amazon sustainability

# **Carbon Neutralization**

# Amazon's Approach to Neutralizing Remaining Emissions on the Path to Net Zero

Amazon's first priority under The Climate Pledge is to innovate and invest to eliminate emissions within the value chain of our businesses, keeping pace with science-aligned pathways to the temperature targets established in the Paris Agreement. In parallel, we are investing in climate mitigation outside of our value chain ("carbon neutralization") as a contribution to global climate action. This document provides an updated explanation of Amazon's science-based approach to carbon neutralization.

## **A New Paradigm**

The conventional conception of "carbon offsetting" claims to present companies with a choice between decarbonizing their own businesses ("carbon elimination") and financing climate mitigation elsewhere. Yet every viable pathway to stabilizing climate change requires both deep reductions in carbon from corporate value chains and also large-scale investment to tackle other climate mitigation priorities that remain dangerously offtrack—not one or the other. Moreover, the voluntary carbon market (VCM) has suffered from a pervasive lack of quality. If carbon credits lack quality, the desired neutralization effects are not fully realized. We estimate less than five percent of credits in the global VCM meet Amazon's quality bar.

We do not believe this approach is conducive to the scaled climate action we need. The science community and other companies are also rejecting this approach. There is now strong alignment among leading companies and stakeholders that companies should eliminate their own emissions at a pace that aligns with science-based decarbonization pathways, and that the VCM needs stronger quality standards. These elements are necessary for the VCM to be a meaningful tool for climate action, but represent only the start of the integrity framework we need to scale climate mitigation. Amazon's approach, informed by our engagements with thought leaders in NGOs, universities, governments, and peer companies, embraces the following elements we believe should form a new paradigm for carbon neutralization:

- 1. **Contributory** Carbon neutralization is a contribution to global climate action—a necessary complement to decarbonizing corporate value chains, not an alternative.
- 2. Market-based Unlocking private sector climate finance at scale will require market-based mechanisms, which in turn require an asset that can be financed and traded. Carbon neutralization is measured in tons of CO<sub>2</sub>-equivalent reductions or removals that are real, additional, quantifiable, permanent, and socially beneficial. For this model to work as intended, we need to insist on a high-bar for carbon credit quality that has largely eluded the VCM to-date.
- **3. Catalytic** Carbon neutralization is a tool to unlock critical climate solutions. Integrity in carbon neutralization means seeking to maximize impact by focusing on climate priorities where targeted investment can have an outsized effect on the trajectory of global climate mitigation. This approach is distinct from a cost minimization approach, or one that selects project types based on simplicity of impact evaluation in order to avoid controversy.
- **4. Positive** The business case for carbon neutralization is grounded in engaging customers in positive action and instilling hope. Companies should use carbon credits to signpost and celebrate progress in their own decarbonization journey, rather than compensate for lack of progress.
- **5.** Adaptive Scaling carbon neutralization will require learning by doing, and failure is an important part of innovation. Companies should be willing to experiment, and continually adapt to incorporate learnings from the field as well as new science and technology as they emerge.
- 6. **Right Now** Carbon neutralization is an immediate contribution to global climate action, not a far-off promise. Companies should ramp up investments in carbon neutralization as they make progress along the journey to deep decarbonization, rather than wait until the end of that journey to support broader climate action. Without such immediate action, it is increasingly difficult to envision a viable path to the Paris Agreement targets.

# **Amazon's Carbon Neutralization Priorities**

Amazon is currently focused on three priorities—**reducing tropical forest loss, restoring degraded land,** and **advancing technological carbon removal**. Across these areas Amazon is using a range of strategies including direct investment, advance purchase agreements, coalition building, new methodology development, and technological innovation to scale outcomes and advance carbon credit quality. We will continue to expand our portfolio where we find opportunities that align with our approach, and continually adapt our approach as we learn.

Carbon credit quality refers to the degree of confidence we have that a credit represents what it claims—one metric ton of durable CO<sub>2</sub> equivalent reduction or removal achieved in a socially beneficial manner and that would not have occurred without carbon finance ("additionality"). Amazon's approach to quality is to start from first principles and identify or develop honest and rigorous impact evaluation methodologies, rather than default to current standards, and to continually revisit these approaches as the science and technology change. While we aim for comprehensive and accurate impact evaluation, methodologies we use may overestimate impact in some areas, and underestimate in other areas. Our approach is to be explicit about these potential sources of over- and under-crediting, with a bias toward under-crediting, and improve accuracy at the program-level over time. In the appendix, we provide an accounting of possible sources of over- and under-credits that currently feature in our investment priorities and growing portfolio.

