NEGATIVE EMISSIONS PLATFORM

CORPORATE PURCHASES OF CARBON REMOVAL CREDITS

Corporate purchases on the road to net zero

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Corporate purchases on the road to net zero

Key messages:

- **Connect your climate contributions to your emissions**. Introducing a sufficiently high internal carbon price not only gives a strong incentive to reduce operational emissions but can also provide a long-term funding scheme to neutralise any remaining emissions with additional, quantifiable, permanent carbon removals.

- **Help build the CDR ecosystem**. Besides reducing emissions, companies can contribute by actively developing the ecosystem that brings novel CDR methods from the lab to the market -by prioritising R&D and novel pathways over the amount of CO_2 removed.

- **Don't try to reach net zero with the use of short-term carbon offset credits**. Net zero aligned offsetting means offsetting with removals, and those removals must eventually be permanent. Companies should increasingly focus on opportunities that provide support, grow the CDR ecosystem and ensure future supply.

- **Be transparent about your purchases to stimulate other players on the supply side**. Publish not only the name of the project and amount of removals purchase, but include the cost, investments, contract period and vintage, if applicable.

- **Consider taking a blended approach**. A combination of carbon removal purchases, grants for technological development and the inclusion of renewal clauses into the contracts is the perfect trifecta for a demand-driven scale-up of negative emissions.

- **Advocate for an increase of R&D support for carbon removal projects**. R&D support should enable technologies to move from the lab to the market with support for early-stage research and innovation up to demonstration with the goal of large-scale deployment and commercialisation. Current European CDR funding is not sufficient for the timeframe and scale we need. The US support through ARPA-E and the UK governments Greenhouse gas removal program are two examples on how it can be done.

- **Advocate for adequate mechanisms to create a market for negative emissions**. Various regulatory measures have been put forward or implemented in different jurisdictions such as: public procurement, service contracts, contracts for difference, reverse auctions, tax credits, or proposals for a carbon take back obligation. Companies should support the supply side actors in lobbying for a policy change to ensure a future steady supply of high-quality carbon removals.

Carbon Dioxide Removal and the need for negative emission technologies

“There is a need to shift to technology-based removal while maintaining historical nature-based carbon sinks: nature-based sequestration has a ceiling on potential, so there is a need for additional tech-based removal, the potential of which is abundant.”

Task Force on Scaling Voluntary Carbon Markets (Jan. 2021)

With the momentum and public pressure building ahead of COP26 to shift from our current fossil dominated economy to one that is defossilised, there is a strong need to explore not only the amount of removals needed to reach net zero targets but also the configuration of the portfolio of methods and technologies, the required scale needed by 2030, 2050 and the role of corporate action in the broader carbon dioxide removal (CDR) ecosystem.

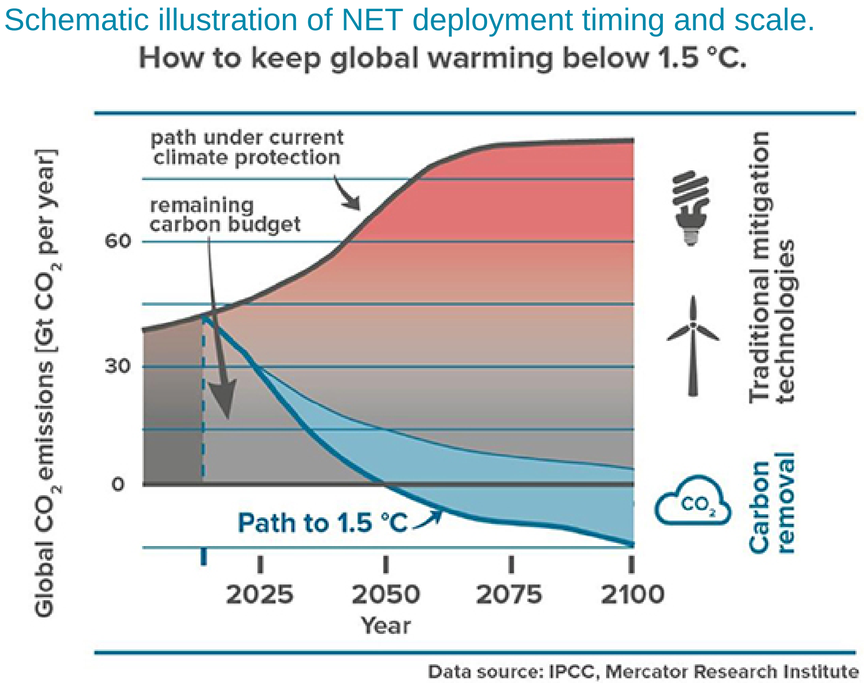
We have at most three decades left to achieve our net zero targets. If we stick to business as usual, the world could heat up by about five degrees Celsius by 2100. To avoid this worst-case scenario, deep emissions reductions and a full commitment to defossilisation is needed. It is at this junction when we cannot reduce emissions anymore (due to physical constraints) yet still have emissions to remove that CDR will play an indispensable role in helping to remove the residual CO_2 emissions.

Given our best efforts to model a complex system like Earth’s climate and distil from these models potential pathways that simulate the different possible outcomes, we know we will need negative emissions to achieve climate neutrality by 2050 and keep global temperatures below 1.5°C.

We already know that there will be a substantial amount of residual emissions due to physical constraints, social justice standards, and techno-economic reasons, coming on top of historical emissions accumulated in the atmosphere since the Industrial Revolution. Knowing that we have an urgent problem and how to solve the problem is only half the battle. The other more challenging part is ensuring we have a pipeline of solutions in place and at scale in time.

Thus far, most of the focus has been on the first part of the problem.

Figure 1: Schematic illustration of NET deployment timing and scale.



Source: The Role of Direct Air Capture in Mitigation of Anthropogenic Greenhouse Gas Emissions- www.frontiersin.org

We know what we have to do, and we know the vital role of CDR.

The second even more critical part is having it all in place in time. It is estimated that we will need CDRs at a scale between 6 and 10 gigatons by 2050. If we start now, CDR will require an annual growth rate of over 55%. Delaying the scale-up to the 2025s will already require a sustained growth of 80% per year, whilst scale-up starting in 2030 means that CDR capacity will need to double every year[1].

Globally, approximately 650 Mt of additional negative emissions capacity needs to be set in motion by the end of 2021 – four times the current pipeline – to meet the average 2025 IPCC target. If this is not met, the world will continue on a dangerous trajectory towards irreversible warming. Scaling CDR to such levels is a daunting challenge, but we need to take it on today.

An even more daunting scenario would be if CDR is not scaled. Even if all 1.5°C emission reduction pathway requirements are fully complied with and followed, without carbon removals we would still break our carbon budget and exceed 1.5°C warming before 2040.

[1] The Role of Direct Air Capture in Mitigation of Anthropogenic Greenhouse Gas Emissions, 21 November 2019

Project types facing quality issues, such as non-additionality and over-crediting, continue to dominate in voluntary carbon markets, while carbon removals are rare and those with permanent storage - nonexistent.

It is not only governments, regions and cities making net zero pledges. Many companies, organisations and financial institutions are relying on voluntary carbon offsetting, ingrained in their climate strategies, to meet their net zero targets[2]. Best practice guides (see The Oxford Principles for Net Zero Aligned Carbon Offsetting) do help in clarifying some of the well-known risks associated with existing offsets such as improper carbon accounting, re-release of stored carbon, negative unintended impacts on humans or ecosystems. However, recent research on the quality of carbon credits indicates that project types facing quality issues, such as non-additionality and over-crediting, continue to dominate in voluntary carbon markets, while carbon removals are rare and those with permanent storage - non-existent[3].

It is therefore encouraging to see how different organisations take on this challenge and that some see their roles as catalysts, first buyers or early adopters rather than merely being passive buyers of carbon offsets. This is an important shift as the markets for high quality offsets and removals are still immature and in need of support to ensure its evolution and scale- up.

It is clear that even with the best efforts no government or company will be able to reach their net zero targets by 2050, without removals forming an -ever- increasing part of their policy and strategy. More funding, government support and enabling policies are desperately needed to ensure we have this pipeline for when we need it most. According to the IPCC 1.5°C Special Report, CDR and by extension, NETs will have an important role to play at global level. Developing and testing them anywhere in the world would serve a local and global agenda.

Currently, carbon removal represents a small percentage of corporate climate procurements and investments, with a small number of passionate organisations - Amazon, Apple, BCG, Delta, Facebook, Google, Mars, Shopify, Stripe, SwissRe, United, and Velux- including carbon removal into their climate strategies[4] . **SwissRe**, **Stripe, Shopify** and **Microsoft,** are making carbon removal a core focus and for this reason are the main focus of the report.

Lastly, if we manage to reach net zero by 2050, this would only be the first step on a long road. Due to our slowness to react in a proportionate manner, CO_2 in the atmosphere is well above 417 ppm today[5], and it will continue to increase until we reach a point of equilibrium between our annual emissions and carbon sinks. Until we reach the point of equilibrium and we are able to remove historical emission and return to normalised levels, CDR will continue to play a vital role.

*“Carbon offsets are often **opaque** and **misleading**.”*

Tobi Lütke- Shopify CEO

[2] The Oxford Principles for Net Zero Aligned Carbon Offsetting, September 2020

[3] Carbon Direct Commentary: Release of the Voluntary Registry Offsets Database, April 2021

[4] Foresight Transitions: Carbon Removal Foresight Report, June 2021

[5] Carbon Brief: Met office atmospheric CO2 now hitting 50 higher than pre-industrial levels, March 2021

Transition from avoidance offsets to removals

Most of the offsets available today are in the form of emission reductions, which as mentioned earlier are important, but not sufficient to reach and maintain net zero targets. Our priority should be reducing GHG emissions, with negative emissions playing an ever more important role, removing the remaining emissions that are most difficult to abate in transport, in industry and the non-CO_2 residual emissions from the agriculture sector.

It is essential to make a clear distinction between conventional offsets and removals. Figure 2 below provides a practical method to determine whether it is an emission reduction/avoidance offset, or a reversible or permanent removal.

When using avoidance offsets, one person or entity essentially pays someone else to emit less via deployment of renewable energy, avoiding deforestation or energy efficiency improvements etc. At the same time, your own emissions still end up being released into the atmosphere. Carbon removals on the other hand, remove carbon directly from the atmosphere.

With removals, you target your own emissions. With carbon removal, you take out of the atmosphere as much, or even more than you emit (more if you want to be net-negative).

Avoidance offsets remain in the spotlight due to a worrisome trend toward the use of low-quality projects that do not necessarily deliver what they promise, the lack of overall transparency and transparency around pricing.

Therefore, offsets are often based on a counterfactual claim that cannot be observed.

A recent report from CarbonPlan highlighted the systematic over-crediting of forest offsets. In the report, they analysed California's forest carbon offset program — the largest such program in existence, worth more than $2 billion.

