

Commentary

Carbon offsets are incompatible with the Paris Agreement

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Carbon offsets allow companies and governments to outsource emission reductions to third parties and have played a prominent role in many climate mitigation policies to date. But in order to support temperature stabilization under the Paris Agreement, nearly everything about them must change.

Why Paris matters

As governments and companies around the world plan for deep cuts in greenhouse gas emissions, many are looking to carbon offsets—tradable credits that reflect outsourced climate action—to help reduce costs and channel climate finance to lower-income countries. Meanwhile, climate negotiations under the Paris Agreement have embraced carbon budgets and net-zero emissions targets,¹ with profound implications for carbon offsets that have largely escaped notice outside the expert community. The resulting tensions threaten to undermine global climate goals.

To support the Paris Agreement's commitment to limit global warming, climate policies must reach and sustain near-net-zero CO₂ emissions in perpetuity. Today's carbon offsets are not only inconsistent with this goal, but the majority actually frustrate temperature stabilization efforts. A growing literature reveals that carbon offsets rarely achieve the climate benefits they claim. Even if they did, vanishingly few lead to long-duration carbon removal, which is needed to counteract any unabated CO₂ emissions. Meanwhile, carbon offsets are primarily used to justify ongoing emissions, rather than reduce them. And on top of that, private offset claims are poised to double-count climate benefits reported under the Paris Agreement's emissions accounting system.

Any one of these problems with carbon offsets would be sufficient to undermine the Paris Agreement; right now, all remain unresolved.

Offsets were designed for a different purpose

The widening chasm between what carbon offsets deliver and what the Paris Agreement requires reflects the fact that carbon offsets were not designed to reduce net greenhouse gas emissions, let alone support their near-total elimination. Instead, carbon offsets were designed to introduce flexibility in where emission reductions occur in order to lower the cost of meeting initial climate targets and accommodate political opposition to legally binding climate policy.

The largest carbon offsets program in history helps illustrate the point. During the 1997 Kyoto Protocol negotiations, a political deadlock over which countries should face mandatory obligations was ultimately resolved with carbon offsets. Some wealthier countries pledged to reduce their emissions by about 5% under Kyoto's first commitment period, while lower-income countries would participate only on a voluntary basis by selling carbon offset credits earned under a program called the Clean Development Mechanism.

In theory, using offsets to shift the geographic distribution of CO₂ emission reductions has no meaningful climate consequences because CO₂ has the same effect on global temperatures no matter where it is emitted. By allowing wealthier countries to pursue their mitigation obligations through international offsets, the argument goes, the Clean Development Mechanism reduced compliance costs while simultaneously providing voluntary climate finance to lower-income countries.

Carbon offsets' original promise looks completely different in a world where governments and companies are seeking to stabilize planetary temperatures instead of supporting modest emission cuts. Outsourcing reductions can save costs when most parties are looking to reduce their emissions on the margin, as was contemplated under the Kyoto Protocol, but planetary temperature stabilization under the Paris Agreement requires global CO₂ emissions to fall to near-net-zero levels. This goal cannot be achieved when governments and companies justify their own ongoing pollution by paying someone else not to pollute.

Five critical challenges

The shift from modest emission reductions under the Kyoto Protocol to temperature stabilization under the Paris Agreement calls for a reconsideration of carbon offsets' role in climate mitigation. Five overlapping problems require an urgent response.

First, carbon offsets rarely deliver the benefits they promise. In order for carbon offsets to cancel out their buyers' emissions, they must accurately reflect additional climate benefits that go beyond business-as-usual outcomes. In contrast, non-additional or over-credited carbon offsets increase net emissions.² The first generation of carbon offsets under the Clean Development Mechanism was widely criticized for producing non-additional carbon credits, rather than new emission reductions.³ Similar problems have been documented in subsequent carbon offset programs. A persistent pattern of exaggerated climate benefits



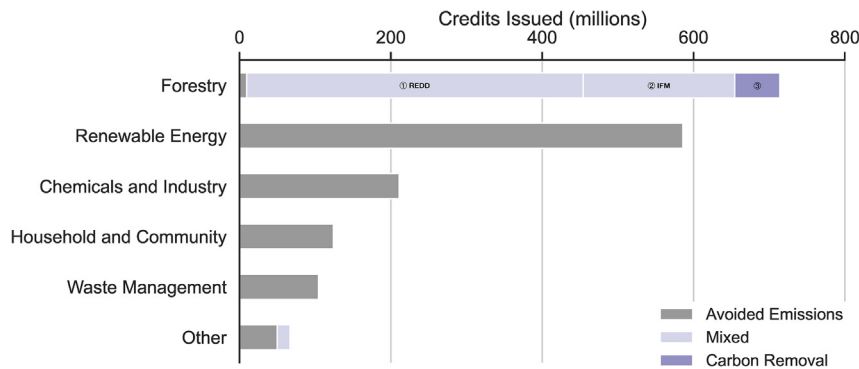


Figure 1. Carbon offset credit issuance by project category

Each credit is denominated as 1 tCO₂-equivalent. To illustrate key market segments, we highlight three types of forestry projects: (1) tropical forest conservation (REDD) projects, (2) improved forest management (IFM) projects, and (3) afforestation/reforestation projects. Project categories are shaded according to whether they achieve temporary carbon removal, avoided emissions, or a mix of both climate services; none of the credits shown here have been issued to projects that store CO₂ outside the atmosphere for more than 100 years. Forestry and renewable energy projects account for 41 percent and 32 percent of credits issued through May 2023, respectively, and about three-quarters of the global market together. Data source: UC Berkeley.⁹

has been observed across tropical forest conservation projects,⁴ renewable energy projects,⁵ and improved forest management practices in working forests^{6,7}—the largest sources of offsets in today’s voluntary carbon market (Figure 1).