## **Reducing Tropical Forest Loss**

Tackling deforestation is one of the most significant actions the global community must take this decade to limit catastrophic climate change.<sup>1</sup> Iconic forests like the Amazon Rainforest could be nearing a tipping point, beyond which the world could experience runaway climate change no matter how fast we decarbonize.<sup>2,3</sup> Reducing deforestation and forest degradation is already the largest segment of the VCM, but the credits represent a project-by-project approach. Project-based efforts can play an important role in protecting special areas, but there is no endgame to deforestation without stronger government policy—legal protections for the forest across entire jurisdictions, enforcement of those protections, recognition of indigenous rights, and sustainable natural resource planning. These are all public sector mechanisms. Governments in the tropics need capital to implement these policies and create pathways for developing their economies that do not rely on continued forest loss, but this kind of international finance has not materialized at the requisite scale.

In 2021, Amazon co-founded the <u>LEAF Coalition</u> and anchored the coalition as its largest corporate buyer. Through LEAF, Amazon provides sustainable development finance to tropical forest jurisdictions—nations or large states—using carbon credits that represent year-over-year reductions in deforestation emission rates as the basis for finance. Proceeds are reinvested by a financial intermediary (e.g., a national bank) in further forest protection and sustainable economic development. In the LEAF Coalition, Amazon is investing alongside the governments of Norway, the United Kingdom, and the United States as well as dozens of other corporate climate leaders, all using the same carbon standard to quantify results.

Crediting in jurisdictional programs necessarily relies on simple but conservative methods, and as a result impact measurement is imprecise. LEAF currently uses the <u>ART TREES methodology</u>, an independent verification standard that issues credits only when deforestation rates fall below a five-year historical average. A recent historical average is likely a conservative proxy for deforestation emissions in the counterfactual scenario in which policymakers in tropical forest jurisdictions have no expectation of carbon finance. It is also a consistent baseline that rewards jurisdictions only for further progress and avoids documented "baseline inflation" in past project-based standards that have caused significant over-crediting. The historical average baseline is most conservative in jurisdictions that are already implementing effective government policy. Amazon seeks out jurisdictions with both a demonstrated track record of working to reduce deforestation, and a compelling plan for how LEAF funds would be invested to create durable reductions.

Relative to project-based interventions, jurisdictional programs are less susceptible to leakage—when deforestation is simply displaced to another location—because jurisdictions can address drivers of

deforestation across entire landscapes, although inter-jurisdictional leakage likely still occurs. Bringing more forested jurisdictions into initiatives like the LEAF Coalition would help mitigate this risk.

The durability of carbon reductions—the duration over which carbon is stored out of the atmosphere—is also enhanced in jurisdictional programs compared to project-based approaches, although risks remain. Because jurisdictional programs cover vast areas, they are less vulnerable to single natural disturbance or encroachment events. However, policies to protect forests can be reversed or loosened, leaving only temporary reductions in deforestation emissions. Jurisdictions must contribute 5-25% of credits to a buffer pool, depending on jurisdiction-specific risk factors. We expect that reversals will occur—progress is rarely linear. We believe this risk should not deter investment to keep the world's forests intact.

The social benefits of forest protection can be significant given the biodiversity and local ecosystem services benefits of forests, provided forest communities are included as partners. Amazon seeks out jurisdictions where we see active engagement between the jurisdiction and indigenous peoples and local communities to plan for the implementation of the jurisdictional program and equitable distribution of finance. These communities play a critical role in protecting standing forests, and have a right to be active partners in forest carbon finance—whether through jurisdictional benefit sharing programs or direct participation in the VCM via their own projects, at their own determination.