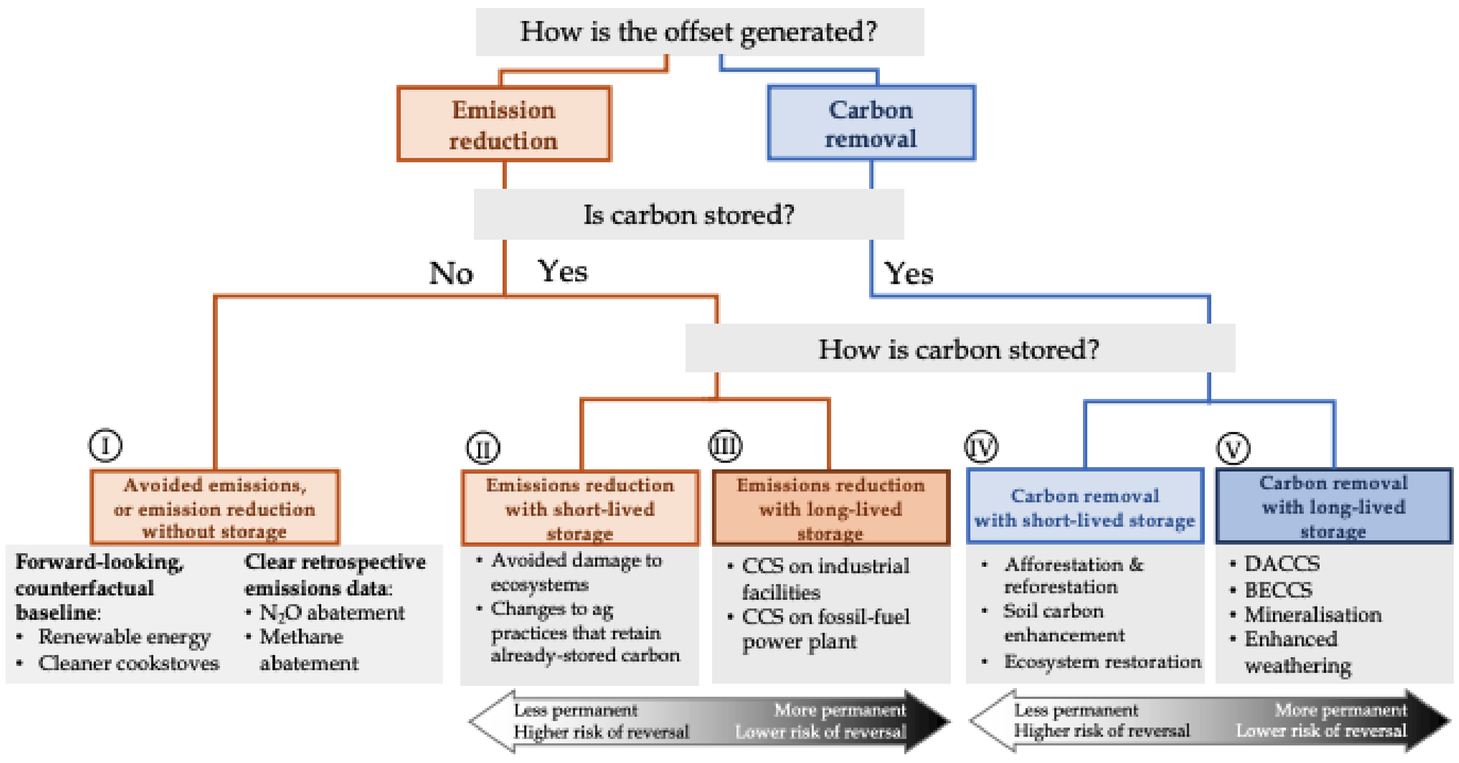
Their analysis of crediting errors showed that a significant fraction of credits in the program does not reflect real climate benefits. According to their findings, the scale of the problem is enormous: 29% of analysed offsets are over-credited, totalling 30 million tCO_2e worth approximately $410 million.

As the quote states - “do our best, remove the rest” - we need to do everything within our capabilities to limit and reduce the amount of annual greenhouse emissions released into the atmosphere. The pathways and the different options available are well documented, with over 600 companies already signing up for the Science-Based Target Initiative (SBTi) that leads the business ambition for the 1.5°C target. Once companies have determined, in line with the SBTI, what their level of reduction should be, they can, for example, transition to renewable energy, improve energy efficiency, and electrify anything that can be electrified up to physical constraints.

*“Do our best, **remove the rest**”*

Mischa Repmann- Swiss Re

Figure 2: Taxonomy of Carbon offsets



Source: The Oxford Principles for Net Zero Aligned Carbon Offsetting, September 2020

Following on from the above, organisations can reuse and possibly recycle already existing materials and products as much as possible. By doing so, they can avoid the additional extraction of resources for both the energy and material needed to make a new product, thereby avoiding additional emissions. This includes reusing atmospheric CO_2.

Finally, any remaining emissions that they were not able to either reduce or reuse despite their best efforts, particularly in the hard-to-abate sectors, will have to be removed in a final and complementary step, using a portfolio of solutions that include both nature and technology methods.

In a recent white paper published by Microsoft that details the lessons they learned from being a early corporate purchaser of removals, Microsoft explains that from their experience, the current carbon removal market is far from mainstream and partly as a result of this, the market for quality, durable carbon credits is nascent and underdeveloped.

Furthermore, during the process a number of key challenges were identified:

- The global carbon credit economy as it exists today was not set up for carbon removal, and instead has an undifferentiated focus on avoidance of emissions.
- Assessing the quality and validity of carbon removal projects is very difficult in the absence of strong protocols and verification infrastructure.
- Without a way to get clear and valid credit for funding removals, such as alignment with the Greenhouse Gas Protocol and the Science Based Targets Initiative, corporations do not have a strong business case to support removal projects.
- The limited supply of high-quality carbon removal projects today means that a commitment like Microsoft's—let alone others—will be difficult to meet.

It is not only a shift towards durable carbon removal that is gaining momentum, but also the call to join forces, pool resources and open the process to include customers suppliers and other stakeholders.

Microsoft, Mitsubishi, Stripe, Shopify, Swiss Re and South Pole, to mention a few, have all called for more collaboration. Given the need to grow the supply of removal projects, their various stages of technology readiness the volume of removals needed and limited policies in Europe. Collaboration among organisations will be vital to fulfill the different roles (seed funding for R&D, venture capital, early adopters/first customer, insurers, and market brokers) needed to maximise the impact and grow the market.

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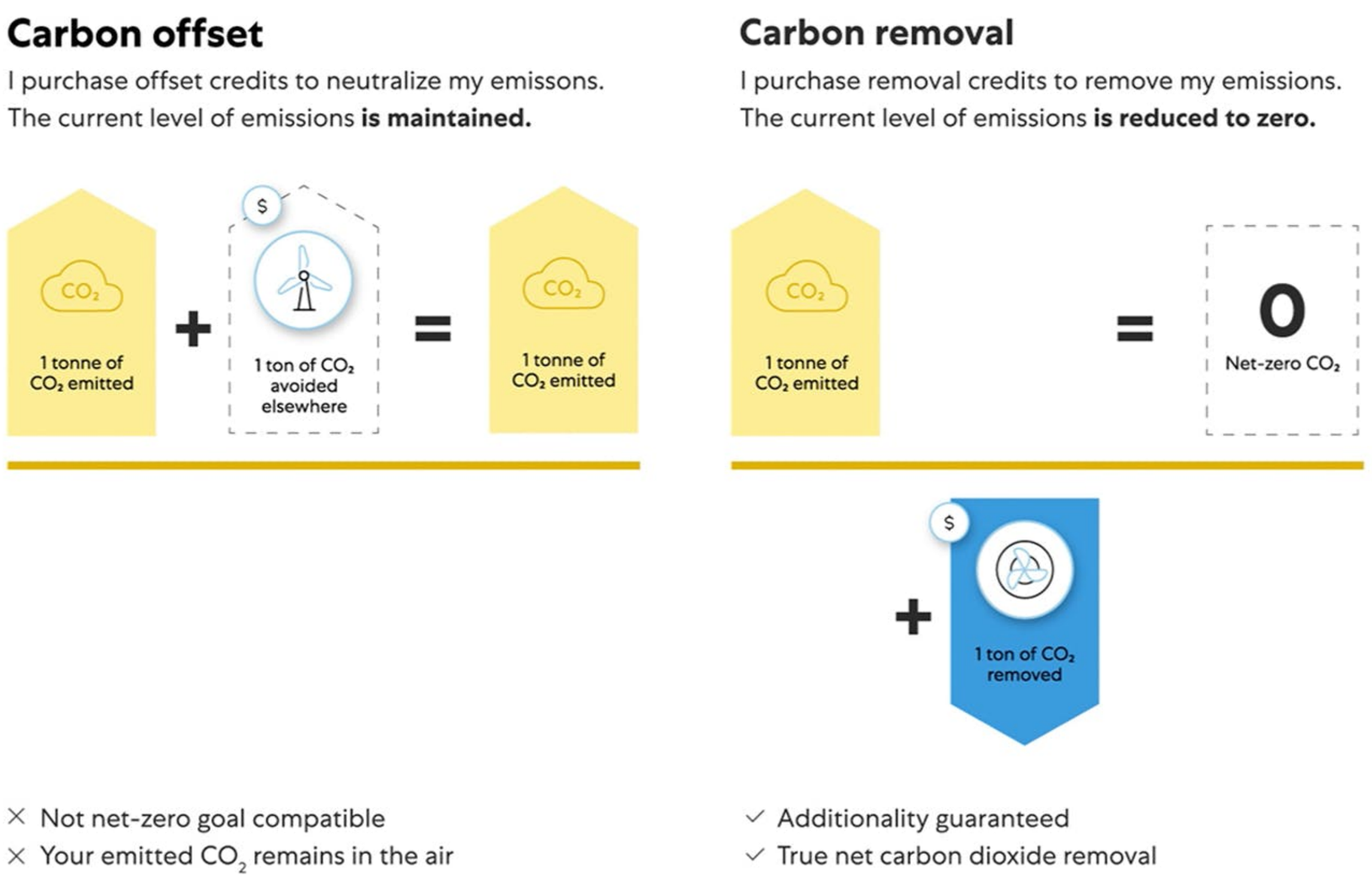
"Though much needed, a distinct carbon removal market simply doesn't exist today."

Microsoft

Figure 3: A visual representation of the difference between avoidance offsets and carbon removals.



Source: Climeworks: The difference between carbon offsets and carbon removal

Changing dynamics - focus on durability

“Notably, ***the full cost of relying on temporary carbon removal is higher*** *than the* ***upfront*** *and* ***relatively low cost of most temporary carbon removal projects today****, with the extent of the difference dependent on key parameter choices.”*

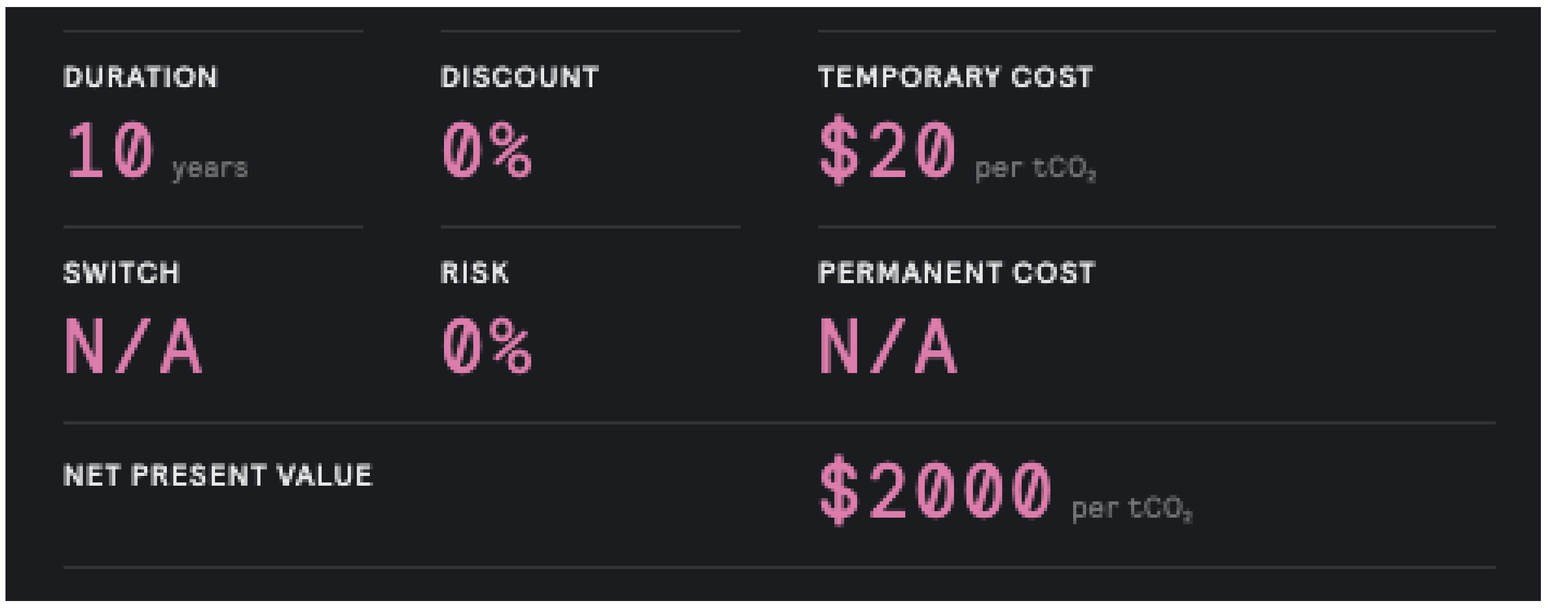
CarbonPlan

CO_2 can be stored in a safe, economical and durable manner for thousands of years. These three parameters together are in part enabling the current changeover from avoidance offsets to removal with long-term, durable storage. The above changeover is essential if we are to reach net zero and even more so to reach net negative. It is encouraging to read and see that this has filtered down into how we can or should be classifying CDR methods and technologies.
Short-term storage involves methods that have a higher risk of being reversed over decades. Long-term storage refers to methods of storing carbon that have a low risk of reversal over centuries to millennia, such as storing CO2 in geological reservoirs or mineralising carbon into stable forms (for example biochar). Short-lived storage offsets help buy time to reduce emissions and invest in developing long-lived methods, but would need to be repeated over time.