Second, most carbon offsets claim to avoid emissions, such as building a wind farm instead of a coal power plant, rather than remove CO₂ from the atmosphere. The distinction matters because reaching and sustaining near-net-zero CO₂ emissions requires unabated CO₂ emissions to be matched with carbon removal and durable storage.⁹ Just over a third of carbon offsets claim a mix of carbon removal and avoided emissions, primarily from forest-sector projects in which forest preservation (avoided emissions) leads to forest growth (carbon removal). Even for forest projects that deliver mixed outcomes, however, the majority of climate benefits come from avoiding emissions through forest preservation.⁶ Less than 4% of today’s market provides dedicated carbon removal, through afforestation and reforestation.

Third, carbon storage must be durable enough to mitigate the near-permanent warming effects of CO₂, but nearly all credited carbon storage is only temporary. Although the warming effects of fossil CO₂ emissions persist on geologic time frames, carbon storage in forests and soils is credited on much shorter time frames that range from one to one hundred years.⁷ This is a problem because

offsetting the effectively permanent consequences of CO₂ with temporary carbon storage necessarily leads to higher temperatures at the end of the temporary carbon storage period.¹⁰ Figure 2 shows the global temperature effects of using temporary carbon storage offsets, based on historical carbon offset credit issuance data from Figure 1. At first, temporary carbon offsets negate the temperature effects of CO₂ emissions, resulting in no initial change in global temperature. However, global temperatures quickly rise once stored carbon is released. Offsets backed by long-duration storage, on geological timescales, are all but non-existent in the current market.¹¹

Fourth, buyers of imperfect carbon credits are making unsubstantiated claims. When a company or government uses an offset to report lower net CO₂ emissions, it is making a compensatory claim that is premised on the equivalence of the harms of CO₂ emissions and the benefits of the carbon credit. Such a claim is physically inaccurate if the carbon credit is non-additional or based on non-durable storage (Figure 2).

Fifth, even the most robust carbon offsets are poised to be double-counted. Under the Paris Agreement’s emissions accounting rules, governments must report greenhouse gas emissions and removals that arise within their borders. This creates a dilemma whenever a carbon offset is traded across borders:

should the buyer or the seller’s host country get to book the credit’s climate benefits? Absent an intervention, both parties could claim the same benefits.¹² Under Article 6.2 of the Paris Agreement, trades between governments must include a corresponding adjustment in which the seller country increases its climate mitigation efforts for every carbon offset transferred abroad. But under Article 6.4, trades between private parties do not require the seller’s host country to make a corresponding adjustment. If private buyers make international offsetting claims without a corresponding adjustment, they will double-count the same benefits the seller’s host country reports under the Paris Agreement.¹³

Reconciling carbon offsets and warming limits

Reorienting carbon offsets to support the Paris Agreement’s commitment to temperature stabilization requires three transformative changes.

First, carbon offsets need government regulation and independent scientific oversight. Despite decades of academic studies documenting persistent quality problems with non-additional, non-durable, and over-credited offset projects, the voluntary carbon market remains largely unresponsive and unregulated. The lack of accountability persists, in part, because the private organizations that issue carbon offsets face few consequences for disregarding critical evidence about the quality of their offerings. While some buyers may be unaware of the market’s supply-side quality problems, others may be willing to purchase low-quality offsets and engage in greenwashing. Regulation and enforcement are needed both to hold offset sellers accountable for delivering what they promise and to make buyers responsible for any claims they should know are not supported by the quality of the offsets they procure.

Independent scientific evidence will also be needed to guide the evolution of market standards and government interventions over time, but much of civil society funding comes from companies, non-profits, and philanthropies that actively participate in or otherwise support the voluntary carbon market. Independent scientific review is particularly important because government-run offset programs are as vulnerable to the same quality