#### **Restoring Degraded Land**

Restoring nature is an imperative to solve climate change. The Intergovernmental Panel on Climate Change (IPCC) calls for up between 5-10 billion tons of CO<sub>2</sub> removal each year by midcentury to meet Paris-aligned global temperature targets.<sup>4</sup> A wide range of novel technologies are being developed to meet this challenge, but only nature-based carbon removal is poised to truly scale today. Natural ecosystems already take nearly a third of anthropogenic emissions out of the atmosphere each year. <sup>5</sup> Enhancing this effect by restoring natural ecosystems has the potential to remove an additional ~2-4 billion tons CO<sub>2</sub> annually through the end of the century.<sup>6,7</sup>

The single largest nature-based potential lies in restoring forested ecosystems in landscapes that are now degraded.<sup>8</sup> This can take the form of reforestation or agroforestry—a form of regenerative agriculture that integrates trees with crops and/or livestock. There are an estimated 700 million hectares of formerly forested grazing land and cleared non-agricultural land globally that are suitable for such interventions—an area nearly twice the size of the European Union. When done well, restoration can bolster rural livelihoods, food security, and biodiversity. Despite the scale of potential, the VCM has so far passed over restoration (<3% of all credit issuances to-date<sup>9</sup>) due to upfront capital costs and long payback periods. We estimate that the costs of high-quality restoration are an order of magnitude higher than the global average price in the VCM today.

To unlock large-scale finance for restoration projects, credit-worthy companies like Amazon will need to sign long-term purchase agreements for the carbon credits these projects will generate—in the same way that Amazon has unlocked tens of billions of dollars in finance for renewable energy over the last decade. We are <u>building our restoration project pipeline</u>, focusing on projects that help family farmers to adopt agroforestry, and projects that work with governments to restore native forests on public lands. Agroforestry projects address barriers to adoption by family farmers such as access to capital, technical knowledge, and offtake for regenerative commodities. Public land restoration projects provide private capital to generate public benefits. They provide revenues to local jurisdictions for sustainable economic development and land stewardship, and can deter land grabbers while restoring biodiversity corridors and local ecosystem services.

Amazon takes a project-based approach to restoration in order to mobilize scalable private sector finance to cover upfront costs of restoration. With privately financed projects, Amazon and our partners also have more flexibility to innovate in carbon measurement and monitoring methods, whereas jurisdictional programs necessarily rely on government monitoring systems and simple but conservative crediting protocols. Our scientists have collaborated with a consensus-based group of leading practitioners, conservation professionals, and scientists to develop <u>ABACUS</u>, a set of innovations in carbon standard methodologies for the restoration segment. We expect ABACUS requirements to advance iteratively as we learn from its application in the field.

Under ABACUS, Amazon uses a "treatment-control" approach to measure the impact of our restoration projects. Project areas (treatment) are matched to a population of remotely monitored control plots in the surrounding landscape. We will monitor those controls through time, and credits will be issued only where project areas gain carbon at a faster rate than the controls. This approach is more sophisticated, and categorically more conservative, than the conventional approach in the VCM today where it is assumed that project areas would never be restored or naturally regenerate without the aid of carbon finance.

Quantification of all major carbon pools must be based on direct measurements within the project area, with data and scaling models made public for scrutiny and the advancement of ecosystem science. Conventional methodologies often allow for use of coarse default factors to calculate carbon removal, which fails to capture realities within the project area and can result in overestimation. We are also cognizant of limitations in existing methods for scaling field plot measurements to project-wide carbon storage estimates, typically using coarse allometric equations and root to shoot ratios developed through limited destructive sampling of trees. We are experimenting with alternative methods—including below-canopy and above-canopy LiDAR.

Amazon also requires projects to eliminate 'leakage,' which occurs when a reforestation project displaces agricultural production and leads to conversion of natural ecosystems elsewhere to satisfy global commodity demand. Conventional methodologies apply standardized crediting deductions to account for leakage effects, but these deductions are based on a sparse and generally stale literature—actual leakage effects are highly uncertain. Under ABACUS, we require projects to replace lost agricultural production to effectively eliminate leakage. This tends to favor restoration projects on the most degraded (least productive) land, agroforestry projects that produce food alongside carbon storage, and projects that work with local communities to sustainably enhance agricultural productivity.

We are seeking to achieve enduring shifts in land use systems at the landscape scale. Once barriers to adoption are overcome, agroforestry systems can boost income for farmers even without carbon revenues, which suggests we could achieve a new equilibrium in land management that maintains higher carbon storage on the landscape even as some areas are inevitably cleared and re-planted over time. Public reforestation projects benefit from public protection, and these projects inject resources for both local livelihoods and enforcement of forest protections. Working with large-scale interventions across a landscape reduces the risk of reversals related to disturbances in any given plot that can return captured CO<sub>2</sub> to the atmosphere.

