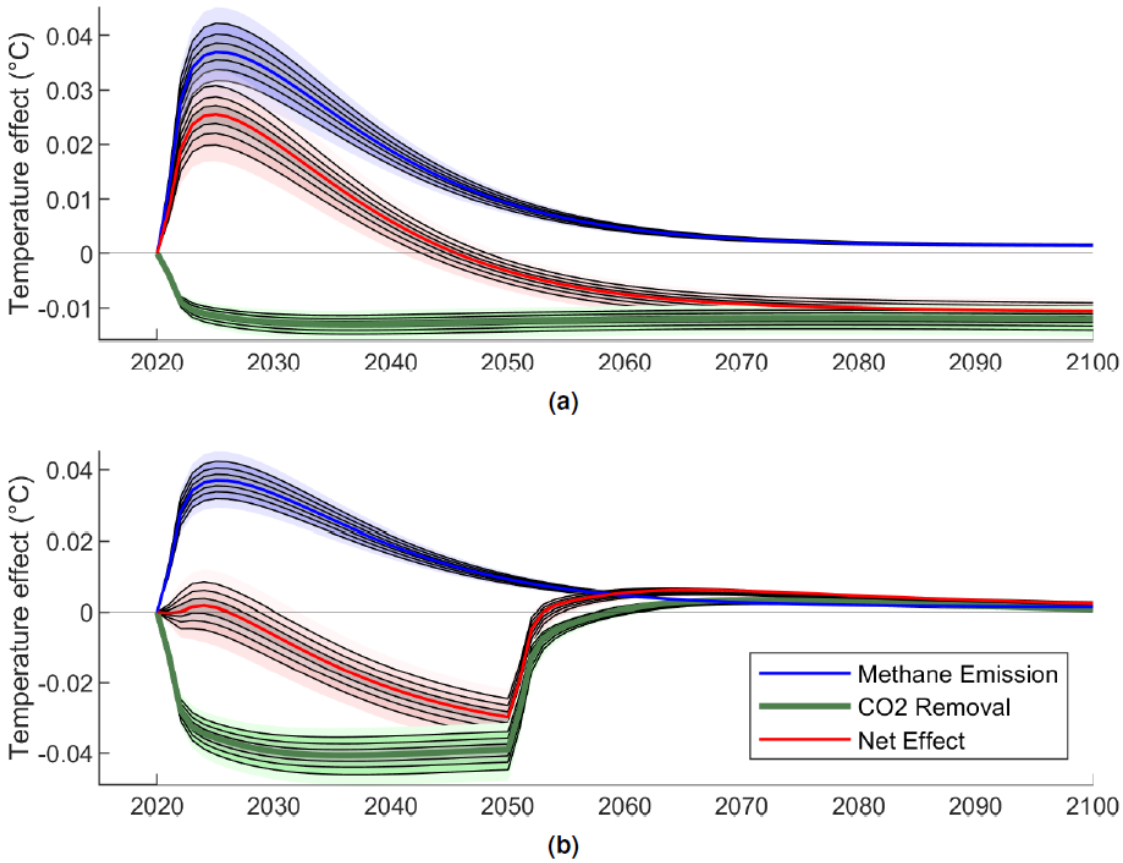

Figure 1. The temperature effect of a CH_4 emission offset by 25 100-year CO_2 removals (Panel a) and by 80 30-year CO_2 removals (Panel b).

Table 1. Equivalence of Temporary and Risky CO_2 Offsets to CH_4 Emissions

RCP	Discount rate (r)	Failure risk (φ)	20 years	25 years	30 years	35 years	40 years	100 years	500 years
2.6	2.5%	0.0%	132	105	87	75	66	30	17
	2.5%	0.5%	140	113	95	83	74	38	27
	2.5%	1.0%	148	121	103	91	81	46	38
	3.0%	0.0%	119	96	81	71	63	32	23
	3.0%	0.5%	126	103	88	77	69	39	32
	3.0%	1.0%	133	110	95	84	76	48	42
	3.5%	0.0%	112	92	78	69	62	35	29

Notes: Values report the number of 1-tonne temporary CO_2 removal projects that are welfare-equivalent to a 1-tonne CH_4 emission. Welfare equivalence is calculated as the ratio SCM/SVO. Source: Venmans et al. (2025).

Table 1. Equivalence of Temporary and Risky CO_2 Offsets to CH_4 Emissions

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Economic Policy Decision Making for Biodiversity

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