Knowing when to make this switch, enable better decision-making and to simulate the cost of avoidance with short-term storage and carbon removal with long-term storage, CarbonPlan developed a permanence calculator.
The CarbonPlan calculator puts projects that temporarily remove CO_2 from the atmosphere on an equal footing with those that do so permanently by modeling a strategy that relies on sequential temporary projects to achieve a permanent climate benefit. By making a simple set of assumptions around project costs, project sequencing, and the applicable discount rate, it lets users calculate and compare the total cost of different climate strategies.
According to the study that prompted the development of the permanence calculator, the current $tCO_2 metrics assume that climate benefits of different mitigation and carbon removal projects are comparable. However, in practice this is not what they found to be true. Not all tons are equal and only when taking the duration of carbon storage, a commonly overlooked cost of permanence, does this become evident.
The calculator shows how the initial cost of a temporary carbon removal can be far smaller than the total cost of achieving permanent climate benefits. The calculator works in a similar manner to "rent orvs. buy" home calculators by calculating whether it is better to continue with temporary removals (rent) or is it better to invest (buy) in permanent removal today?

The following three hypothetical scenarios are provided to show how the initial low cost of temporary credits changes into higher cost down the line.

Scenario A
Company A repeatedly purchase temporary 10-year projects for the entire time horizon of the model (1 000) without ever switching to permanent removals, with a 0% discount rate and 0% project risk.
Project Duration: 10 years; **Switching Time:** 1 000 years
Discount Rate: 0%; **Project risk:** 0%
Temporary cost: $20; **Permanent cost:** $500
In this extreme scenario, the total amount Company A needs to budget, is the time horizon divided by the project duration times the cost of each project. In this scenario, the cost would be ~**$2000/tCO$_2$**, which is much larger than the cost of a single project[6].



[6] CarbonPlan: Permanence calculator explainer, December 2020

Scenario B

Company B repeatedly purchases temporary 30-year projects for the entire time horizon of the model (1 000) without ever switching to permanent removal, with a 3% discount rate and 5% project risk.

Project Duration: 30 years; **Switching Time:** 1 000 years

Discount Rate: 3.0%; **Project risk:** 5.0%

Temporary cost: $20; **Permanent cost:** $500

In this scenario, the cost would be **~$500/tCO$_2$**, which is less than $2000/tCO$_2$ and closer to the price an early adopter would pay for 1 tCO$_2$.removed from the atmosphere and stored via DACS.

Scenario C

Company C purchases temporary 30-year projects for the first 50 years, after which the company switches to permanent storage, a 2,4% discount rate and a 4,7% project risk is assumed.

Project Duration: 30 years; **Switching Time:** 50 years

Discount Rate: 2.4%; **Project risk**: 4,7%

Temporary cost: $20; **Permanent cost:** $500

In this scenario, the cost would be a more realistic $204/tCO$_2$, which is still 10 times the original cost.

The calculator drives the point home that all projects and their associated tonne are not equal. We need to take a longer-term perspective when evaluating potential projects and their upfront cost. The one-off-cost of atmospheric CO$_2$ in most cases is higher, but you only have to make it once. When looking at it from a Life Cycle Cost (LCC) approach, cost-benefit analysis and broader societal impacts, it could make sense to already switch to atmospheric carbon removal with permanent storage.

Durability and storage as the lenses to classify CDR types?

Many have developed different taxonomies for NETs to try and catgeroise them in some form or shape ranging from the capture process to the storage medium. The dominant method to classify NETs is nature vs technology vs hybrid approach. This method of classification can lead to mixing and misunderstanding of their climate benefits.

In this section a brief overview of different "lenses" to classify NETs is provided after which we make the case to abandon this dominant approach and rather use durability of storage as the key differentiator.

1. Nature vs technology vs hybrid

In such a classification framework, we would group the following:

- Forestry, Soil Organic Matter, Land-use/Wetlands
- Direct Air Capture and Storage, Enhanced Weathering
- Bio-energy with Carbon Capture and Storage, Biochar

Finding the threshold between nature and technology is not an easy task. For example, planting trees is seen as a nature-based solution, but how much human intervention does there have to be involved for it to switch over to the technology side?

2. Biomass-based vs. Non-biomass based

- Bio-energy with Carbon Capture and Storage, Biochar, Forestry, Soil Organic Matter, Land-use/Wetlands
- Direct Air Capture and Storage, Enhanced Weathering

3. Long-term/durable & accountable" vs. Reversible & Difficult to measure

- Enhance Weathering, Direct Air Capture and Storage, Bio-energy with Carbon Capture and Storage, Biochar
- Soil Organic Matter, Forestry, Land-use/Wetlands

4. Storage of Carbon vs. Storage of CO2 vs. Generation of carbonates

- Biochar, Forestry, Soil Organic Matter
- Direct Air Capture and Storage, Bio Energy Carbon Capture and Storage
- Enhance Weathering, Direct Air Capture and Storage, Bio-energy with Carbon Capture and Storage

The third and fourth classification frameworks, that uses durability (also referred to as permanence) and the type of carbon sink are gaining momentum over the classical nature vs. tech classification.

From a climate- effect and net zero perspective, using durability and the type of carbon sink to distinguish between the different NETs is our best option.

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Types of CDR

Removing CO_2 from the atmosphere is an important step in reaching net zero. However, this is only half the process.

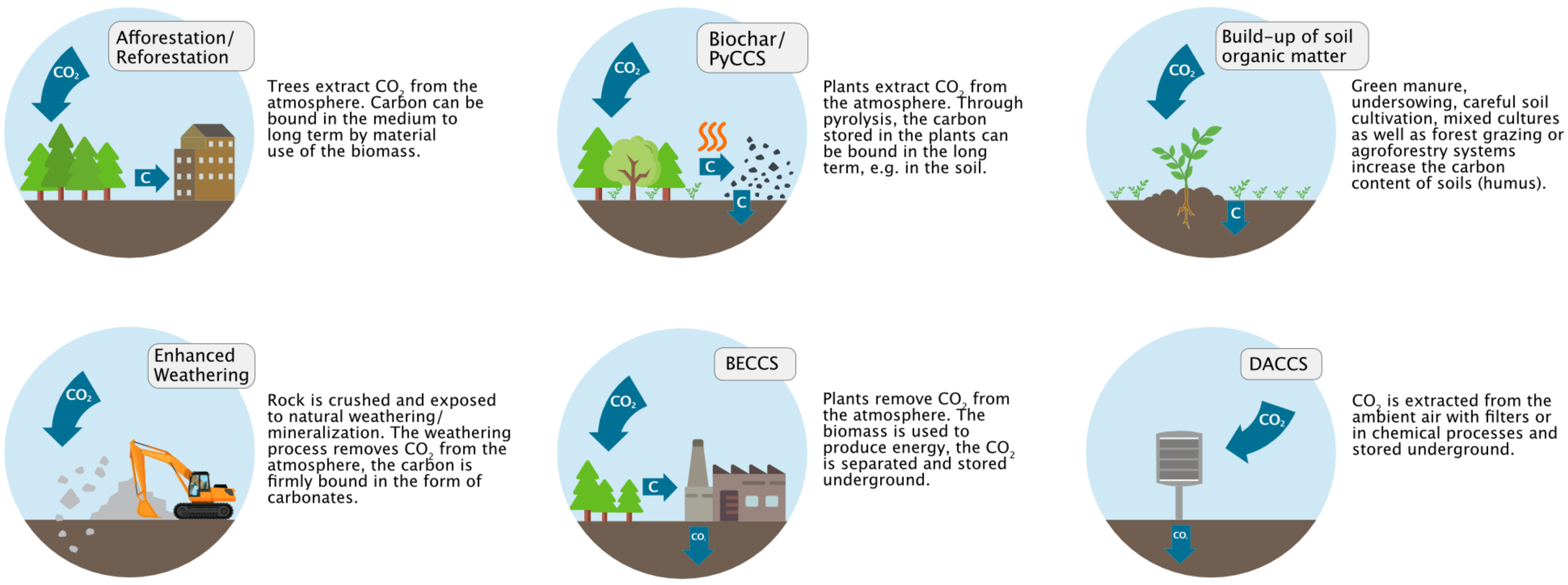
To ensure we have the best chance of tackling climate change, we will need to do two things:

1. Take a portfolio approach regarding CDR technologies. The scale of the problem we are trying to solve is of such magnitude that no one technology can provide the scale needed to reach our goals in 2030 and 2050. From a pure risk perspective, given that most CDR technologies are still in lower technology readiness levels (TRL) or early in the stages of commercialisation, such diversification makes sense.

2. We need to grow the pipeline of new CDR projects and start-ups.
There is no single solution that could be deployed at scale to remove hundreds of gigatonnes of CO_2 from the atmosphere by the end of this century. Carbon removal technologies and practices face varying domestic capacities, environmental and physical limits, more so than mitigation technologies. This is why we need to look at carbon removal as a portfolio of options that will complement one another in different locations and timeframes.

Removing CO_2 from the air is an essential step in reaching net zero. However, this is only half the process. The other crucial step is the efficient, economical and safe long-term storage of the removed CO_2.

Figure 4: Portfolio of negative emissions technology capable of scaling in an economic and low risk manner.