Amazon also requires project design elements to enhance durability. Projects must plant ecologically appropriate systems that will tend to be more resilient to climate change. We exclude monocultures—single-species plantations lacking in biodiversity and typically planted for future harvest. Projects must either provide a plan for the financial sustainability of the restoration system after the crediting period (for example, agroforestry is lucrative for family farmers to maintain), and/or receive public protection. We are also working with external experts to consider a requirement to deposit credits generated beyond year 30 in a buffer pool or other mechanism to assure ongoing durability.

Amazon is intentionally working with small family farmers and on public lands with shared use by local communities to maximize the social benefits of our investments. Our criteria and investment priorities are also designed to provide benefits for local and global food security, local livelihoods, and biodiversity.

#### **Advancing Technological Carbon Removal**

Technological carbon removal is a broad category of emerging technologies and approaches that remove CO<sub>2</sub> from the atmosphere and durably store it. Nature-based solutions are only capable of meeting about half the global need for carbon removal; by midcentury we will also need a scaled portfolio of cost-effective and socially-beneficial technological solutions to remove carbon.

As with restoration, deploying technological carbon removal will require long-term purchase agreements from credit-worthy buyers to bring these expensive technologies down the cost curve. Amazon became one of the world's largest buyers of carbon removal from direct air capture technology, following our first investments in 2023. Direct air capture technologies (there are several, and each operates differently) bind  $CO_2$  from the ambient air using a wide range of closed loop processes. Captured  $CO_2$  is generally stored deep underground.

We continue to look for ways to advance promising direct air capture technologies and we are scoping other technological and open-system segments, including biomass carbon removal and storage, enhanced weathering, and some forms of ocean carbon dioxide removal. Given our scale, Amazon is principally focused on supporting technology providers that are ready to make the leap from demonstration-scale to commercial-scale facilities, and need support from larger buyers. We focus on supporting solutions with potential to remove billions of tons of  $CO_2$  from the atmosphere annually, and where we believe learnings from early deployments and economies of scale can rapidly reduce costs.

As of early 2024, there are no established, industry-standard quantification methodologies for direct air capture, although multiple methodologies are being developed. Direct air capture has several characteristics that simplify impact evaluation relative to nature-based solutions. Additionality is straightforward—there is no reason to build a direct air capture plant other than to remove  $CO_2$ , and available government subsidies constitute a fraction of the costs. Measuring captured  $CO_2$  is also straightforward relative to nature-based solutions. However, there are nuances in the lifecycle assessment of direct air capture plants that need to be addressed comprehensively and conservatively—including the carbon impact of energy inputs, embedded and life cycle emissions of the facilities and materials consumed, and long-term monitoring of sequestered  $CO_2$ .

Until carbon standard methodologies are well-established, Amazon is requiring assurances from direct air capture companies in a few key areas:

- Grid-connected direct air capture plants must explicitly build and/or purchase dedicated carbon-free energy to cover their operations in a not-yet-decarbonized grid.
- Direct air capture plants that store captured CO<sub>2</sub> in concrete must account for potential impacts on long-term natural carbonation of in-use concrete and any reductions in the concrete's compressive strength.
- Direct air capture plants that utilize natural gas or waste biomass for thermal energy must capture the CO<sub>2</sub> emissions associated with combustion, and conservatively account for the life cycle emissions in the production and distribution of natural gas and waste biomass. Estimates of natural gas fugitive emissions from production and transport must be based on sampled direct measurements from upstream natural gas infrastructure.
- Embodied carbon in construction, facilities, and end-of-life must be fully and conservatively accounted for.

Other carbon removal technologies pose different sets of challenges in impact evaluation. As Amazon expands our portfolio to include these technologies, we will conduct our own technical assessment to identify or develop leading methodologies.

## Interim Solutions from the "Legacy" Voluntary Carbon Market

Our efforts to kickstart new segments in the VCM under our quality bar take years from standards development through project origination, investment, and implementation—and even longer for results to be generated and independently verified, and credits issued. As a bridge to these new segments, Amazon has looked for bright spots in the existing VCM. We supported a reforestation project and two forest protection projects. The balance of our forest protection project portfolio appears to have underestimated baselines based on a peer-reviewed study using matched controls,<sup>10</sup> which would lead to under-crediting. Nonetheless, we plan only to use these legacy project types as a bridge to the future VCM we are helping to seed.

