Apple's Carbon Removal Strategy

January 2024

Overview

Apple has been carbon neutral for our global corporate operations since 2020,[1] and we've set an ambitious goal to become carbon neutral across our entire value chain by 2030.[2] In line with the latest climate science, we've committed to reduce emissions by 75 percent compared with 2015 levels by the end of the decade, and balance residual emissions with high-quality carbon removal credits. Apple has further committed to 90 percent emissions reduction by 2050.

Apple is unequivocal in our priority: emissions reductions take precedence over carbon removal. Achieving this requires urgent action within our own operations and partnership across our entire value chain. We're designing products to be less carbon intensive through material selection and increased material efficiency, and we're working with our manufacturing partners to create more energy efficient processes. We are reducing direct greenhouse gas emissions in our facilities, and supporting emissions reductions in our supply chain through process innovation, direct emissions abatement, and transitioning to renewable energy.[3]

But even with these comprehensive measures, there are emissions in our value chain that can't yet be avoided. For example, even when we transition to 100 percent renewable electricity, there are still emissions associated with generating clean electricity, like those from manufacturing and maintaining renewable energy infrastructure. While technology may evolve over time to reduce emissions that are currently unavoidable, it is critical that we take steps now to prevent the worst impacts of climate change. To catalyze efforts to reach a 1.5° C pathway, we're rapidly scaling up carbon removal solutions beginning with those that are available today, while exploring the solutions of the future.

In 2021, Apple partnered with Goldman Sachs and Conservation International to launch the Restore Fund — an innovative nature-based carbon removal investment strategy. In 2023, we doubled our commitment to nature-based restoration with a second fund in partnership with Climate Asset Management. Both of these funds aim to remove 1 million tonnes of carbon dioxide annually from the atmosphere at peak as well as provide important benefits for local communities and protect and enhance biodiversity.

This paper sets out our approach to scaling up carbon removal, including the standards we've put in place to ensure that we're investing in high-quality, high-impact projects; early lessons from implementing the Restore Fund; and challenges we are working to overcome in the coming years to expand our efforts.

Our 10-year Climate Roadmap to address Apple's carbon footprint

>75% emissions reduction

Low-carbon design

Energy efficiency

Clean electricity

Direct emissions abatement

<25% of footprint

Carbon removal

Carbon neutrality across our supply chain

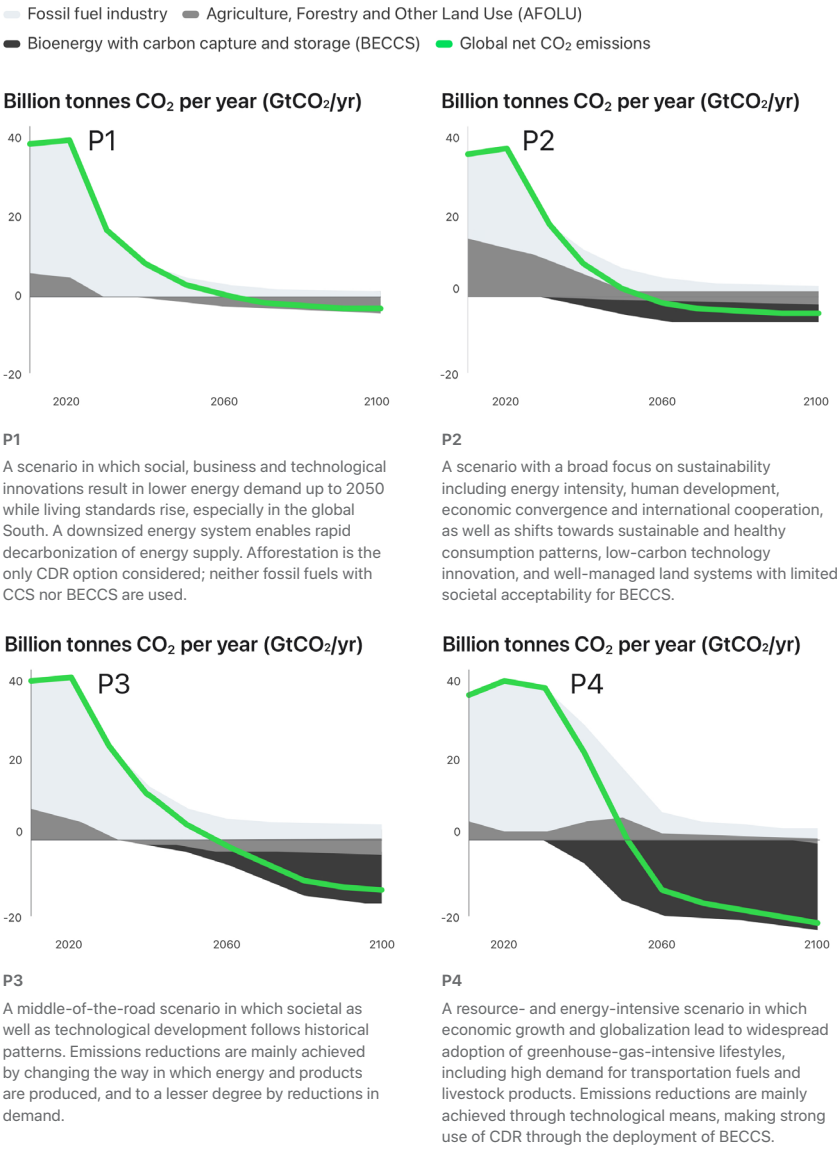
Contents

Why Carbon Removal?

In 2018, the Intergovernmental Panel on Climate Change (IPCC) produced a report outlining the latest science on how to limit the planet's warming to just 1.5° C and, as a result, avoid the worst impacts of climate change.[4] The science shows that meeting this target will require both deeply decarbonizing industrial emissions over the next 30 years, and significantly ramping up carbon removal to address the surplus carbon dioxide (CO_2) already emitted. The report lays out four scenarios for achieving this goal, ranging from steep decarbonization to a slower global decline in fossil fuel use (see Figure 1).

Figure 1. Four pathways to achieve 1.5° C of warming

Adapted from IPCC, 2018



P1

A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2

A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3

A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4

A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

In a more recent report, the IPCC highlights that in the most aggressive decarbonization scenario, the land sector would need to shift from emitting around 5 billion tonnes of CO2 ($GtCO_2$) annually to becoming a net sink of around 5 $GtCO_2$ annually. In the least ambitious decarbonization scenario, the

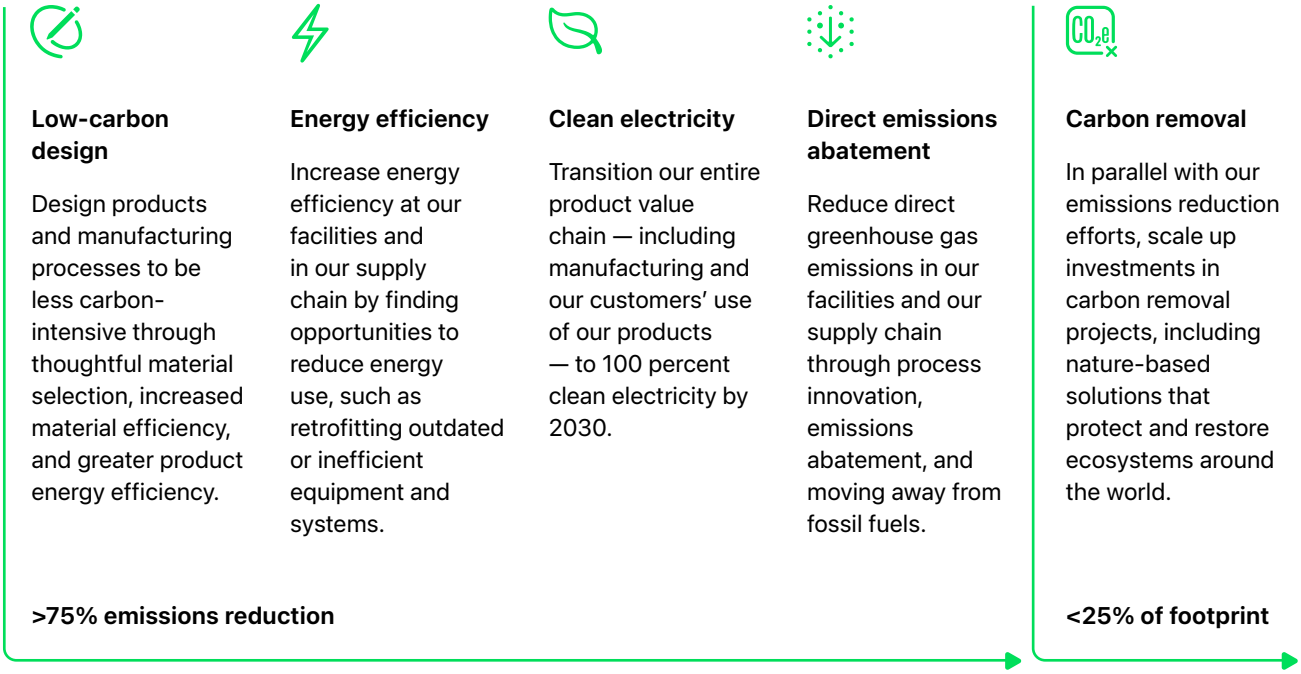
report calls for carbon removal of around 10 $GtCO_2$ annually and cumulative carbon removal of around 360 $GtCO_2$ by 2100 — equivalent to around 10 years of global annual greenhouse gas (GHG) emissions combined.[5]

The science shows clearly that any successful strategy for addressing climate change must decarbonize energy and industry, protect and restore Earth's ecosystems, and develop carbon removal technologies - all pursued urgently, jointly, and in parallel.