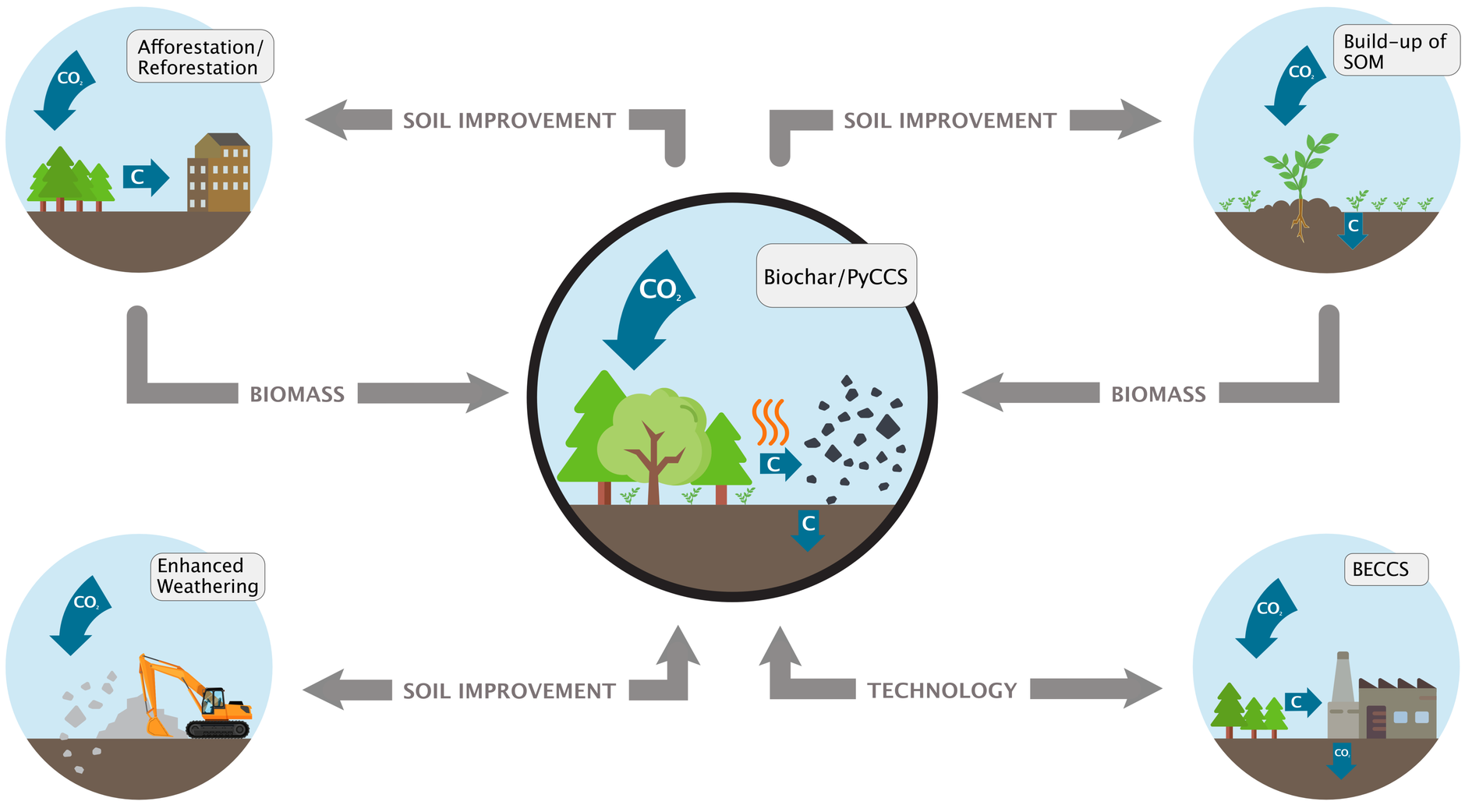
It is important to note that these technologies should not be seen as in competition with each other. In some cases, there might be an overlap in terms of resource needs such as land or biomass, but the potential scale of the opportunities when there are synergies should not be dismissed.

The 16 companies forming part of the report are group according to their NET method in Figure 5. Direct Air Capture and Biochar both have four companies making up their groups.

Figure 5: Grouping of NETs companies

Figure 6 below shows the different potential synergies between the different NETs. A practical example of a possible synergy is the use of biochar as feedstock for BECCS.

Figure 6: Synergies between the different negative emissions technologies.



Corporate pledges and corporate purchases - from ambition to commitment

According to a recent PWC study, the climate tech sector (start-ups developing technology-enabled solutions to climate change and the transformation to net zero emissions), which is still at a nascent stage and represents a small part of the global Venture Capital (VC) market (approx 6% of total capital invested in 2019), has seen an incredible increase in funding over the past seven years[7]. The report shows climate tech VC investment increased from $418 million per annum in 2013 to $16.3 billion in 2019. That is approximately three times the growth rate of VC investment into Artificial Intelligence (AI) over the same period.

The report also highlights that the ecosystem is still nascent, with crucial gaps in the depth and nature of funding available to founders and awkward structural hurdles for them to navigate as the start-ups begin to scale. The report came at a time when more progressive companies started to look beyond the usual and popular carbon markets at what is now termed “Frontier (or emerging) Carbon Removal Projects”. The majority of these carbon marketplaces would provide verified carbon projects according to some standard and verification process. The process would provide evidence that confirms the reduction or removal of carbon. This would provide the buyer of carbon offsets the opportunity to compensate or even neutralise their emissions.

However, with the increase in visibility of the importance of the challenge, increase in funding, and the volume of carbon removal needed, new technologies started to appear. These new technologies, mainly in an early stage, did not fit the more traditional mould of carbon markets and a new form of voluntary carbon market developed in parallel. Some of the more popular carbon markets listed these new technologies whose impact, scale and additionality could not always be verified.

Private organisations started to notice these new frontier technologies, with some developing their own evaluation process to evaluate projects falling outside of the traditional verified carbon markets. Soon, instead of being passive buyers of carbon offsets, organisations started to shift towards being catalysts or enablers of the broader CDR ecosystem by investing in novel carbon removal technologies in the hopes to grow the pipeline into a portfolio of solutions needed at scale. The sentiment is to develop and invest in new technologies that have the potential to be high volume and low cost between 2030 and 2050. This is a crucial role private organisations are playing within the broader CDR ecosystem, future-proofing CDR pathways.

“While Shopify is investing in proven solutions that are already fighting climate change, we are placing bets on high-potential technologies at the frontier of the carbon removal industry. Our goal is to help prove, scale, and commercialize climate technology for massive impact in the long-term.”

Tobi Lütke- Shopify CEO

[7] PWC: Climate tech investment report climate-week.html,December 2020

Corporate purchases

For the first of a series of deep-dives into corporate purchases of carbon removals, we selected four companies to showcase their innovative approaches toward the voluntary carbon market. They are committed to going beyond the status quo. They are pioneers at the frontier of climate innovation because of their commitment to meeting companies on their level through flexible funding, generating demand, proving scale and commercialisation potential, placing bets on early-stage unproven technology and helping drive down the cost of mature solutions.

Swiss Re 2019

Putting action to their motto “Do our best, remove the rest”, Swiss Re participated in May 2019 in the world’s first auction for carbon removal certificates managed by Puro.earth. As this was a first of its kind, only small volumes of carbon removal certificates were on offer and traded. Swiss Re wanted to support and test the new marketplace and bought a small batch of 100 tonnes of carbon removal certificates from Carbofex, a biochar project based in Tampere, Finland. In participating in the auction, Swiss Re became a first customer of Carbofex and the platform.

On top of that, Swiss Re is the first multinational company to introduce a triple-digit real internal carbon levy on both direct and indirect operational emissions (such as from business travel). The new Carbon Steering Levy has been set at USD 100 per tonne CO_2 as of 2021 and will gradually increase to USD 200 per tonne CO_2 by 2030. The levy gives Swiss Re a strong incentive to further reduce its operational emissions. It also provides a 10-year funding scheme to move from carbon offsetting to supporting carbon removal projects, enabling the compensation of any unavoidable emissions in line with its ’remove the rest’ strategy.

The new Carbon Steering Levy has been set at USD 100 per tonne CO2 as of 2021 and will gradually increase to USD 200 per tonne CO2 by 2030.

Stripe 2020-2021

In 2019 Stripe announced, as part of their environmental program, their Negative Emissions Commitment with a pledge of $1M per year. Under this pledge, Stripe would be able to pay any amount for the removal of CO_2 directly from the atmosphere and sequester it in secure long-term storage. This commitment to paying a higher premium for the removal of quality atmospheric CO_2 with secure long-term storage, would set the stage for both the 2020 and 2021 rounds of corporate purchases. During these two years, Stripe would take a blended approach to funding projects and play a catalyst/enabler/first customer role. They would be the first customer of four projects and fund a number of first of a kind (FOAK) projects. This resulted in a much needed departure from the typical buyer profile and role in traditional verified voluntary carbon markets.

Stripe would take a blended approach to funding projects and play a catalyst/enabler/first customer role.

Shopify 2020

In September 2019, Shopify announced the launch of its Sustainability Fund committing at least $5M in annual funding for environmental investments that include carbon sequestration. Similar to Stripe, Shopify takes their role as a catalyst/enabler/first customer seriously which means they are willing to pay more and in some cases even overpay. Their goal is to spur market demand for the highest-potential, most innovative technologies and projects. Furthermore, they committed to buying $1M of sequestered carbon annually at any price. This form of investment will help increase demand and predictability of the market so industrial engineering can scale up the technology curve and scale down the cost curve. According to Shopify it would be very hard to spend their $5M budget because there are simply not enough commercially ready solutions. That is why they committed to intentionally overpay for carbon removal, funding pilot projects and generating demand to kickstart the market and drive down future prices. Their purchases enabled companies to fund research, pilot plants, equipment purchases, and establish monitoring and verification standards.

The Sustainability Fund is made up of two different portfolios:
Frontier portfolio (76%): Groundbreaking technologies that permanently remove carbon from the atmosphere. Their goal is to spend most of the funds in this category each year.

Evergreen portfolio (24%): Key solutions that temporarily remove carbon or reduce carbon emissions. These are needed right now while permanent carbon removal technologies begin scaling for the long term.
For the purpose of our analysis, we will only look into the Frontier portfolio.

“Capital expenditure fund that purchase carbon removal at any price. The main goal of the fund is to accelerated the carbon removal market.”

Shopify

Microsoft 2021

On January 16, 2020, Microsoft announced a new climate commitment: “we will be carbon negative by 2030.” This builds on their commitment since 2012 to be operationally carbon neutral, extending it in both scale— to beyond net zero emissions—and scope —to include the emissions not just from their operations but also from their supply and value chains. Carbon removal soon became a major factor underpinning the strategy to achieve the commitment. Even with deep carbon reduction as their top priority, physically removing carbon from the atmosphere will also be essential to their ability to meet net-negative target scale and timeframe.

By 2030 Microsoft will be carbon negative, and by 2050 Microsoft will remove from the environment all the carbon the company has emitted either directly or by electrical consumption since it was founded in 1975.
Through the Climate Innovation Fund, Microsoft committed to invest $1 billion over four years into new technologies and expand access to capital around the world to people working to solve the climate problem.

The capital will be deployed in two areas:
(1) to accelerate ongoing technology development by investing in project and debt finance; and (2) to invest in new innovations through equity and debt capital.
Thurtheremore, funding on investments will be primarily based on four criteria: (1) strategies that have the prospect of driving meaningful decarbonisation, climate resilience, or other sustainability impact; (2) additional market impact in accelerating current and potential solutions; (3) relevance to Microsoft by creating technologies they can use to address their unpaid climate debt and future emissions; and (4) consideration of climate equity, including for developing economies.

“Through the Climate Innovation Fund, Microsoft committed to invest $1 billion over four years into new technologies.”

Microsoft

An ever-increasing number of companies find innovative and collaborative ways to fund carbon removal purchases. In doing so, they seek to have a catalytic impact on the CDR ecosystem. Two such initiatives are Klarna/ Milkywire and Sourceful Climate.

Klarna / Milkywire

The international fintech Klarna recently announced it is putting $1M into a portfolio of carbon removal and other climate solutions instead of buying offsets. The amount is based on an internal tax on carbon of 100 USD for scope 1,2 and travel and 10 USD for the rest of scope 3. The portfolio is hosted by the impact platform **Milkywire** and is designed to reflect the needs of climate finance, both supporting nature base solutions, permanent carbon removal and decarbonisation action, including advocacy efforts.

Just as Stripe and Shopify, the portfolio seeks to have a catalytic impact, for example helping new carbon removal solutions grow and come down in price rather than focusing on reaching a set number of tonnes removed and just scaling up existing methods such as reforestation. Milkywire is also taking in donations to the portfolio from Klarna's customers, the public and other companies.