<sup>&</sup>lt;sup>1</sup> M. Pathak. et al. 2022. https://doi.org/10.1017/9781009157926.002

<sup>&</sup>lt;sup>2</sup> Flores, B.M., et al. 2024. https://doi.org/10.1038/s41586-023-06970-0

<sup>&</sup>lt;sup>3</sup>Wunderling, N. et. al. 2022. https://doi.org/10.1038/s41558-022-01545-9

<sup>&</sup>lt;sup>4</sup>Smith, S. M. et al. 2023. https://www.stateofcdr.org

<sup>&</sup>lt;sup>5</sup>Friedlingstein, P. et al. 2023. https://doi.org/10.5194/ESSD-15-5301-2023

<sup>&</sup>lt;sup>6</sup>Mo, L., et al. 2023. https://doi.org/10.1038/s41586-023-06723-z

<sup>&</sup>lt;sup>7</sup> Walker et al., 2022. https://www.pnas.org/doi/full/10.1073/pnas.2111312119

<sup>&</sup>lt;sup>8</sup>Griscom, B. W., et al. 2017. https://doi.org/10.1073/pnas.1710465114

<sup>&</sup>lt;sup>9</sup> Ivy S. So et al. 2023. https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database

<sup>&</sup>lt;sup>10</sup> Guizar-Coutiño, A. et al. 2022. https://doi.org/10.1111/COBI.13970

# FAQs

# **1.** Is carbon removal better for the atmosphere or a more appropriate carbon neutralization strategy than carbon reduction?

The effect of a carbon removal and a carbon reduction on atmospheric concentrations of GHGs is the same just as turning down a bathtub faucet and opening the drain have the same effect on water levels in the tub. Therefore, carbon removals and carbon reductions are interchangeable for carbon neutralization purposes, provided they are truly additional and meet other key quality criteria (not overestimated, durable). As other actors begin to take responsibility for their own emissions on the road to global net zero, the availability of truly additional carbon reductions will diminish and supply of high-quality carbon credits will transition to primarily carbon removals. But today, removals are not available at scale. Investing now to begin scaling them up is critically important, but creating climate mitigation at scale right now is primarily a matter of carbon reduction.

## 2. Does carbon removal prolong the use of fossil fuels?

There is no viable path to stabilizing global climate change that does not involve a rapid transition away from fossil fuels. IPCC pathways to the Paris Agreement targets call for a significant scaling of nature-based and technological carbon removal alongside a transition from fossil fuels.

## 3. How does Amazon view durability risk in nature-based solutions?

Amazon is embracing solutions that the IPCC has made clear are imperatives to stabilize the climate, and where we believe our engagement can have an unlocking effect on scaling these solutions even beyond our own investments. There is no solution to climate change without halting tropical deforestation and restoring vast tracts of forest we have already lost. We are focused on creating change that will lead to durable outcomes—stabilizing higher carbon storage on the landscape while at the same time improving livelihoods. Forests have the potential to be highly durable carbon reservoirs—today's primary forests have been around for thousands of years. Unlike geological carbon storage, biological carbon storage retains long-tail durability risks that must be managed for. There is a real risk that some of these climate mitigation benefits will be temporary. On the other hand, nature-based solutions can create significant climate benefits well beyond what is credited—through spillover effects and avoiding tipping points, for example. We are collaboratively innovating towards insurance and assurance mechanisms to achieve effectively permanent carbon storage. In general, sustaining protections for existing and restored forests will be an imperative not only for the VCM, but also for the broader global community given its criticality to mitigating climate change.

## 4. How will jurisdictional forest carbon programs like the LEAF Coalition affect carbon rights?

Under the LEAF Coalition, any holder of carbon rights has the right to opt out of the jurisdictional program and may determine whether to participate directly in the VCM (i.e., using the project-based approach) or not to participate. LEAF contracts also include termination provisions in the event social safeguards are not respected, such as a taking of carbon rights by the government—a design intended to dispel any real or perceived incentive by the government to take such actions. In order to issue credits, jurisdictions must also adhere to the Cancun Safeguards, a set of social and environmental safeguards adopted by the United Nations Framework Convention on Climate Change. The Cancun Safeguards require full and effective participation by indigenous peoples and local communities (IPLCs). LEAF Coalition contracts further require jurisdictions to work with stakeholders including IPLCs to develop plans for equitably distributing proceeds from LEAF transactions so that these communities have resources for sustainable development.

# 5. Do the mitigation outcomes underpinning carbon credits need to be carved out of the national inventories in the countries where the credits are generated ("corresponding adjustments")?