As a large global company, we believe it's our responsibility to take strong, decisive, and inclusive steps to mitigate our impact on the climate. And that's why in 2020, we set a bold commitment to become carbon neutral across the life cycle of our products by 2030.[6]

Since April 2020, we've achieved carbon neutrality for our corporate emissions by sourcing 100 percent renewable electricity for Apple facilities, implementing energy efficiency, directly abating emissions, and securing high-quality carbon credits to counter-balance all unabated emissions (See Figure 2).

Figure 2. Our 10-year Climate Roadmap addresses Apple's carbon footprint through five pillars:

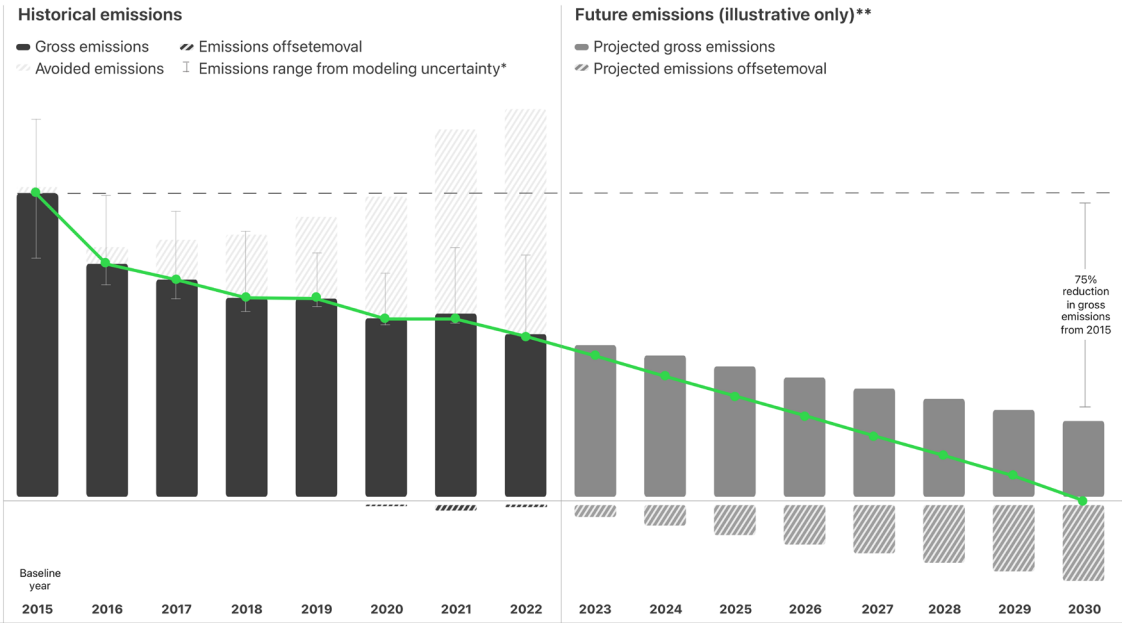


Our Apple 2030 commitment - to become carbon neutral for our full value chain - similarly begins with a steep reduction in our comprehensive carbon footprint. We aim to reduce emissions by 75 percent compared with our fiscal year 2015 footprint by 2030, and 90 percent by 2050. We're achieving this commitment through innovative product designs, improving supplier energy efficiency, and switching to 100 percent clean electricity for both our manufacturing and our customers' electricity use for powering Apple devices.

The trajectory of these reductions (see Figure 3) aligns with a 1.5°C scenario, meaning that Apple is committed to reducing its Scope 1, 2, and 3 emissions in line with what's globally required for a 1.5°C scenario. Our reduction target - which doesn't include any offsets or carbon removals - translates to an absolute carbon target of 9.6 $MtCO_2$ in 2030 (including Scopes 1, 2, and 3) and has been validated by the Science Based Targets Initiative (SBTi).[7]

To achieve carbon neutrality, we'll balance the remaining, unavoidable emissions with high-quality carbon removal credits. To ensure that removals are equivalent to unavoidable emissions we'll follow guidance set out by international standards, and apply our own high-quality standards and criteria.

Figure 3. Emissions trajectory to meet Apple's 2030 commitment



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gross emissions	38.4	29.5	27.5	25.2	25.1	22.6	23.2	20.6								
Carbon offsets/removal						0.1	0.7	0.3								
Net emissions	38.4	29.5	27.5	25.2	25.1	22.5	22.5	20.3								

* Error bars: Were continuously refining our methodology to improve our carbon footprint estimate. But theres uncertainty inherent to modeling product-related carbon emissions, which weve illustrated through error bars in this graphic.

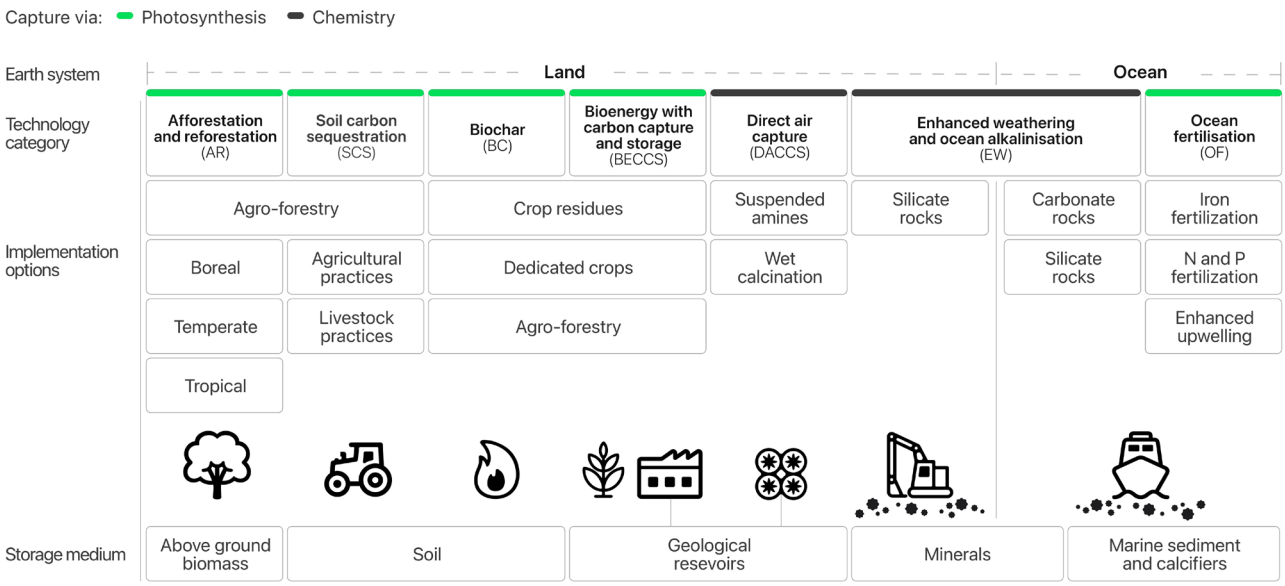
** Future emissions: Future emissions, including offsets and removals, are displayed as a linear trend to reach carbon neutral by 2030. Actual future emissions will likely not be linear.

Why Nature-based Carbon Removal?

The IPCC lays out a range of options to remove carbon from the atmosphere using a combination of photosynthesis and chemistry (see Figure 4).[8] These approaches include existing climate solutions such as afforestation and reforestation and relatively new technologies such as direct air capture (DAC) and ocean alkalinization.

Figure 4. A range of carbon dioxide removal technologies

Adapted from Minx et al 2018



Apple looked at how these approaches could help balance our residual emissions while focusing on the global urgency to align with a 1.5°C pathway to scale up carbon removal. We evaluated each option against five key criteria: stage of development, scalability, durability, carbon methodology, and cobenefits.

Stage of development

Given the immediacy of the global need to scale climate solutions, our first threshold for assessing approaches was technology readiness and degree of commercialization. Under this criteria, carbon removal technologies were evaluated against their level of commercialization within a 2030 timeframe. This is important both to meet our Apple 2030 target, and to reach scale within the timeframe needed to stay within a 1.5°C trajectory.

Scalability

The second criteria we looked at was the overall scale that carbon removal solutions could achieve. As we urgently work towards our Apple 2030 goal, we're also working to ensure that the strategies and technologies we pursue are scalable for others. The climate crisis is a collective responsibility, and the impact of Apple's solutions should scale beyond our own environmental footprint.

Durability

Our third criteria was how durable removals are in terms of keeping CO_2 out of the atmosphere. Given the longevity of emissions in the atmosphere, our removals must be permanent or, where there's a risk of reversal, there must be measures in place to address those risks and compensate for any reversals for a defined period of time.