Sourceful Climate

Sourceful provides companies the opportunity to support pioneering projects that permanently remove carbon from the atmosphere. They've made it easier for companies to contribute to three innovative and pioneering carbon removal projects. By providing a technology mix and supporting projects at different stages of maturity, Sourceful is able to lower the cost of a tonne of a tCO_2 removed. The company currently pays £48.77 per tCO_2 permanently removed.
The contribution gets divided between Charm (46%), Greensand (46%) and Heirloom (7%).

Corporate purchases
- the numbers -

Corporate purchases Carbon Removal Credits

Swiss Re, Stripe, Shopify and Microsoft

2019-2021

Total tCO_2 purchased

~64 896

# of purchasing companies

4

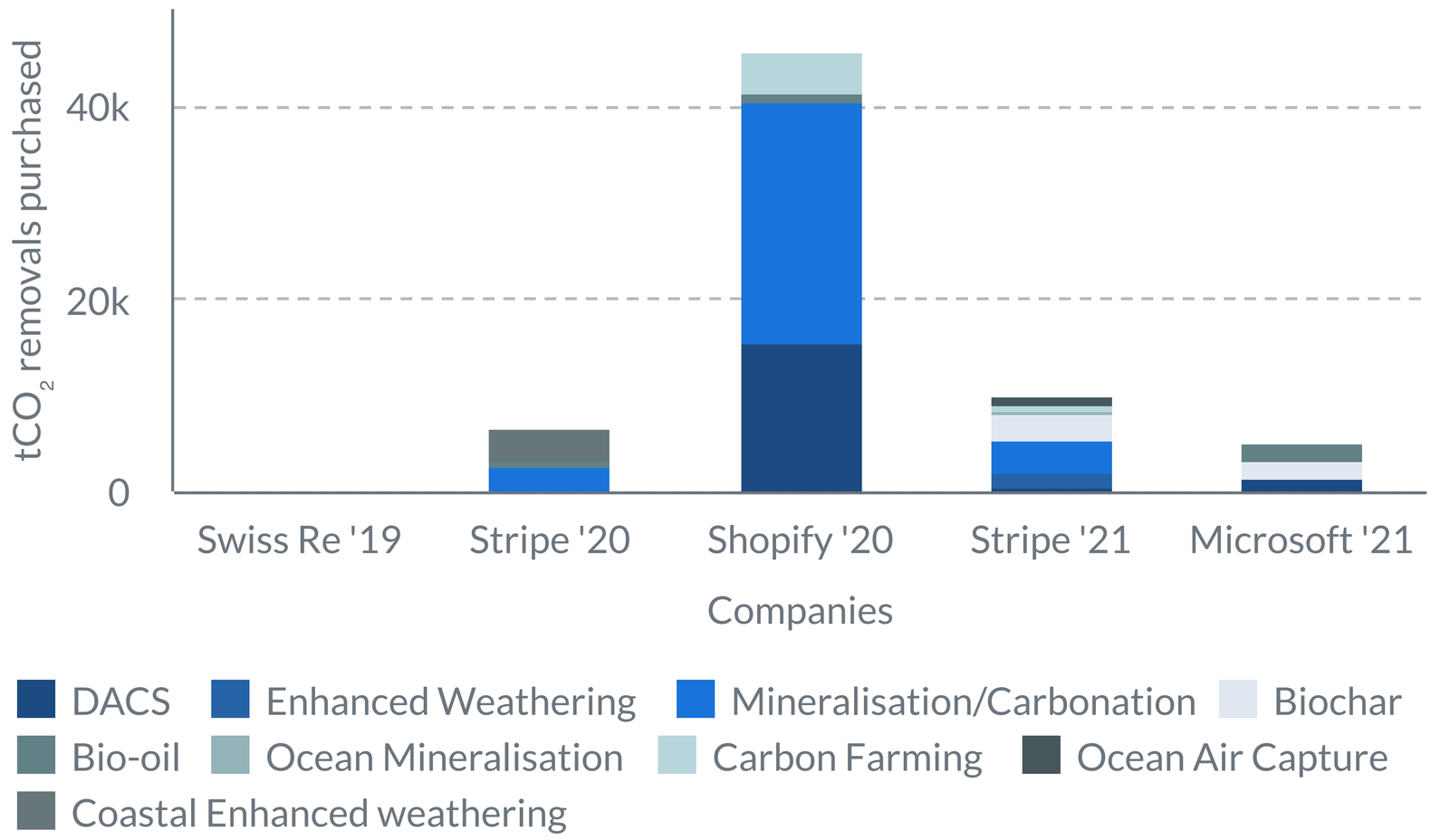
# of unique sellers

16

# of NET categories

9

Corporate purchases 2019-2021



Share of total volume per NET category (Swiss Re, Stripe, Shopify and Microsoft)

M/C

43,9%

DAC

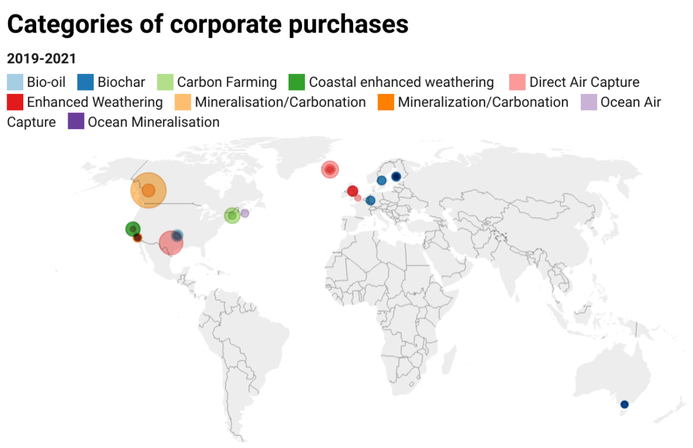
27,6%

Biochar

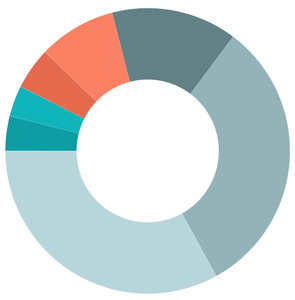
7,25%

CF

7,25%

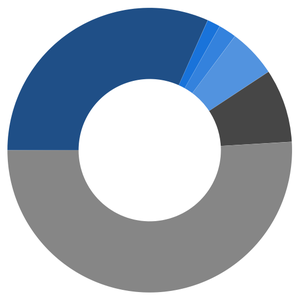


Stripe's NET portfolio



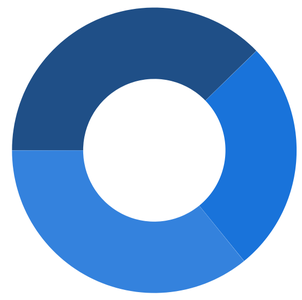
- Bio-oil (3.96%)
- OC (3.47%)
- CF (4.76%)
- DAC (8.79%)
- EW (14.28%)
- CEW (31.72%)
- M/C (33.01%)

Shopify's NET portfolio



- DAC (31.7%)
- OAC (1.49%)
- Bio-oil (2.04%)
- Biochar (5.5%)
- CF (8.35%)
- M/C (50.93%)

Microsoft's NET portfolio



- Bio-oil (37.74%)
- DAC (26.42%)
- Biochar (35.85...

Key takeaways

Importances and practicality of having a f**lexible carbon price** and acting as **first purchaser/customer**.

Building the CDR ecosystem.

The configuration of the NET portfolios and the **low volume** indicates that they are **looking beyond volume** and **cost**, helping start-ups lower their costs as they learn by doing and scale up.

Stripe has the most diversified portfolio.

Swiss Re 2019

100 tCO_2

Stripe 2020-2021

10 606,8 tCO_2

Shopify 2020

49 090 tCO_2

Microsoft 2021

5 300 tCO_2

The numbers on the left presents the total amount of tCO_2 removal purchased by each company between 2019 -2021