No, provided that the mitigation outcomes are not transferred to the national inventory of any other party to the Paris Agreement. Proposals to separate the VCM from Nationally Determined Contributions (NDCs) were considered by parties to the Paris Agreement and were not accepted. It has been posited that allowing VCM mitigation outcomes to be accounted for in a national inventory constitutes "double claiming." Double claiming requires two claims of attribution for the same mitigation outcome. Accounting for a mitigation outcome in a national inventory does not constitute a claim of attribution to a national government with respect to other actors within national boundaries—indeed, many of the mitigation outcomes in national inventories are attributable to subnational and private sector actors. Aspired mitigation outcomes in NDCs are not assured to materialize without private sector climate finance. The VCM should focus on aiding especially developing countries to achieve their NDCs, and unlocking new climate solutions to enable these NDCs to be strengthened over time. Companies participating in the VCM should be thoughtful to support solutions that serve to support and enhance national ambition, and avoid displacing other sources of finance.

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# Appendix

<b>Reducing Tropical Forest Loss</b> ART TREES Reductions Protocol for "Non-HFLD" Jurisdictions + Amazon selection criteria		
Possible sources of over-crediting	<ul> <li>ART TREES does not apply a leakage deduction for jurisdictions that include &gt;90% of the national forest area in the accounting area, which could result in over-crediting if there is international leakage.</li> </ul>	
Possible sources of over-crediting or under-crediting	<ul> <li>The baseline methodology could result in under-crediting if the simple historical average of deforestation emissions is an underestimate of actual deforestation emissions in the counterfactual scenario (i.e., without policy intervention motivated by an expectation of carbon finance). Over-crediting could also occur in jurisdictions where policy to control deforestation emissions is ineffective and declines in deforestation are attributable to exogenous factors like fluctuations in commodity prices. Amazon works to select jurisdictions where we can gain confidence in the efficacy of their efforts, and we require that our funding be reinvested in further forest protection and sustainable economic development.</li> </ul>	
	<ul> <li>National forest monitoring systems used to measure changes in forest carbon stock due to deforestation and forest degradation can have large uncertainty bands. In the absence of systematic bias, the risks of over- and under-crediting should be equally weighted. However, the ART TREES methodology imposes a crediting deduction based on estimated uncertainty to minimize (but not eliminate) the risk of over-crediting. In the absence of systematic bias, this deduction will tend to lead to under- crediting. The uncertainty deduction does not account for uncertainty in allometric equations, on the premise that measurement error will be consistent in the historical period and the performance period, and therefore generally "wash out." This may or may not be the case.</li> </ul>	
	• The ART TREES leakage deductions for subnational jurisdictions, ranging from 5-20% depending on the percentage of national forest area covered in the accounting area, may be too high or too low depending on a range of factors that are jurisdiction-specific and dynamic, which could result in either over-crediting or under-crediting.	
	• ART defines a reversal as when emissions exceed the historical five- year average emissions, although conceptually a true reversal does not actually occur unless emissions exceed a jurisdiction's true counterfactual emissions, which could be considerably higher than its ART TREES baseline. If a true reversal occurs and the buffer pool is inadequately capitalized to compensate for it, then over-crediting would occur. It is also conceivable that buffer pool contributions exceed what is necessary to compensate for true reversals. This would result in under-crediting.	
Possible sources of under-crediting	• The ART TREES methodology omits biophysical climate impacts of avoiding deforestation—i.e., the albedo, roughness, and energy partitioning impacts on surface. In the tropics, there is high confidence that	