Carbon methodology

To ensure quality and consistency in our own carbon accounting systems, and to adhere to international carbon accounting rules, the fourth criteria we examined was the availability of robust methodologies for measuring and quantifying carbon impact across the different carbon removal strategies. This included evaluating any uncertainty in the underlying science, as well as making sure that our projects meet existing principles as defined in carbon accounting methodologies.

Cobenefits

Finally, we looked at the cobenefits across different carbon removal technologies. Most carbon removal approaches have the potential to generate additional benefits for biodiversity and communities but can also pose risks.

Table 1. Comparison of carbon removal technologies based on development state, scalability, maturity of carbon accounting methodology , and connection with the supply chain

		Development stage	Scalability	Durability	Carbon methodology	Cobenefits
Nature based	Aforestation, reforestation, and revegetation (ARR)	●	●	◒	●	●
	Soil carbon sequestration	●	●	○	◒	●
	Biochar	●	◒	●	◒	●
Non-Nature based	Bioenergy with carbon capture and storage (BECCS)	◒	◒	●	◒	◒
	Direct air capture (DAC)	◒	◒	●	◒	○
	Enhanced weathering / ocean alkalinity	○	●	●	○	◒
	Ocean fertilization	○	●	●	○	○

● Covered ◒ Partially covered ○ Not covered

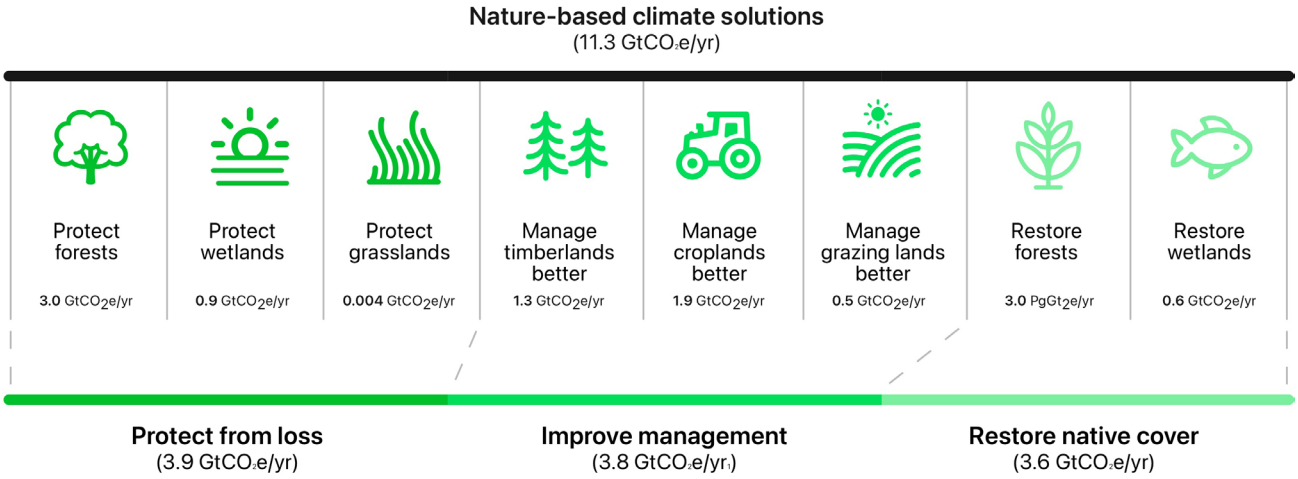
From our review of different available technologies (see Table 1), we determined that nature-based solutions - including afforestation, reforestation and revegetation (ARR) and soil carbon sequestration - currently offer the most comprehensive carbon removal approach today.

While many geological and engineered carbon removal approaches have the potential to remove billions of tonnes of CO_2 per year from the atmosphere, most aren't commercially ready today or have only achieved tens of thousands of tonnes of removals per year to date.[9]

Nature-based solutions, on the other hand, are one of the most scalable solutions to mitigate climate change in the short term.[10] A study published by Nature in 2021 estimates that nature-based solutions can mitigate up to 10 $GtCO_2$ per year globally.[11] Around 5 $GtCO_2$ of emissions can be avoided per year by protecting intact ecosystems and managing working lands better, and around 5 $GtCO_2$ can be removed per year by managing and restoring grasslands, wetlands, and forests (see Figure 5).

Figure 5. Climate change mitigation potential from nature-based climate solutions

Adapted from Girardin et al., in review. Based on estimates from Griscom et al., 2017, Griscom et al., 2020, Busch et al., 2019 and consistent with Roe et al., 2019



Estimates for global tree restoration vary, with one recent publication projecting that an additional cumulative amount of 226 $GtCO_2$ could be sequestered in natural forests globally.[12]

From a durability perspective, carbon removal technologies with geological storage offer the most permanent CO_2 sinks. There are also systems within carbon markets that allow nature-based solutions to be durable for decades if not centuries. And, while there's uncertainty in carbon accounting methodologies for nature-based solutions in general, the methodologies for afforestation and reforestation projects in particular include a robust assessment of additionality,[13] and they provide transparent methods to quantify the carbon impact of projects.[14] Afforestation and reforestation methodologies also provide tools for determining the quantity of credits to allocate to a buffer pool to address permanence (see Box 1 on the following page).[15]

In addition to their climate benefits nature-based solutions offer multiple cobenefits, including enhanced employment and local livelihoods, improved biodiversity, soil carbon and nutrient cycling, and increased timber supply that can reduce the pressure on primary forests.[16]

While our focus has been on scaling nature-based carbon projects, there's no silver bullet. Achieving global climate targets will require pursuing all carbon removal strategies.

Apple has also been looking at what will be needed in the future and working to advance projects that aren't yet commercially scalable. In 2022, through our engagement with the MIT Climate & Sustainability Consortium, Apple began jointly funding research with PepsiCo and Cargill on improving soil carbon

measurement in nature-based carbon removal projects. Apple has also funded research with Conservation International to pilot approaches to improve rangeland restoration in Africa's savanna ecosystems that can sequester hundreds of millions of tonnes of carbon per year at scale.

We'll monitor our carbon projects for permanence for 40-100 years.

Box 1. Permanence in nature-based carbon projects

A common criticism of nature-based carbon projects is that carbon isn't stored permanently in trees, plants and soils; if trees are cut down or subject to fire CO_2 will be released back to the atmosphere. This general process is known as a "reversal".

Nature-based removals, however, can endure for decades or centuries when they are well designed and managed. Many factors related to reversal risks can be addressed during project design - for example, by creating long-term financial incentives, or creating legal restrictions to ensure the land isn't over-harvested or converted for other uses.

Project permanence can also be monitored during and after project implementation through commonly available monitoring, reporting and verification systems that use globally available data sets. The Restore Fund uses a number of these data sets (for example, Landsat, and JEDI) to ensure that the impacts of our projects are measurable and sustained over time.

In the case that a reversal does occur, there are systems to insure that carbon isn't over issued from a project. Verra, for example, maintains a pooled buffer account that holds a percentage of project credits that can't be used for retirement.[17] If reversals occur during the monitoring period of a project (we require 40 to 100 years today), credits can be canceled from the buffer pool to cover any loss of carbon from the project, much like an insurance mechanism.

Lastly, there are misconceptions around the role of harvesting in afforestation and reforestation projects and how this affects permanence. In our afforestation and reforestation projects we only generate carbon removal credits up to the long term average carbon stocks on the land.[18] Using a river's water level as an analogy for carbon storage, a fixation on locking up individual carbon atoms for centuries is irrelevant to the climate, what matters is that the river's water level is maintained, not the "permanence" of individual drops of water in the river. And while many nature-based reductions in atmospheric CO_2 can be sustained over time, even shorter-term removals produce climate impacts that are long-lasting.

Apple is also exploring the role that biomass carbon removal and storage (BiCRS) can play in achieving our Apple 2030 target, and we're seeing a few promising areas for potential future innovations in our supply chain. These areas include the use of bioenergy with carbon capture and storage for electricity production, capturing biogenic CO_2 from pulp and paper processes, and developing sustainable aviation fuels that are produced using carbon capture and storage.[19]

Creating the Restore Fund

As we looked at what's needed to scale the market for nature-based solutions, we identified three main barriers that need to be overcome: scale, quality and capacity.