Corporate purchases Carbon Removal Credits

Stripe

2020

Total tCO_2 purchased

6 571,8

Total value of purchases

$999 535

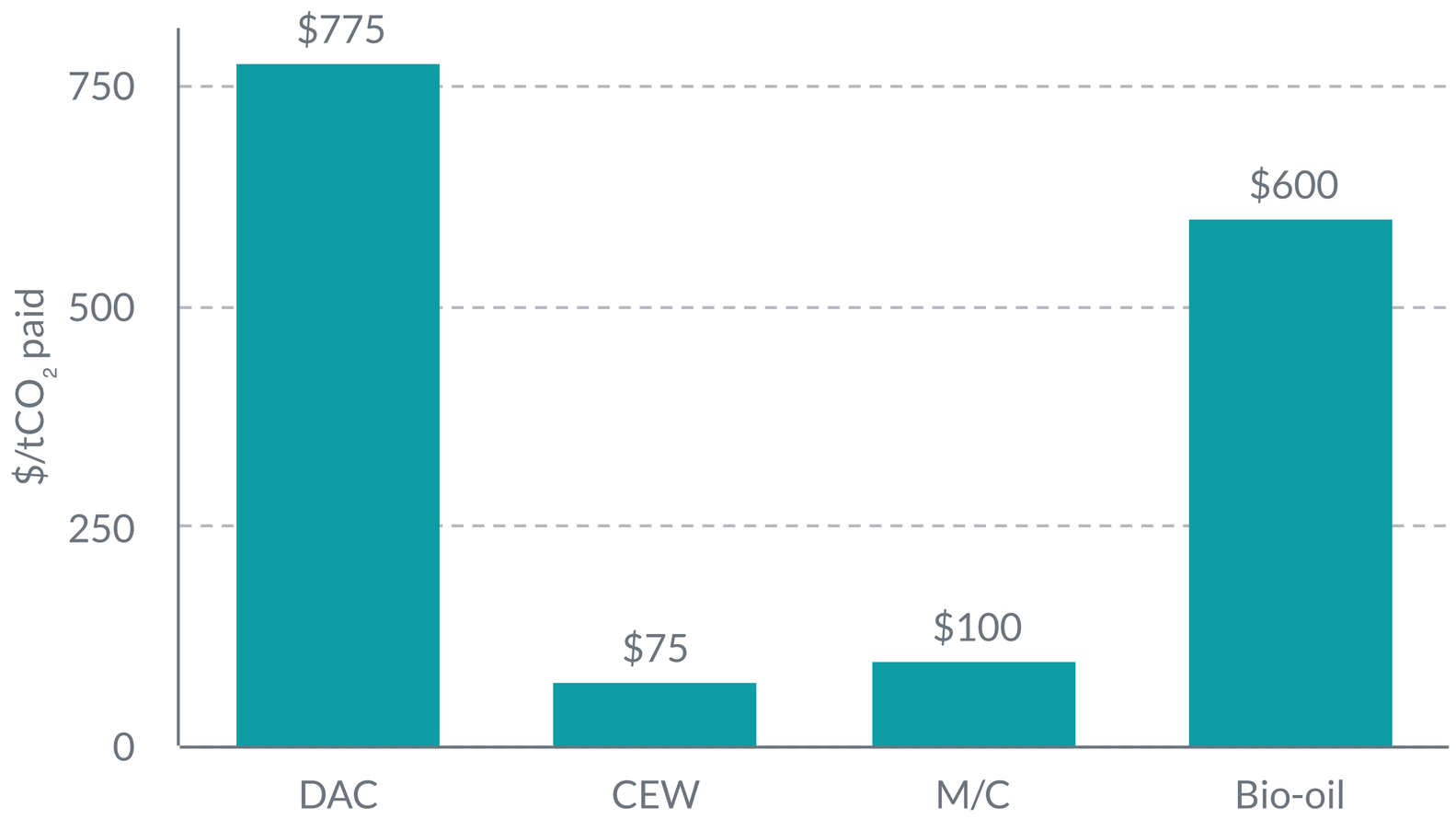
Yearly pledge

$1 000 000

# of NET categories

4

2020 $/$tCO_2$ paid



Share of total volume per NET category

CEW

50,65%

M/C

37,99%

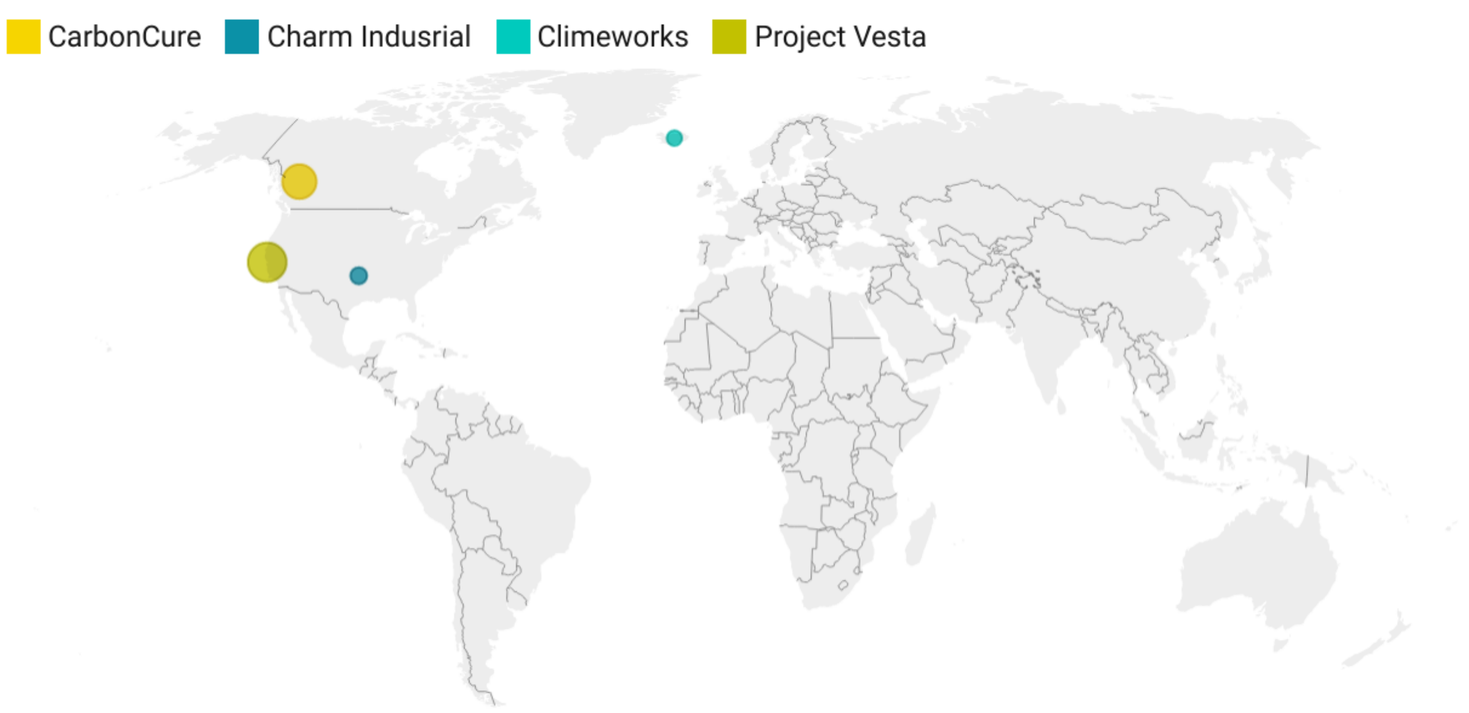
Bio-oil

6,32%

DAC

5,04%

Corporate Purchases 2019



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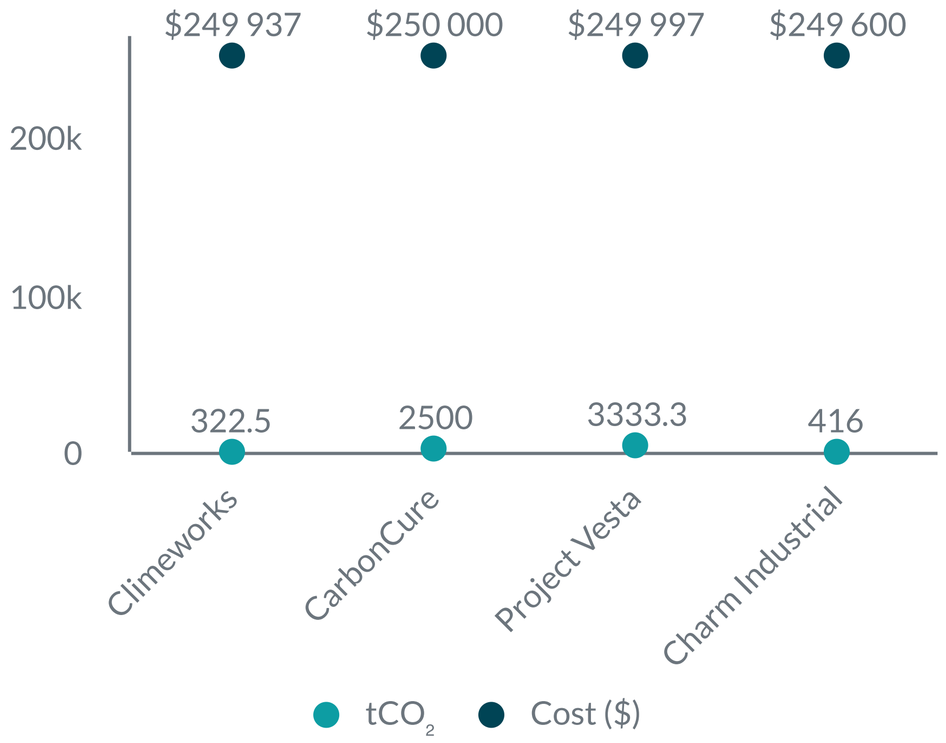
Total value, total $/$tCO_2$



Key takeaways

Transparency about **purchases** help to stimulate other players on the.

Stripe was the **first purchaser** of **three projects**.

Purchased **6 571,8 tCO_2** at a total cost of **$999 535 with** an average cost of **$152,09 tCO_2** removed.

Committed to **paying a higher premium** for the removal of **quality atmospheric CO_2** with **secure long-term storage**.

Grow the pipeline - core focus is on **early-stage projects** that will help **increase** the number of projects with a **credible path to scale**.

Corporate Purchases Carbon Removal Credits

Stripe

2021

Total tCO_2 purchased

4 035

Total value of purchases

$1 815 000

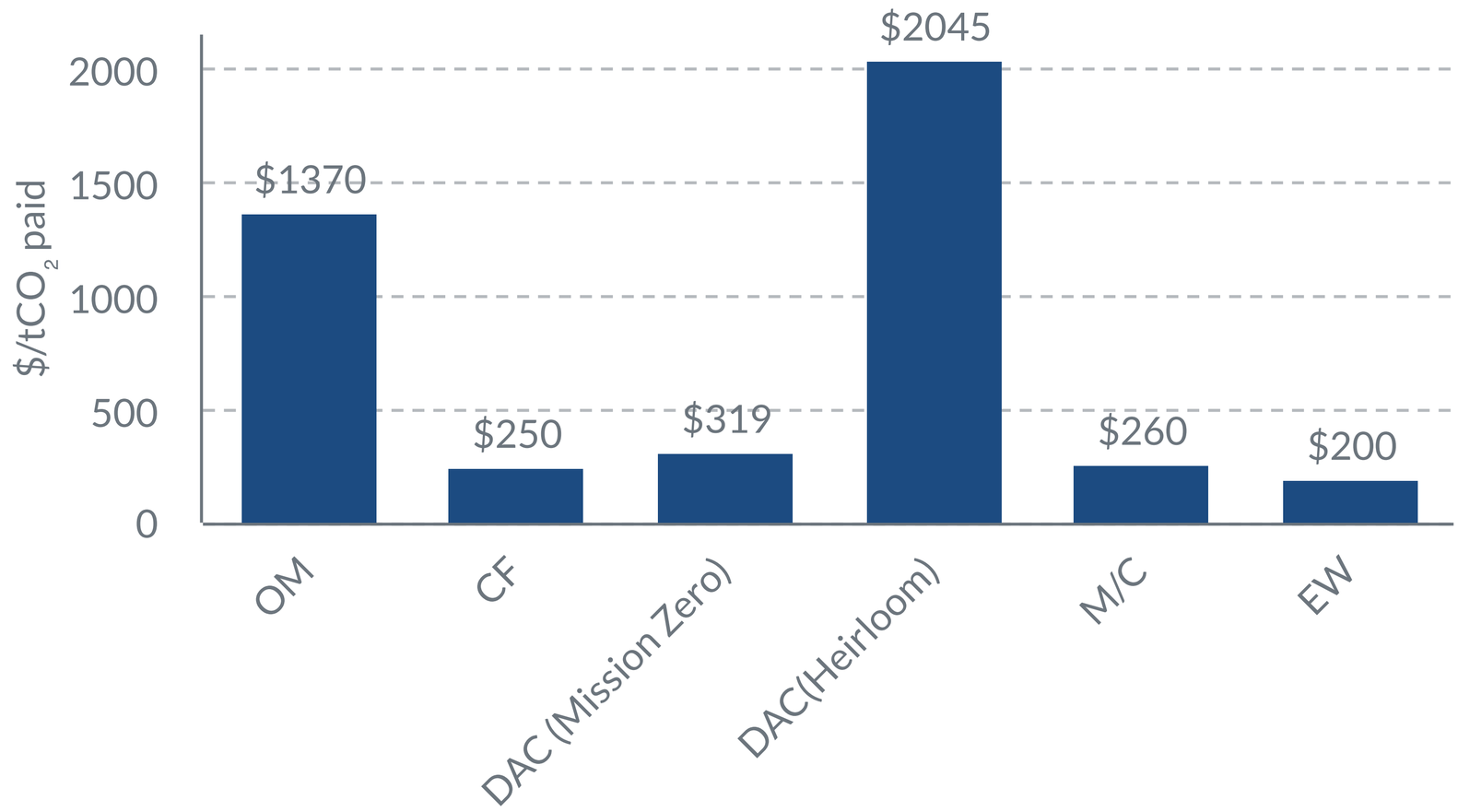
R&D grant funding

$908 000

# of NET categories

5

2021 $/$tCO_2$



Share of total volume per NET category

M/C

33,10%

CEW

31,72%

EW

14,28%

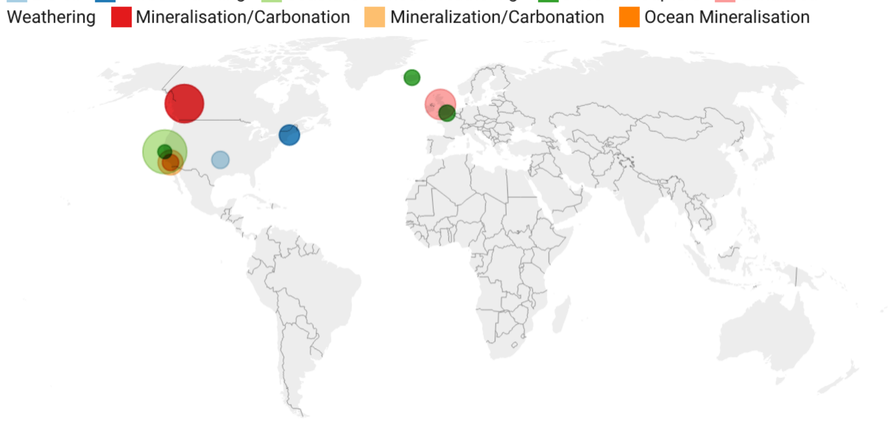
DAC

8,79%

Stripe's categories of corporate purchases

According to category and tCO2 removal purchased

Bio-oil · Carbon Farming · Coastal enhanced weathering · Direct Air Capture · Enhanced Weathering · Mineralisation/Carbonation · Mineralization/Carbonation · Ocean Mineralisation