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Possible sources of under-crediting (continued)	the net biophysical impact of avoiding deforestation has a significant net cooling effect. <sup>11, 12</sup> The ART TREES methodology does not contemplate the avoidance of tropical forest tipping points, where forest loss reduces evapotranspiration and drives further tree mortality. To the extent credited reductions in deforestation avoid these tipping points, their true climate mitigation impact could be significantly underestimated.
<b>Restoring Degraded Land</b> VM0047 + ABACUS + Amaz	on selection criteria
Possible sources of over-crediting	There is likely some unavoidable bias in the selection of control plots to form the dynamic baseline. Areas that enroll in projects likely have some non-biophysical characteristics that increase their propensity for restoration (for example, family size, education, income) that cannot be remotely observed for the selection of controls. This will tend to lead to over-crediting. Carbon storage in natural systems is inherently impermanent, even with
	ABACUS requirements to enhance durability of carbon storage within project areas. Durability risk is currently addressed through buffer pool contributions. ABACUS requires credit issuance beyond year 30 to be deposited in a buffer pool or similar mechanism. If the buffer pool is not adequate to compensate for reversals, this will be a source of over- crediting.
Possible sources of over-crediting or under-crediting	Conventional methods for forest carbon inventories are prone to uncertainty in measurement due to reliance on allometric equations (which scale tree diameter measurements to above ground carbon) and "root to shoot" ratios (which relate unobserved below ground carbon) to above ground carbon) constructed using limited destructive samples for a limited number of species. This uncertainty is compounded by sample error. In the absence of systematic bias, the risks of over- and under-crediting should be equally weighted. However, the VM0047 methodology imposes a crediting deduction based on estimated uncertainty to minimize (but not eliminate) the risk of over-crediting. In the absence of systematic bias, this deduction will tend to lead to under-crediting. Bias may very well be present in typical projects where project developers have an incentive to select favorable estimation methods. ABACUS requires transparency measures to disincentivize such behavior, and Amazon is addressing estimation method selection directly in contractual arrangements with project developers in our portfolio. Biophysical impacts of restoration, including changes to albedo, energy partitioning, and turbulent fluxes, can enhance or counteract biogeochemical benefits (i.e., the reduction in global warming attributable to removing carbon from the atmosphere).13 Despite this, net biophysical impacts have not been considered when accounting for the climate impacts of nature-based carbon removal due to challenges in harmonizing the radiative and non-radiative biophysical processes with the radiative biogeochemical impacts. While restoration and reforestation

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Possible sources of over-crediting or under-crediting (continued)	tend to decrease albedo, causing a global increase in radiative forcing (i.e. warming),14 they can also cause a local- to regional- surface temperature cooling effect that can provide a climate adaptation benefit and avoid ecosystem tipping points.15 We will continue to seek scientific frameworks to explicitly account for the total, net biophysical impacts or project-scale restoration.
Possible sources of under-crediting	<ul> <li>In order to avoid severe deductions under the ABACUS leakage methodology, projects will likely be designed to achieve a net land sparing effect. The avoided emissions associated with net land sparing are uncredited.</li> </ul>
	• Where projects do not achieve a net land sparing effect, the ABACUS requirement to assume that 100% of displaced agricultural production within the project area will cause deforestation somewhere else is highly conservative and will result in under-crediting. This is an intentional design feature to motivate project developers to achieve a net land sparing effect.
	<ul> <li>In many cases, matched control areas are likely to experience a reduction in carbon stocks over time as the historical land use—for example extensive grazing—continues. While enhancements in carbon stocks in the controls are captured in the dynamic baseline, reductions in carbon stocks in the controls (and thus project avoided emissions) represent an uncredited mitigation outcome.</li> </ul>
	• Agroforestry projects tend to work by addressing systemic barriers to new agricultural practices that are otherwise lucrative for farmers—such as access to technical knowledge and markets for regenerative commodities. If successful, these barriers will be reduced not only for farmers in project areas, but other farmers too. If farmers outside the project area adopt agroforestry as a result of the projects interventions, this positive spillover effect would be a source of under-crediting. If this positive spillover affects the control plots that form the project's dynamic baseline, it could actually reduce project crediting artificially.
Advancing Technologie Amazon selection criter	
Possible sources of over-crediting	• The net marginal effect of grid-connected direct air capture plants on grid emissions, even where these plants purchase renewable energy to power their operations, is uncertain and could result in over-crediting.
Possible sources of under-crediting	<ul> <li>Where emission factors, measured values, or lab analyses have an uncertainty range, suppliers should use the conservative end of the range. This should result in under-crediting.</li> </ul>

<sup>13</sup> Section 2.5.2.1 in Jia, G., et al., 2019. Land-climate interactions. In: Climate Change and Land: an IPCC special report (https://www.ipcc.ch/srccl/chapter/ chapter-2/)

- <sup>14</sup> Hasler et al., 2024. https://doi.org/10.1038/s41467-024-46577-1
   <sup>15</sup> Li et al., 2023. https://doi.org/10.1038/s41467-023-35799-4

 <sup>&</sup>lt;sup>11</sup> Jia, G., et al. 2019. https://doi.org/10.1017/9781009157988.004
 <sup>12</sup> Lawrence et al., 2022. https://doi.org/10.3389/ffgc.2022.756115