Scale

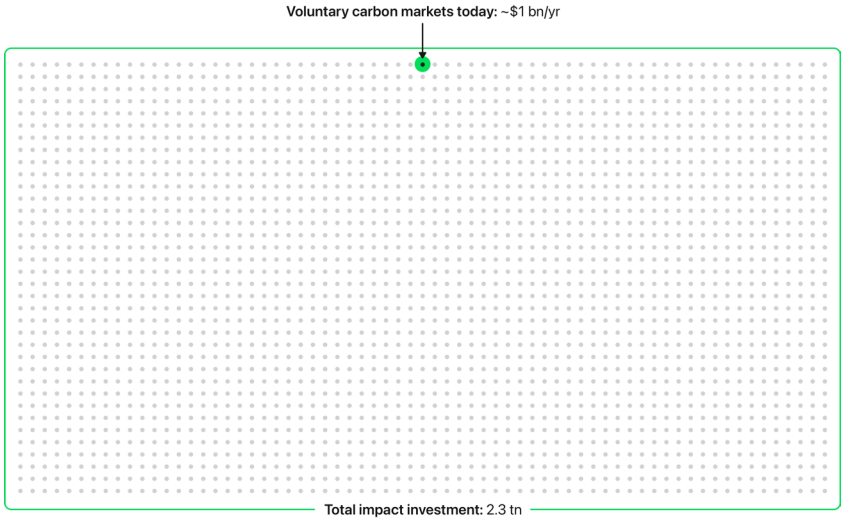
The first barrier we sought to address with the Restore Fund was scale. Between 2019 and 2023, the voluntary carbon market (VCM) averaged 129 $MtCO_2$ of offsets retired annually.[20] And in 2022, the VCM was estimated at $1.3 billion.[21] In comparison, the IPCC estimates that between 100 and 1000 $GtCO_2$ need to be removed cumulatively by 2100 to limit warming to no more than 1.5° C. Reaching this goal requires 5 to 10 $GtCO_2$ of removals by 2050. Given the current VCM is between 1 and 3 percent of what is needed annually, limiting warming to 1.5° C will require rapid scale-up and deployment of all viable carbon removal technologies.

From a financial perspective, even the most optimistic scenarios project a total market size of $50 billion by 2030[22] — far short of the estimated financing gap of $600 to $800 billion per year required to address biodiversity loss and climate change.[23]

To address this, we drew from our experience with renewable energy investments and looked to other sources of capital. Compared with the voluntary carbon markets, the impact investment market is orders of magnitudes larger (see Figure 6). A 2021 report by the International Finance Corporation (IFC) estimated the impact investment market to be worth $2.3 trillion in 2020[24] - more than a thousand times the scale of voluntary carbon markets.

When we created the Restore Fund, we therefore sought to align carbon market impact with impact investment capital, which would scale nature-based carbon removals well beyond the current scale of voluntary carbon markets.

Figure 6. Scale of today's voluntary carbon markets and impact investment



Our first Restore Fund - launched in 2021 with Goldman Sachs and Conservation International - leverages the size of the timberland investment universe — currently estimated at around $120 billion of assets under management (AUM) — with carbon market methodologies (see Box 2).

More specifically, our investments with Goldman Sachs generate carbon removal impacts over the lifetime of our investment by creating new working forests on marginal and degraded agricultural and pasture lands. And once the forests mature, they can be sustainably managed for the long term as working forests that generate the financial return that makes these projects investable.

Timber demand is expected to grow 37-60% between 2020 and 2050

Box 2: Thinking differently: Addressing timberland investment gaps

Current forestry funds typically invest in existing forested land or timber assets to generate returns for investors by harvesting and selling timber or other wood products. This approach isn't sustainable, however, because natural forest ecosystems are declining in area, and the demand for timber is increasing.

The Food and Agriculture Organization (FAO) projects that timber demand will increase by 37 to 60 percent by 2050, driven by population growth, urbanization, the growing middle class, and wood replacing more carbon-intensive materials as part of the broader climate transition.[25] Meeting this growing demand - without causing further deforestation and forest degradation from existing natural forests - will require new sustainably managed working forests.

Despite this, afforestation and reforestation projects in timberland investments have historically been underfunded due to the long interval between initial financial outlay and generating returns from harvesting wood products. The value of carbon can help make afforestation and reforestation financially viable by offering a new source of value in the early years of reforestation investments that can bridge the gap to make these investments viable.

In addition, carbon finance can also create a value stream for conservation and restoration areas that are not managed for timber production, allowing investors to expand the total area dedicated to ecological restoration.

Apple's first Restore Fund will invest up to $200 million and aims to remove at least 1 million metric tons of CO_2 annually from the atmosphere at peak, while demonstrating a viable financial model that can help scale up investment in reforestation and forest restoration.

In 2023, we expanded the Restore Fund with Climate Asset Management (CAM), a joint venture of HSBC Asset Management and Pollination. Our Restore Fund with CAM aims to develop an investment vehicle to scale nature-based solutions using a different kind of financial innovation. The expanded fund pools two distinct types of investments: high-quality regenerative agricultural projects that generate income from sustainably managed farming practices, and carbon projects that protect and restore critical ecosystems that remove and store carbon from the atmosphere. This unique blended fund structure is intended to achieve both financial and climate benefits for investors while advancing a new model for carbon removal that addresses a broader spectrum of the global potential for nature-based solutions.

Apple's expanded fund will also invest up to $200 million and aim to remove, at peak, at least 1 million metric tons of CO_2 annually from the atmosphere.

Quality

The second barrier we sought to address with the Restore Fund was quality. We are putting measures in place to ensure the quality and integrity of carbon removals. There has been much criticism of carbon markets in recent press. While some of this criticism is warranted, and the need for stronger global standards of quality is clear, much of the narrative around voluntary carbon markets misses the complexities of what constitutes a high-quality carbon project.[26] Nonetheless, we recognize that not all carbon projects are created equal, and that we need robust standards to achieve our goal of scaling up high-quality nature-based projects.

Our first step in ensuring that the projects the Restore Fund invests in improve the livelihoods of communities and protect and enhance biodiversity was to codevelop the fund with Conservation International, an independent, mission-driven international nongovernmental organization. Conservation International has two key roles in the Restore Fund: they offer guidance on fund-level strategy and investment decisions as an investor in the fund, and they conduct project-level due diligence to make sure individual investments meet strict environmental and social standards.

Box 3. Transparency and integrity in carbon markets

Apple believes that carbon standards (both voluntary and compliance) play an important role in ensuring the transparency and integrity of carbon projects. Every project that the Restore Fund invests in must deliver carbon credits that are real, additional, measurable, and quantified — with systems in place to avoid double counting — and that address permanence and avoid leakage.

In the Restore Fund with Conservation International and Goldman Sachs, our projects reforest degraded and marginalized agricultural and pastureland to sustainably managed, certified working forests. We rely on independently reviewed carbon accounting methodologies to quantify the carbon stock increase from low-carbon agricultural and pastureland to the long-term average carbon stocks of a sustainably managed working forest and credits are only generated after the growth in stocks has occurred (ex post).

Each project the Restore Fund invests in must pass a detailed additionality screening following peer-reviewed additionality tools. And to address risks of leakage and reversals — for example, fire or storm damage — a buffer is deducted from gross sequestration before credits are issued.

In addition to our own review, each project is reviewed and audited by independent third-party validation and verification bodies (VVBs). As a first step each project is independently **validated** to determine if the rules and requirements laid out by carbon market standards have been met. Projects are then **verified** to confirm that their impacts have been achieved and quantified in a manner consistent with the requirements of the carbon standard.

Conservation International created robust environmental, social and governance criteria for the Restore Fund that every investment must adhere to (see Annex).

These criteria build on existing international standards, such as the IFC performance standards, Forest Stewardship Council Principles and Criteria, and UNFCCC safeguards. They include provisions for biodiversity - such as protection of native ecosystems - and protection of the rights and values of local communities and Indigenous Peoples.

To improve transparency, we also require that the projects we invest in adopt recognized international carbon standards. These include carbon market standards such as the Verified Carbon Standard, the Gold Standard, and the Climate, Community and Biodiversity Standards (see Box 3 on the previous page). And where projects are harvesting timber, we also require that these projects adhere to internationally recognized forest management standards, such as the Forest Stewardship Council (FSC) Principles and Criteria.

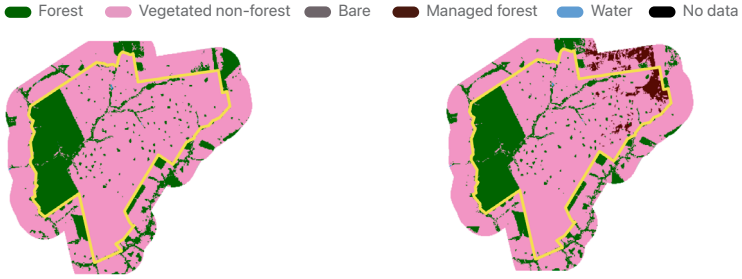
The next step to ensure that our projects meet strict quality criteria is to conduct project-level and manager-level due diligence. The Restore Fund conducts detailed ex ante assessments of each prospective investment. Through these assessments, we get a detailed understanding of the carbon impacts that our investments can unlock and the additionality of project finance. The due diligence process begins with prescreening the project manager, including their standards and track record, followed by a more in-depth screening of the project proposal.

Most opportunities that the Restore Fund considers are ruled out at this stage. Goldman Sachs reviewed more than 200 investment opportunities around the world in the first two years of the Restore Fund, and only a handful of managers met our requirements, which include a strong investment track record, proven forest management experience, potential to scale beyond Apple's impact goals, and alignment with our environmental and social criteria.

Before investing in potential projects, the Restore Fund works with external remote-sensing service providers to conduct detailed land-use assessments using satellite and other information to make sure our investments are consistent with our investment criteria and with existing carbon standards. In 2023, we partnered with Space Intelligence and Upstream Tech to construct habitat and forest carbon maps of potential Restore Fund investments.

These detailed reviews include assessments of historical forest cover, native and nonnative vegetation (including wetlands and grasslands), and land uses (including forestry) to identify if prospective investment properties have been deforested or converted to other native ecosystems in the 10 years preceding project initiation (see Figure 7). The Restore Fund also uses remote sensing to quantify forest carbon stocks in properties before investing and to confirm field inventory of the projects' carbon removal impact over time.