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Company	First Customer	Largest Customer	R&D grant
CarbonBuilt	Yes	Yes	-
Heirloom	No	Yes	-
Mission Zero	Yes	Yes	$385k
Running Tide	No	Yes	$350k
Seachange	Yes	Yes	-
Future Forest Company	Yes	Yes	$200k

Heirloom
DAC via mineralisation
244 tCO_2 for $500k
$2 054/$tCO_2$
Est. delivery- Dec 2023

Renewal kicks in
Jan 2024
$1M
~ cost plus max 35% tCO_2
Est. delivery- June 2025

Mission Zero
DAC
319 tCO_2 for $115k
$319/$tCO_2$
Est. delivery- Oct 2023

Renewal kicks in
Nov 2023
tCO_2 to the value of $1M
Est. delivery- 2026

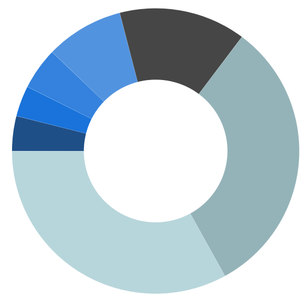
CarbonBuilt
Mineralisation
968 tCO_2 for $250k
$258/$tCO_2$
Est. delivery- Jun 2023

Renewal kicks in
Jun 2023
~968 tCO_2 for $250k
@ $258/$tCO_2$
Est. delivery- Jul 2024

Running Tide
Carbon Farming
600 tCO_2 for $150k
$250/$tCO_2$
Est. delivery- Dec 2022

Renewal kicks in
Jan 2023
tCO_2 to the value of $1M
Est. delivery ~2024 +/- 2 years

Stripe's NET portfolio total



- Bio-oil (3.96%)
- OM (3.47%)
- CF (4.76%)
- DAC (8.79%)
- EW (14.28%)
- CEW (31.72%)
- M/C (33.01%)

Key takeaways

Stripe took a **blended** approach to funding projects and played a **catalyst/enabler/first customer** role.

First customer of **four projects** and fund a number of **first of a kind** (FOAK) projects.

The **lowest purchase price** per ton of CO_2 removed was **$200/ tCO_2** for e**nhanced weathering** with **biochar,** and at **$2 045/$tCO_2$**, the highest went to a novel approach combining d**irect air capture and mineralisation**.

Seachange
Ocean Mineralisation
365 tCO_2 for $500k
$1370/$tCO_2$
Est. delivery- Mar 2024

Renewal kicks in
Apr 2024
tCO_2 to the value of $1M
Est. delivery- between 2-3 years

The Future Forest Company
Enhanced weathering
1 500 tCO_2 for $300k
$200/$tCO_2$
Est. delivery- Dec 2023

Renewal kicks in
Jan 2024
tCO_2 to the value of $1M
Est. delivery- between 2-3 years

Corporate purchases Carbon Removal Credits

Stripe

2020-2021

Total tCO_2 purchased

10 606,8

Total value of purchases

$2 814 535

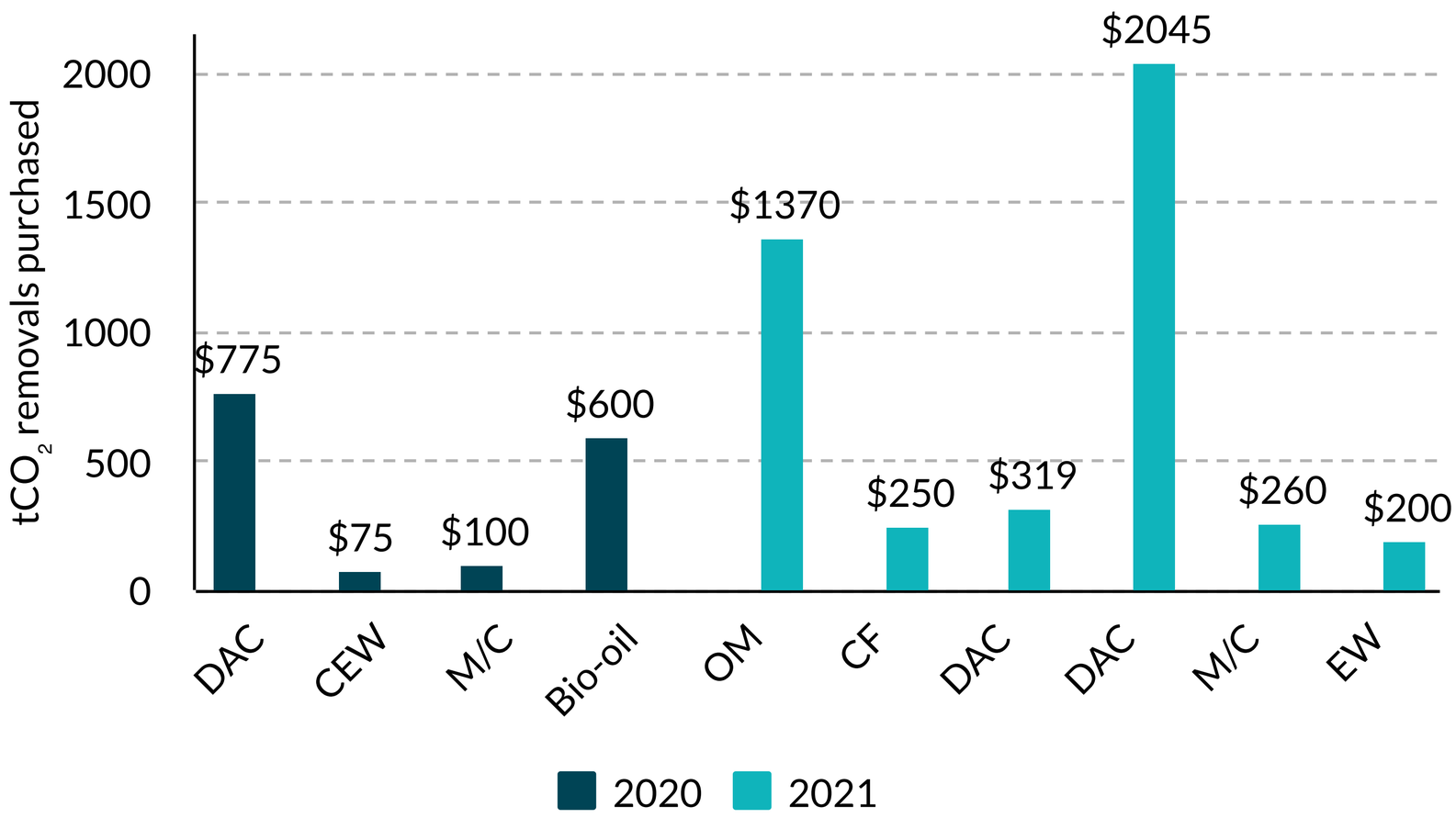
R&D grant funding

$908 000

# of NET categories

5

2020-2021 $/$tCO_2$ paid



Share of total volume per NET category

M/C

33,10%

CEW

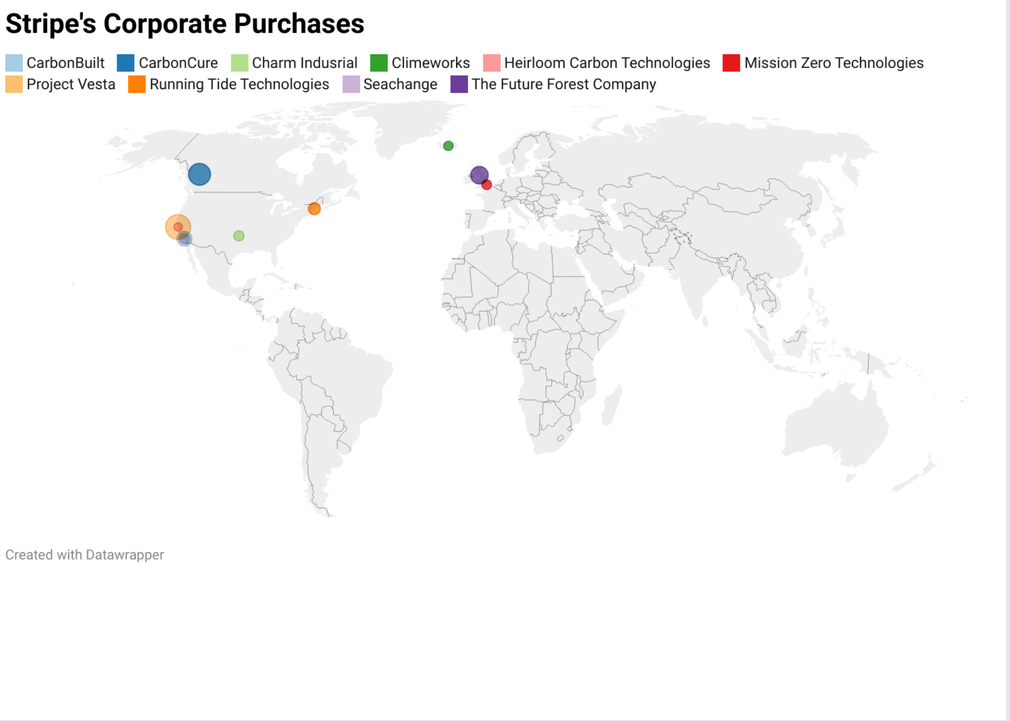
31,72%

EW

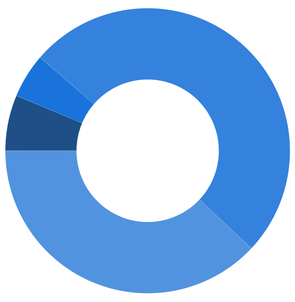
14,28%

DAC

8,79%

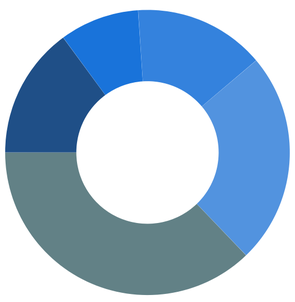


NET portfolio 2020



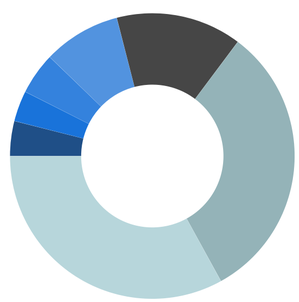
- Bio-oil (6.32%)
- DAC (5.04%)
- CEW (50.65%)
- M/C (37.99%)

NET portfolio 20211



- DAC (14.92%)
- OM (9.05%)
- CF (14.87%)
- M/C (23.99%)
- EW (37.17%)

NET portfolio total



- Bio-oil (3.96%)
- OM (3.47%)
- CF (4.76%)
- DAC (8.79%)
- EW (14.28%)
- CEW (31.72%)
- M/C (33.01%)

NET- Negative Emission Technology
EW- Enhanced weathering
DACS- Direct Air Capture and storage
tCO_2- 1 tonne of carbon dioxide
$/tCO_2$- cost of 1 tonne of carbon dioxide
* total tCO_2 removal purchased
** total value of purchases
** average price per tCO_2

2020	2021	2020-2021
*6 571,8 tCO_2	*4 035 tCO_2	*10 606,8 tCO_2
**$999 535	**$1 815 000	**$2 814 535
***$152,09 tCO_2	***$449 tCO_2	***$265,35 tCO_2