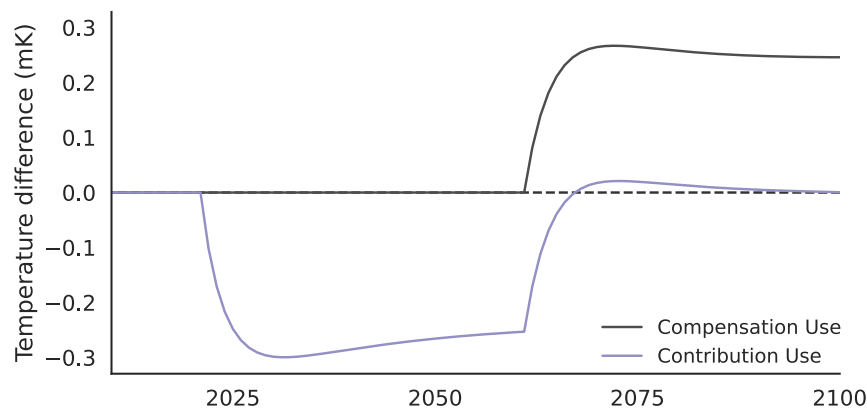


Figure 2. Temperature effect of temporary carbon storage

The temperature effect of temporarily storing 700 MtCO₂ for 40 years, a magnitude and duration of carbon storage that is comparable to historical forest carbon credit issuance from Figure 1. When temporary carbon storage is used as an offset that justifies increased CO₂ emissions (compensation use), temperatures increase at the end of the carbon storage period. In contrast, when temporary carbon storage is pursued as a supplemental climate strategy that does not justify any CO₂ emissions (contribution use), it produces a temporary climate benefit without any long-term warming effects. Dashed line depicts baseline conditions, where neither intervention takes place. Temperature effects are modeled using FaIR v1.6, with the results for compensation and contribution scenarios expressed as a change from the SSP2-4.5 emissions pathway.

problems as private markets and often share the same underlying market standards.⁵ While the United Nations is not the right institution to regulate financial markets and truth-in-advertising claims, climate negotiators should recognize the need for meaningful regulation and independent scientific review as a prerequisite to scaling the use of carbon offsets under the Paris Agreement—and not as an afterthought.

Second, the carbon offsets market must shift its focus from avoided emissions and temporary carbon storage to long-duration carbon removal. The implications of this change are profound and require the creation of an entire new set of industries subject to robust standards. These new entrants must address many of the same additionality and over-crediting concerns found in the incumbent industry, as well as a host of novel challenges that include uncertain environmental impacts, measurement and monitoring complexities, and social license considerations.

Responsible carbon removal governance must also confront the linked problems of scale and priority. Researchers have identified significant mitigation deterrence risks, where the prospect of future carbon removal services is used to delay or diminish the ambition of climate mitigation efforts.¹⁴ The value of

carbon removal should be understood as contingent on cutting emissions first,¹⁵ but those reductions are not yet assured as real-world climate policies are not on track to limit warming below 2°C.¹⁶ Although carbon removal might still be needed for temperature stabilization in a world with zero CO₂ emissions,¹⁷ its role in climate mitigation must be subordinate to deep decarbonization.

Third, companies and governments must resolve the Paris Agreement's double-counting problem, which arises whenever a carbon offset is transferred across national borders. Unfortunately, the carbon trading rules adopted under Article 6 of the Paris Agreement allow both the countries that host offset projects and their private purchasers to claim the same climate benefits. In theory, this double-counting is avoidable if the host country makes a corresponding adjustment that commits it to extra emission reductions for each carbon offset sold abroad.¹² As currently written, however, neither the Article 6 rules nor the leading offset industry standards require corresponding adjustments for private transactions. As a result, most cross-border private transactions are poised to be double-counted.

Absent the political will to close this sizable loophole, the only practical response is to stop making offsetting

claims altogether, as the Voluntary Carbon Market Integrity Initiative recently recommended.¹⁸ If carbon offset purchases were made under a contribution model, with buyers explicitly decoupling their purchases from any offsetting or compensatory claims, then there would be no double-counting because only the host country would book the climate benefits of a cross-border trade. While it is unclear how many private buyers are interested in purchasing carbon credits without making an offsetting claim, this approach is the only feasible way to avoid double-counting in the absence of corresponding adjustments—a condition we expect to dominate the voluntary carbon market going forward.

The consequences of falling short

Each of these reforms requires massive change, but anything less will undermine the Paris Agreement's pursuit of temperature stabilization. When carbon credits suffer from even one of the five problems we have identified, their use as offsets exacerbates climate change and wastes precious resources when the world is not on track to limit warming to under 2°C.

Worse still, low-quality carbon offsets send a misleading signal about the effort required to halt temperature increases. Today's carbon offsets trade at wholesale prices of close to \$1/tCO₂, or about two orders of magnitude below contemporary estimates of climate damages.¹⁹ That is not because carbon offsets offer a low-cost mitigation strategy but because they do not deliver what the physical climate system demands.

To help correct these problems, the United Nations' Global Stocktake process should emphasize the need to move away from carbon offsets in order to meet the Paris Agreement's goals. There is a role for carbon offsets to play in mitigating residual emissions through durable carbon removal, but that role must be carefully constrained.²⁰ Offsets cannot be used to delay climate mitigation nor justify activities that harm local communities and ecosystems.

What matters most in climate mitigation is the rapid and deep reduction of CO₂ emissions. Today's carbon offsets undermine that goal. To support the Paris Agreement, nearly everything about them must change.

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DECLARATION OF INTERESTS

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