Figure 7. Example of a project showing areas of forest and nonforest in a preinvestment screen



Includes imagery captured between 01/01/2012 and 12/31/2012

Includes imagery captured between 01/01/2022 and 12/31/2022

The next stage of quality control is onsite diligence of prospective properties before making an investment decision. This typically involves a team of international experts from our fund managers (for example, Goldman Sachs, Conservation International, or Climate Asset Management) in conjunction with local and subject matter experts — for example, hydrology experts if there are questions about wetlands, or local community experts to evaluate stakeholder engagement processes.

These steps culminate in confirmation of whether the project satisfies our environmental and social criteria, followed by the fund manager investment committee recommending whether or not to proceed with a prospective investment (see Figure 8).

Figure 8. Restore Fund diligence process

Initial Screening

Desk based review

Remote sensing analysis

Site visit

Manager due diligence

Financial due diligence

ESG due diligence

Final project approval

Certification

Carbon project (PDD) development

Validation

Verification

FSC certification (optional)

Ongoing monitoring reporting and verification

Continual satellite monitoring

Ground based inventories

Carbon audits

And we don't stop our diligence once an investment is made; our investment managers continue quality control during the project life cycle. On an ongoing periodic basis, Space Intelligence's CarbonMapper and HabitatMapper and Upstream Tech's Lens platform detect changes in forest area, forest growth, and forest loss, including from fire. Each project manager also conducts their own periodic assessments, including forest inventories, regular fire monitoring and control, and forest maintenance activities. Managers document these assessments quarterly and annually in investment and impact reports for every project the Restore Fund invests in, and periodic third-party verifications under carbon standards and audits under FSC.

Lastly, we've been working to improve how we measure carbon on the ground. Using the LiDAR scanner on iPhone. We've been piloting methods to measure the diameter of trees - a key indicator of forest carbon stocks. Preliminary results of this pilot demonstrates a clear relationship between tree diameter measured with iPhone compared to diameter measured with a traditional tape measure. Because this information is digitized, it's also easier, if repeat measurements are taken in subsequent years, to show change over time, as well as to permanently store these data, saving time and money for inventories.

Capacity

The last barrier we sought to overcome in scaling up nature-based carbon removals is capacity. Apple has been working for several years to build the capacity of project developers, nonprofit organizations, and the architecture supporting nature-based carbon removal implementation in general to ensure that these efforts are able to grow beyond Apple's demand.

In 2018, for example, we partnered with Conservation International, the Omacha Foundation, Colombia's environmental authorities, and Invemar

Research Institute to strengthen the way coastal carbon — known as *blue carbon* — stocks are measured in the soil component of mangroves by piloting first-of-its-kind methodology (see Image 1). This project protects and restores a 27,000-acre mangrove forest in Cispatá Bay, Colombia, and it's expected to sequester 1 million metric tons of CO_2 over its lifetime. We've since continued our work on mangroves with the Applied Environmental Research Foundation (AERF) to promote mangrove protection and conservation in Maharashtra, India. Both of these projects are important from a climate and disaster resilience perspective, as well as from a biodiversity conservation perspective.

Apple has also supported a number of other nonprofits around the world to help develop high-quality nature-based solutions and build climate resilience and economic benefit to communities most impacted by climate change.

- **The Conservation Fund and World Wildlife Fund**
  This partnership, formed in 2015, successfully improved the management of more than 1 million acres of working forests in the United States and China.
- **World Wildlife Fund**
  We partnered to build the Nature-Based Solutions Origination Platform, which drives impact across selected tropical forest landscapes by designing interventions in priority landscapes and mobilizing long-term sustainable funding through public and private mechanisms.[27]
- **Conservation International**
  In the last year, we supported a first-of-its-kind Irrecoverable Carbon Finance Lab to protect some of the world's most delicate ecosystems. Irrecoverable carbon refers to the vast stores of carbon in nature that are vulnerable to release from human activity and, if lost, could not be restored.
- **China Green Carbon Foundation and SEE Foundation**
  We've provided funding for research and pilots to increase nature-based carbon projects in China.
- **Forest Investor Club, World Business Council for Sustainable Development (WBCSD), World Economic Forum (WEF), and more**
  Apple has participated in several international initiatives to help raise the bar for integrity and transparency and to scale the market.

Image 1. Local government field assistant José Gregorio Padilla Bautista taking a 50 cm soil sample and carbon stock reading in the Cispatá Bay mangroves

Implementation Gaps

We've made huge progress in the last 10 years to scale up nature-based solutions, but there's still considerable advancement needed. Below are some implementation gaps we're working to overcome as we extend our work on carbon removal.

There's a $600 to $800 billion annual finance gap in addressing biodiversity loss and climate change

Capital at scale

Since the establishment of the Restore Fund, several funds have emerged that invest in nature-based climate solutions. But still, the scale of capital for nature-based solutions is far below what's needed from a global climate and biodiversity perspective. Estimates of the nature financing gap suggest an additional $600 to $800 billion per year is required to address biodiversity loss and climate change. Analysis from the Climate Policy Initiative shows that nature-based climate solutions have received an average of just $16 billion per year in 2019 and 2020, or 2.5 percent of total climate finance.[28] This is only the tip of the iceberg, and a significant mobilization of capital is needed.

Both funds that we've invested in to date are now expanding to bring in new investors demonstrating the viability of our solution, but to solve the global climate problem, much more capital and many other investors will be required.

Coordination and collaboration

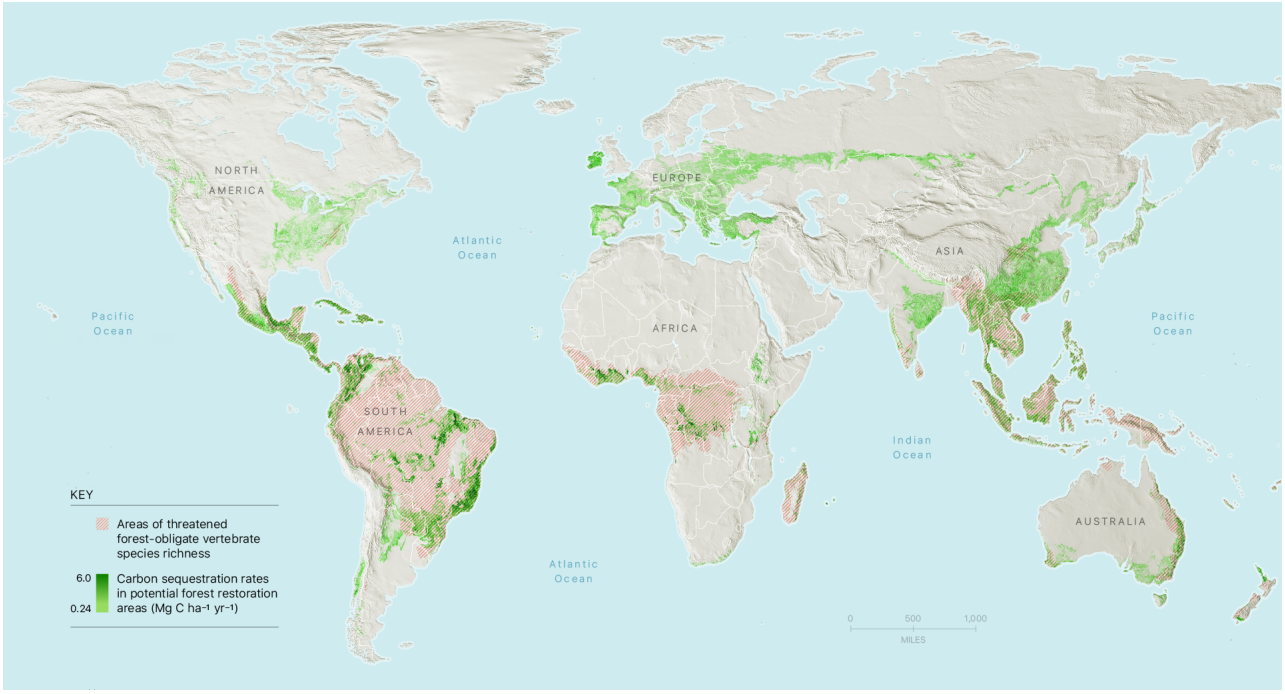
There are several ways in which coordination and collaboration to scale up nature-based solutions could be improved. First is to improve public-private partnerships in project financing. While many of the Restore Fund investments have received cofunding from public finance institutions, these investment processes have occurred in parallel and have been invisible to each other. Significant diligence costs could be saved by coordinating deal review at a more strategic level, and by developing public-private investment vehicles.

Many nature-based opportunities are located in the tropics and subtropics (see Figure 9 on the following page). These regions are more prone to policy, currency, and market risks that create investment barriers particularly in long duration investments such as those needed for nature-based carbon removal. Public and development finance institutions have an opportunity to provide catalytic capital to de-risk investments and crowd in more private sector capital.

Another area of coordination is the alignment of quality and investment criteria for nature-based solutions. There's still much debate, for example, around the role of commercial tree farms, nonnative species, and timber harvesting in scaling up solutions. We see a need for independently reviewed, clearly articulated guidance on the types of projects that can and should be scaled up to create high-quality carbon removal credits.

Figure 9. Many nature-based opportunities are located in the tropics and subtropics

Adapted from Kemppinen et al. 2020 and Cook-Patton et al. 2020



Independent and transparent project diligence

The last five years have seen a dramatic uptick in the range and quality of independent carbon credit review systems, including rating agencies, monitoring platforms, and satellite service providers. In the Restore Fund, we work with external remote sensing service providers Space Intelligence and Upstream Tech to diligence and review individual projects, and in choosing these we came across a number of other companies in this space that provide similar services.

These organizations are increasing the amount of data available to surface high quality carbon projects in carbon markets. But a key challenge is that these services are largely opaque, often inconsistent, and on a fee-for-service basis. This lack of transparent project due diligence and coordination between these efforts make it hard to review individual projects independently.

In addition, a number of efforts are aimed at strengthening the quality of carbon accounting methodologies. Most notable in this space is the Integrity Council for the Voluntary Carbon Market (ICVCM), an independent governance body for the voluntary carbon market. The ICVCM provides governance and oversight over standard-setting organizations on adherence to the Core Carbon Principles (CCPs).[29]

But we believe that a market gap still exists for a centralized transparent process to review individual carbon projects against agreed-upon quality standards. This would build on existing infrastructure, such as ICVCM's CCP and rating agency data, and provide independent third-party diligence over credits.

The review process could also connect carbon credit buyers to these high-quality credits and give them confidence that they're receiving credits that are

real, additional, permanent, and verified. In addition, the process would need to transparently share how these results were demonstrated so that other third-party organizations — such as nonprofits, academic institutions, and journalists — could independently verify them.

National and international policies

The fourth gap we see is the need for strong national and international policies that support the scale up of carbon removal, including the role that corporate investments in carbon projects play in supporting national carbon targets. While some progress has been made at the international level on Article 6 of the Paris Agreement in 2022,[30] there's still uncertainty at both the national and international level coming out of COP 28 in Dubai on the relationship between voluntary corporate carbon claims and national climate targets.

There's also a lack of coordination and alignment between voluntary carbon market registries and national carbon accounting process. This lack of regulatory certainty plays a significant role in hampering corporate motivation to use offsets toward their voluntary carbon targets, which risks lowering investment in nature-based and engineered carbon removals.

Another important signal for carbon removal technologies, at both the national and international level, is a price on carbon. Apple is supportive of a price on carbon including national policies such as the U.S.'s 45Q tax credit.

Scaling up non-nature-based carbon removal

Although to date Apple has focused on nature-based carbon removals, we see an urgent need to increase the scale of non-nature-based carbon removal projects. As we've detailed, this decision has largely been a practical consideration. This reflects the fact that afforestation, reforestation and revegetation (ARR) is a readily available carbon removal solution, while other engineered solutions are both more costly and much less mature technologies.[31]

Our expectation is that over time, these technologies will come down the cost curve - as we've seen with renewable energy projects - to become competitive. In the short and medium term however, a combination of philanthropic capital and direct government support such as the Biden administration's intent to fund direct air capture (DAC) hubs will be necessary to level the playing field and commercialize these technologies.

Conclusions

Our planet is in crisis, and without urgent action on climate change, we won't be able to keep global warming to 1.5°C, and avoid the worst climate change impacts. In addition to deep decarbonization, we must develop carbon removal technologies and protect and restore Earth's ecosystems.

In 2020, Apple responded to this global challenge by setting a bold and ambitious goal to become carbon neutral for our entire product footprint by 2030. As we set out on this journey, we knew there would be barriers to overcome and that hitting this goal would require a significant effort. We also recognize that technologies are continuously being developed and evolved, and we'll need to continually refine and improve our process as we make progress toward our target.

But we also can't afford to wait. We need to act urgently to achieve a 1.5°C pathway. We hope that if we demonstrate a path forward, others will join us on this journey.

Engineered technologies for carbon removal are in their infancy and will need to mature greatly every year to reach the scale needed by 2030. That's why we started our journey with nature-based solutions, which the science shows are the most scalable opportunities for carbon removal today.

We developed the Restore Fund as a pilot, and we're now seeking to expand and improve it so that others can build on the work we have done and scale the market for nature-based removals. And as we grow the Restore Fund, we're looking to see what's next and how we can make nature-based removals more accessible.

We recognize that the current carbon markets aren't equipped to deal with the scale and integrity of impact needed to achieve a 1.5°C pathway and remove tens of billions of tonnes of carbon by 2050. We intend to work to improve the quality of these markets. We're also aiming to build a pipeline of projects that meet the highest-quality standards that can scale to meet the growing demand for nature-based removals. And we'll continue to progress our goal of building much-needed solutions for high-quality engineered carbon removals to complement these efforts.

We welcome feedback and partnership. Reaching our global target of limiting global warming to 1.5°C will require collective action and must meet not only the needs of Apple but, more importantly, the needs of communities and the world at large.

Frequently Asked Questions

How do you verify that carbon is removed permanently from the atmosphere in Restore Fund projects?

There are a number of ways we address permanence in the Restore Fund. Each investment must adhere to current standards, such as the ICVCM, which requires that projects *"monitor and report on emissions reductions and removals for at least 40 years where there's a risk they may be reversed."* We also maintain a risk-based "buffer pool" of carbon credits that can be cancelled to compensate for any reversals.[32] Many factors related to risks of reversal can also be anticipated ex ante - for example through good project design - or quantified ex post through common MRV systems (see Box 1).

Are Restore Fund credits based on future projections of carbon removal as trees grow?

No. We only accept and use ex-post credits that have already removed CO_2 from the atmosphere. In contrast, Apple does not accept ex-ante credits — which are generated based on projected (but not yet realized) carbon removals.

Does Apple use credits generated from Restore Fund projects to address emissions?

Our approach to carbon neutrality prioritizes deep reductions in emissions through clean energy, energy efficiency, and direct abatement. Following these significant reductions, we apply high quality carbon removal credits to balance residual emissions. By 2030 we've committed to reduce our entire emissions footprint, across Scopes 1, 2 and 3, by 75 percent compared with 2015 levels, and balance residual emissions with high-quality carbon removal credits, including those generated by the Restore Fund. By 2050, we've committed to scaling up our ambition and reducing our footprint by 90 percent, which will require a collective global decarbonization effort.

Importantly, we do not believe it is appropriate to apply carbon credits to cover our entire footprint, as a high integrity approach requires significant emissions reductions before the use of offsets.

How does Apple and its partners ensure the quality of credits in the Restore Fund?

Each investment that we make through the Restore Fund must meet strict environment, social and governance standards that build on existing international standards (see Annex). To measure, report and verify the carbon impact of the Restore Fund investments, we work with expert partners to develop rigorous and accurate systems for every project. We use remote sensing service providers such as Space Intelligence and Lens to conduct detailed land use assessments using satellite data before and throughout the lifetime of our investments. These systems provide a time series on data

such as canopy cover, and tree height to estimate the carbon impact of our projects. In addition to these innovations we're using traditional methods of forest inventorying and field plots to verify carbon impacts.

How does the Restore Fund support climate finance targets?

Today, an estimated financing gap of $600 to $800 billion per year is required to address biodiversity loss and climate change.[33] Our approach with the Restore Fund is to help close this gap by investing in projects and programs that deliver economic benefits to the countries, regions, and communities that we work in by creating sustainable and scalable business models. Our investments also provide direct benefits to the local communities surrounding the projects, as well as to the upstream (for example, seedlings nurseries) and downstream (for example timber processing, paper and packaging, etc.) value chains of our projects.

Why does Apple focus on carbon removals instead of avoided emissions projects?

By 2030, we aim to cover 100 percent of our residual emissions with carbon removals. This is consistent with international science and policy, which requires carbon neutrality by around mid century by balancing any residual emissions with an equivalent amount of carbon removals. In the short term, between 2020 and 2025, we also support high quality conservation projects that generate avoided emissions credits, such as the Chyulu Hills Project in Kenya.[34] Our support of these projects provides important social and biodiversity benefits and are essential to halt deforestation and forest degradation and achieve global climate targets.

How much restoration potential is there globally?

A recent publication projects that global forests have the potential to sequester an additional 226 $GtCO_2$ in areas with a low human footprint, and avoiding conflicts with other land uses such as agriculture and urban land.[35] Of this potential 139 $GtCO_2$ (61%) could be realized in existing forests through improved forest management to allow forests to reach maturity and approach their biological carbon storage potential. The remaining 87 $GtCO_2$ could be realized through reforestation of areas that used to have forest cover.

Global reforestation potential is therefore around 10,000 times greater than our carbon removal target. But any carbon removal solution must only be pursued as part of a comprehensive mitigation strategy that includes deep reductions in emissions separate and apart from carbon removal. Coupled with deep decarbonization targets, however, afforestation, reforestation and revegetation (ARR) is one of the few scalable near-term options for carbon removal.

How do your projects impact local communities and Indigenous Peoples?

The Restore Fund has strict investment criteria that requires each project to demonstrate full respect for Indigenous Peoples' identity, dignity, individual and collective rights, livelihood systems and cultural uniqueness. This includes their right to Free, Prior and Informed Consent and their right to own, control, manage and fully and effectively participate in the co-design and implementation of projects that affect them, consistent with international policies such as the UN Declaration on the Rights of Indigenous Peoples and the Cancun Safeguards.

Where can I find more information about the projects Apple is investing in?

As carbon projects are developed, we use Verra and other similar carbon market registries to validate and verify our projects' carbon impact. As part of this process, projects undergo a public review period, and once projects are validated and verified (see Box 3), detailed project-level information is published on these registries.

We also publish an environmental progress report annually that shares the credits that we retire towards our carbon target. The report provides links to the projects in the carbon registries along with the number of credits that we retire.

Do your investments in working forests connect to your packaging and paper supply chains?

Today, we don't have any direct linkages between our paper and packaging supply chains and our Restore Fund investments. Some of our projects may one day generate fiber that is suitable for local paper markets during the growth and thinning phase of these working forests.

Apple has a long history of protecting and restoring working forests dating back to 2017 and our partnerships with The Conservation Fund and World Wildlife Fund. Through that work we have protected and improved forest management practices on more than one million acres of working forests in the U.S. and China. Since 2020, these forests have generated enough responsibly sourced fiber to balance all the virgin fiber in our packaging, while contributing to the global supply of responsibly sourced fiber.[36] And since 2018, 100 percent of the wood fiber in our packaging was either from recycled sources or from responsibly managed forests or controlled wood sources.

Glossary of Terms

Additionality: The greenhouse gas (GHG) emission reductions or removals from the mitigation activity shall be additional, i.e., they would not have occurred in the absence of the incentive created by carbon credit revenues.[37]

AFOLU: Agriculture, Forestry, and Other Land Use (AFOLU) is an IPCC sector that includes mitigation potential from both an enhancement of removals of greenhouse gases (GHG), as well as reduction of emissions through management of land and livestock.

Carbon credit / offset: A tradable financial instrument that is issued by a carbon-crediting program. A carbon credit represents a GHG emission reduction or removal from the atmosphere equivalent to 1 metric tonne of CO_2, calculated as the difference in emissions from a baseline scenario to a project scenario. Carbon credits are uniquely serialized, issued, tracked and retired or administratively cancelled by means of an electronic registry operated by an administrative body, such as a carbon-crediting program.[38]

Carbon removal or carbon dioxide removal: According to the Intergovernmental Panel on Climate Change (IPCC), "anthropogenic activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products".[39]

Carbon neutrality: achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).[40]

Greenhouse gas (GHG) emissions: Gases that absorb infrared radiation emitted from the Earth's surface and reradiate back to the Earth's surface, contributing to the greenhouse effect. An entity's GHG emissions are categorized into three different Scopes:

Scope 1: Direct emissions, including a company's facilities or vehicles.

Scope 2: Indirect emissions from purchased energy consumed by the company.

Scope 3: Indirect emissions not included in Scope 2 that occur in the value chain of a company and aren't owned by the company but linked to its operations.[41]

Nature-based Solutions (NbS): Actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits.[42]

No double counting: The GHG emission reductions or removals from the mitigation activity shall not be double counted, i.e., they shall only be counted once towards achieving mitigation targets or goals. Double counting covers double issuance, double claiming, and double use.[43]

Permanence: The GHG emission reductions or removals from the mitigation activity shall be permanent or, where there's a risk of reversal, there shall be measures in place to address those risks and compensate reversals for a defined period of time.[44]

Residual emissions: Emissions sources that remain unabated in a specific year of a mitigation scenario. Long-term science-based targets define the company's maximum level of residual emissions in line with global or sector net-zero in 1.5° C-aligned mitigation pathways with low or no overshoot.[45]

Robust quantification of emission reductions and removals: The GHG emission reductions or removals from the mitigation activity shall be robustly quantified, based on conservative approaches, completeness and scientific methods.[46]

Value chain emissions: A company's Scope 1, 2 and 3 emissions as defined by the GHG Protocol accounting standard.[47]

Annex: Restore Fund Investment Criteria

Environmental Criteria

- Meet (or present a detailed plan to meet) the Principles and Criteria (P&C) of the Forest Stewardship Council (FSC), the Roundtable on Sustainable Biomaterials, or other equivalent globally accepted, robust and third-party standard.
- Do not contravene international or regional conventions on environmental issues to which the country where the investment is located is a signatory such as, but not limited to, the Ramsar Convention on Wetlands and the Convention on Biological Diversity.[48]
- Do not engage in deforestation or conversion of native vegetation (including grasslands, wetlands, peatlands, or mangroves), key habitat for native fauna, and legally mandated or formally established protected areas.
- Protect rare, threatened, endangered and protected species, including species listed by the International Union for Conservation of Nature (IUCN) or those classified as protected by the host country, and their habitats through strict protected areas, connectivity corridors, buffer zones (e.g., areas where low intensity management may occur as transition from production to protection zones) and/or (where necessary) other direct measures for their survival and viability, including science-based monitoring on how management actions affect species survival as compared to baseline data, with mitigation measures established where species populations may decline due to management approach.
- Do not engage in activities that pollute and/or contaminate the land, air and water, or drainage that negatively impact organic soils, the water table, or downstream flows on a watershed basis.
- Do not conduct illegal or unsustainable harvesting of natural resources, animals, plants, timber, or non-timber forest products.
- Ensure that avoided emissions and removals of greenhouse gases are measured, monitored, reported, and verified in accordance with international best practice.
- Ensure that any carbon credits issued use one of the following established protocols: Verified Carbon Standard, Climate Community and Biodiversity Standard, Gold Standard, Climate Action Reserve, American Carbon Registry

Social criteria

- Minimize adverse social and economic impacts from land acquisition or restrictions on land or resource use by local residents.
- Effective stakeholder engagement resulting from including knowledge and contributions of local stakeholders into design, implementation and monitoring of investee activities and good-faith negotiation of agreements on social and economic costs and benefits on the well-being of surrounding communities over the project lifetime.
- Have established policies and adequate staffing and resources to implement fair, local, and inclusive employment practices and training and

ensure that all employees and contractors (A) are paid at least the national minimum wage (or higher where possible); (B) receive legally required social benefits; and (C) work under safe and healthy conditions.
- Contribute to increased gender equality by establishing and implementing policies, such as a Gender Action Plan, that result in greater participation by women as employees or contractors in the project and yield a measurable increase in benefits to women.
- Demonstrate full respect for Indigenous Peoples' identity, dignity, individual and collective rights, livelihood systems and cultural uniqueness, including their right to Free, Prior and Informed Consent and their right to own, control, manage and fully and effectively participate in the co-design and implementation of projects that affect them, consistent with international policies such as the UN Declaration on the Rights of Indigenous Peoples and the Cancun Safeguards.
- Do not use child labor, adult forced labor, or other forms of modern-day slavery, or engage in human trafficking, gender-based violence, or sexual exploitation, abuse, and harassment.
- Demonstrate that investees will not discriminate against vulnerable and marginalized people.

Governance criteria

- Compliance with international and regional conventions and best practices on human rights (e.g., United Nations International Bill of Human Rights), and labor rights (Labor Organization's Declaration on Fundamental Principles and Rights at Work, and the UN Guiding Principles on Business and Human Rights) including rights specific to Indigenous Peoples, women, and children.
- Established Environmental and Social Management Framework (ESMF) to assess and manage the environmental and social impacts of investee activities.
- Use an accessible Grievance Redress Mechanism (GRM), which includes measures for addressing Gender Based Violence (GBV), Sexual Exploitation, Abuse and Harassment (SEAH), and labor concerns, to provide local stakeholders, employees, and contractors with an effective and efficient process for expressing and resolving concerns and complaints.

Endnotes

1 Apple follows the GHG Protocol Corporate Accounting and Reporting Standard (GHG Protocol) to calculate value chain emissions. The GHG Protocol Corporate Accounting and Reporting Standard covers the seven GHGs covered by the Kyoto Protocol - "carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)." See https://ghgprotocol.org/corporate-standard.

2 Apple Newsroom, "Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030," press release, July 21, 2020, apple.com/newsroom/2020/07/apple-commits-to-be-100-percent-carbon-neutral-for-its-supply-chain-and-products-by-2030.

3 For more information on Apple 2030 visit apple.com/environment/

4 IPCC "Summary for Policymakers of IPCC Special Report on Global Warming of 1.5° C approved by governments," press release, October 8, 2018, www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments.

5 IPCC, "Summary for Policymakers," eds P.R. Shukla, J. Skea, A. Reisinger, R. Slade, R. Fradera, M. Pathak, A. Al Khourdajie, M. Belkacemi, R. van Diemen, A. Hasija, G. Lisboa, S. Luz, J. Malley, D. McCollum, S. Some, P. Vyas, (eds.)]. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (Cambridge and New York: Cambridge University Press, 2022) doi.org/10.1017/9781009157926.001.

6 Apple's 2030 goals refer to the end of fiscal year 2030.

7 The Science Based Targets initiative (SBTi) has validated the following emissions reduction target for Apple: 61.7 percent by fiscal year 2030 relative to our fiscal year 2019 emissions. This SBTi-validated target is derived from our target to reduce emissions by 75 percent by fiscal year 2030 relative to 2015, with a base year of 2019 instead.

8 Jan C. Minx et al., "Negative emissions—Part 1: Research landscape and synthesis," Environmental Research Letters 13, no. 6 (May 2018): 063001, doi.org/10.1088/1748-9326/aabf9b.

9 Stephen M. Smith, Oliver Geden, Jan C. Minx, Gregory F. Nemet, Matthew Gidden, William F. Lamb, and Carter Powis et al., *The State of Carbon Dioxide Removal* - 1st Edition (University of Oxford, 2023), doi.org/10.17605/OSF.IO/W3B4Z.

10 IPCC, *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, eds. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, (Cambridge and New York: Cambridge University Press, 2018), 616

11 Cécile A. J. Girardin et al., "Nature-based solutions can help cool the planet — if we act now," *Nature* 593, no. 7858 (May 2021): 191–194, doi.org/10.1038/d41586-021-01241-2.

12 Mo Lidong et al., "Integrated global assessment of the natural forest carbon potential," *Nature* 624, no. 7990 (November 2023): 92–101, doi.org/10.1038/s41586-023-06723-z.

13 See both "Tool for the Demonstration and Assessment of Additionality in A/R CDM Project Activities" at cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-01-v2.pdf and "Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities," at verra.org/wp-content/uploads/imported/methodologies/VT0001v3.0.pdf.

14 See "AR-ACM0003: Afforestation and reforestation of lands except wetlands --- Version 2.0" at cdm.unfccc.int/methodologies/DB/C9QS5G3CS8FW04MYYXDFOQDPXWM4OE.

15 See "AFOLU Non-Permanence Risk Tool" v4.0 at verra.org/wp-content/uploads/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf and v4.1 https://verra.org/wp-content/uploads/2023/08/AFOLU-Non-Permanence-Risk-Tool-v4.1.pdf

16 IPCC, "Summary for Policymakers," eds. P.R. Shukla, J. Skea, A. Reisinger, R. Slade, R. Fradera, M. Pathak, A. Al Khourdajie, M. Belkacemi, R. van Diemen, A. Hasija, G. Lisboa, S. Luz, J. Malley, D. McCollum, S. Some, P. Vyas, in Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, eds. P. R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (Cambridge and New York: Cambridge University Press, 2022), doi.org/10.1017/9781009157926.001.

17 See Section 2.4 AFOLU Non-Permanence Risk and Pooled Buffer Account at verra.org/wp-content/uploads/2023/08/VCS-Standard-v4.5-updated-11-Dec-2023.pdf

18 This is consistent with current methodologies including "AR-ACM0003: Afforestation and reforestation of lands except wetlands --- Version 2.0" at cdm.unfccc.int/methodologies/DB/C9QS5G3CS8FW04MYYXDFOQDPXWM4OE and " VM0047 Afforestation, reforestation and revegetation" at https://verra.org/wp-content/uploads/2023/09/VM0047_ARR_v1.0-1.pdf

19 In 2023, Apple launched a study with Carbon Direct on how to scale up sustainable aviation fuels (SAF) that included several options with carbon capture and storage. See www.carbon-direct.com/insights/a-primer-on-the-future-of-sustainable-aviation-fuel.

20 Based on retirement data through October 15, 2023, from Clear Blue Markets

21 Dale Hardcastle, Henning Huenteler, Ann Siml, Nicholas Foreman, Pedro Gomez, and Nasim Pour, *Scaling Voluntary Carbon Markets: A Playbook for Corporate Action*, (World Economic Forum, 2023, www3.weforum.org/docs/WEF_Scaling_Voluntary_Carbon_Markets_2023.pdf

22 Taskforce on Scaling Voluntary Carbon Markets, Final Report, January 2021, www.iif.com/Portals/1/Files/TSVCM_Report.pdf

23 Andrew Deutz et al., *Financing Nature: Closing the Global Biodiversity Financing Gap* (The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability, 2020) www.paulsoninstitute.org/wp-content/uploads/2020/10/FINANCING-NATURE_Full-Report_Final-with-endorsements_101420.pdf

24 Ariane Volk, *Investing for Impact: The Global Impact Investing Market 2020* (Washington, DC, International Finance Corporation, July 2021), www.ifc.org/en/insights-reports/2021/impact-investing-market-2020.

25 Food and Agriculture Organization of the United Nations, *Global forest sector outlook 2050: Assessing future demand and sources of timber for a sustainable economy* — Background paper for The State of the World's Forests 2022, FAO Forestry Working Paper, no. 31 (Rome, 2022), doi.org/10.4060/cc2265en.

26 Edward Mitchard, "Tropical forest conservation is tricky to measure, but we're running out of time," Carbon Pulse, January 25, 2023, carbon-pulse.com/189033.

27 "Nature-Based Solutions Origination Platform," Projects, World Wildlife Fund, www.worldwildlife.org/projects/nature-based-solutions-origination-platform.

28 Baysa Naran, Jake Connolly, Paul Rosane, Dharshan Wignarajah, Githungo Wakaba, and Barbara Buchner, Global Landscape of Climate Finance — A Decade of Data: 2011-2020 (Climate Policy Initiative, 2022), www.climatepolicyinitiative.org/wp-content/uploads/2022/10/Global-Landscape-of-Climate-Finance-A-Decade-of-Data.pdf

29 See icvcm.org/the-core-carbon-principles/

30 "COP26 Outcomes: Market mechanisms and non-market approaches (Article 6)," the Glasgow Climate Pact, United Nations Climate Change, unfccc.int/process-and-meetings/the-paris-agreement/the-glasgow-climate-pact/cop26-outcomes-market-mechanisms-and-non-market-approaches-article-6.

31 IPCC, *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, eds. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, (Cambridge and New York: Cambridge University Press, 2018), 616

32 "Global benchmark for high-integrity carbon credits aims to mobilize climate finance at speed and scale," News & Insights, the Integrity Council for the Voluntary Carbon Market, July 27, 2023, icvcm.org/global-benchmark-for-high-integrity-carbon-credits-aims-to-mobilize-climate-finance-at-speed-and-scale

33 Andrew Deutz et al., *Financing Nature: Closing the Global Biodiversity Financing Gap* (The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability, 2020) www.paulsoninstitute.org/wp-content/uploads/2020/10/FINANCING-NATURE_Full-Report_Final-with-endorsements_101420.pdf

34 See https://registry.verra.org/app/projectDetail/VCS/1408

35 Mo Lidong et al., "Integrated global assessment of the natural forest carbon potential," *Nature* 624, no. 7990 (November 2023): 92–101, doi.org/10.1038/s41586-023-06723-z.

36 Based on expected equivalent fiber production from our forestry projects and virgin fiber used for Apple product packaging. To determine the output of Apple's projects, we work with our partners to understand the productive potential of these working forests. The forest management plans required to achieve or maintain certification limit harvest volumes to sustainable levels. We use these potential harvest volumes to estimate the sustainable productive capacity of these forests.

37 There are multiple approaches for additionality that, depending on the type of mitigation activity, can provide strong assurances without the need for an investment analysis. See icvcm.org/wp-content/uploads/2023/07/CCP-Book-R2-FINAL-26Jul23.pdf

38 Core Carbon Principles, Assessment Framework and Assessment Procedure. Accessed at https://icvcm.org/wp-content/uploads/2023/07/CCP-Book-R2-FINAL-26Jul23.pdf

39 IPCC, *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, eds. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, (Cambridge and New York: Cambridge University Press, 2018), 616

40 IPCC, *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, eds. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, (Cambridge and New York: Cambridge University Press, 2018), 616

41 See WRI's GHG Protocol Corporate Standard for more information on Scopes at ghgprotocol.org/corporate-standard

42 UN Environment Assembly of the UN Environment Programme, Resolution 5, Nature-Based Solutions for Supporting Sustainable Development, UNEP/EA.5/Res.5 (March 2, 2022), wedocs.unep.org/bitstream/handle/20.500.11822/39864/NATURE-BASED%20SOLUTIONS%20FOR%20SUPPORTING%20SUSTAINABLE%20DEVELOPMENT.%20English.pdf.

43 "The Core Carbon Principles," Integrity Council for the Voluntary Carbon Market, icvcm.org/the-core-carbon-principles.

44 "The Core Carbon Principles," Integrity Council for the Voluntary Carbon Market, icvcm.org/the-core-carbon-principles.

45 Emma Watson, Andres Chang, Alberto Carrillo Pineda, Christa Anderson, Cynthia Cummis, Martha Stevenson, et al.,*SBTi Corporate Net-Zero Standard* (Science Based Targets, April 2023), sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf.

46 "The Core Carbon Principles," Integrity Council for the Voluntary Carbon Market, icvcm.org/the-core-carbon-principles.

47 Emma Watson, Andres Chang, Alberto Carrillo Pineda, Christa Anderson, Cynthia Cummis, Martha Stevenson, et al., *SBTi Corporate Net-Zero Standard* (Science Based Targets, April 2023), sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf.

48 A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, also known as "The Convention on Wetlands", an international environmental treaty signed on February 2 1971 in Ramsar, Iran, under the auspices of UNESCO.