Corporate purchases carbon removal credits

Shopify

2020

Total NET tCO_2 purchased

~48 990

Value of permanent atmospheric carbon sequestered

~$1 600 000

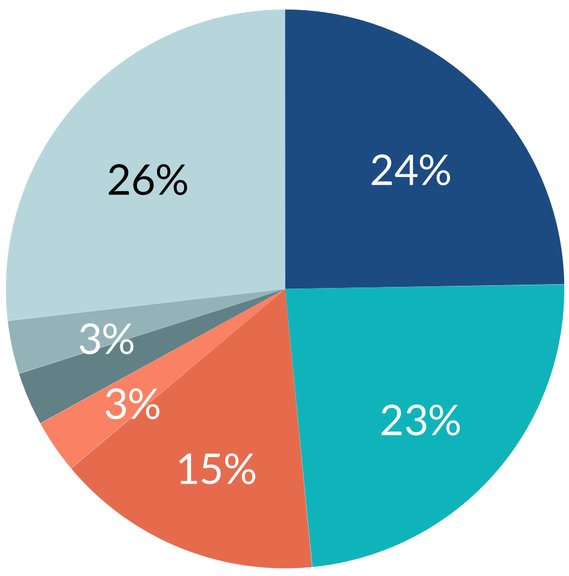
Sustainability Fund

$5M per year

Sustainability Fund

Minimum of $1M earmarked for permanent atmospheric carbon sequestration

Shopify's Sustainability Fund investments 2020



Amount of tCO_2 purchased

CarbonCure

25 000

Carbon Engineering

10 560

Climeworks

5 000

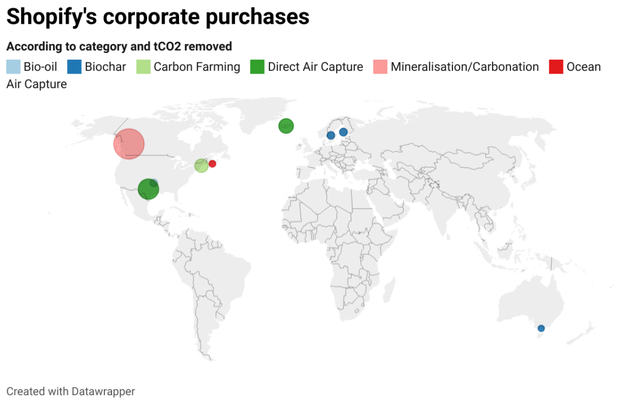
Running Tide

4 100

Shopify's Sustainability fund consist of 74% removal projects with long-term storage.

Many of the purchase agreements have five-year terms, with options to extend for a subsequent five years, providing selected projects with a customer until 2030.

Shopify's Sustainability Fund



Charm Industrial

Method - Geo sequestration of bio-oil
Certification- Under development
Volume- 1 000 tCO_2
Durability- ~10 000 years

Climeworks

Method- Direct Air Capture and Storage (storage via Carbfix method)
Certification- ISO 14064-2
Volume- 5 000 tCO_2
Durability- ~10 000 years
Agreement- five years, option to extend for another five years

CarbonCure

Method - Carbon mineralisation in concrete
Volume- 25 000 tCO_2
Durability- >1 000 years

Running Tide

Method - Carbon Farming
Volume- 4 100 tCO_2
Durability- ~800 years

Planetary Hydrogen

Method- Ocean Air Capture
Volume- 730 tCO_2
Durability- ~10 000 years

Ecoera

Method- Biochar
Certification- Puro.earth
Volume- 1 000 tCO_2
Durability- ~1 000 years

Carbon Engineering

Method- Direct Air Capture and Storage
Volume- 10 5600 tCO_2
Durability- ~10 000 years

Carbofex

Method- Biochar
Certification- via Puro.earth
Volume- 1 100 tCO_2
Durability- ~1 000 years

$ECHO_2$

Method- Biochar
Certification- Puro.earth
Volume- 600 tCO_2
Durability- ~1 000 years

Key takeaways

Focus on finding technologies and solutions that pull CO_2 out of the atmosphere.

Capital expenditure fund that purchase carbon removal at any price. The main goal of the fund to is accelerated the carbon removal market.

View atmospheric carbon removal with long-term storage as fundamentally different from avoided and reduced emissions offsets.

Flexible with purchases to maximise impact on companies.

See long-term storage as >100 years

Has a balanced fund- portfolio of solutions

Corporate purchases carbon removal credits

Microsoft

2021

Total NET tCO_2 purchased

5 300

Total value of NET purchases

$ N/A

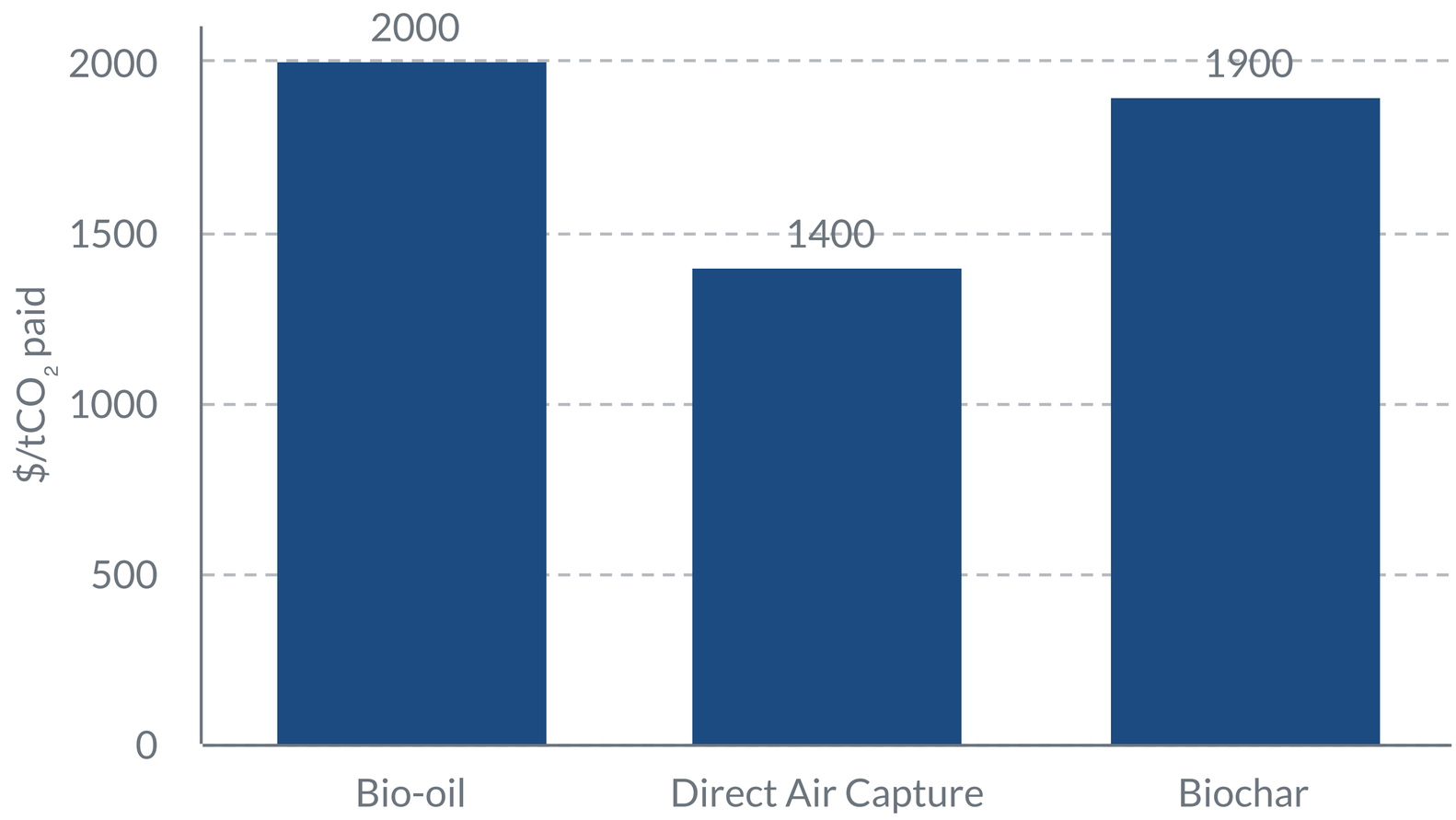
Durability

1 000-10 000 years

# of NET categories

3

tCO_2 removed purchased per NET



Share of total volume per Company

Charm Industrial

33,10%

Climeworks

31,72%

Carbon Cycle

14,28%

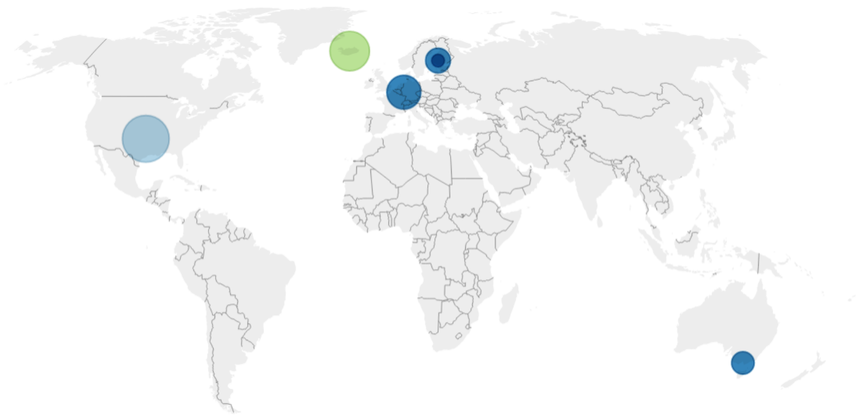
Carbofex

8,79%

Microsoft's corporate purchases

According to category and tCO2 removal purchased

Bio-oil Biochar Direct Air Capture



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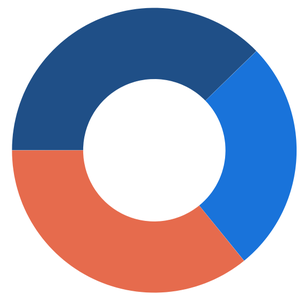
Over **95%** of portfolio is **Nature based** with durability of between **10 to 100** years.

Average **durability** (excl. NETs) **~50 years**
Four projects will need to be replaced within **25 years**.

Microsoft reports a average price of $20/$tCO_2$. See link for more details.

Total value of all purchases based on reported average price of $20/$tCO_2$
~$26M

Microsoft's NET portfolio



Key takeaways

Need for straightforward carbon removal accounting.

Place bigger bets- bigger projects in the 100 000 $mtCO_2$ range.

Advocate for stronger carbon removal standards.

Source projects outside existing carbon market infrastructure.

Call to action and industry wide collaboration.

Charm Industrial

Method - Geo sequestration of bio-oil
Certification- Under development
Volume- 2 000 tCO_2
Durability- 10 000 years

Climeworks

Method- Direct Air Capture and Storage (storage via Carbfix method)
Certification -ISO 14064-2
Volume- 1 400 tCO_2
Durability- 10 000 years

Carbon Cycle

Method- Biochar
Certification- via Puro.earth
Volume- 1 000 tCO_2
Durability- 800 years

Carbofex

Method- Biochar
Certification- via Puro.earth
Volume- 500 tCO_2
Durability- 1 000 years

$ECHO_2$

Method- Biochar
Certification- Puro.earth
Volume- 400 tCO_2
Durability- 1 000 years

Conclusion

Corporate strategies on how to approach, ingrain and implement CDR into their climate plans and company culture differ significantly from one another. This in itself is a positive development. Fixing the damage to our climate is a complex and multifaceted problem that will require different stakeholders willing to engage at varying levels of granularity.
During the past three years, we have witnessed a notable shift in organisations' attitudes towards the climate crises and their approach towards it. The most progressive organisations have gone from passive buyers of carbon avoidance offsets to active shareholders in a larger ecosystem.

Innovative and forward-looking companies like Microsoft, Stripe, Swiss Re and Shopify understand the duality of their role in the broader CDR ecosystem. Moving from pledges to action, they showed that being passive buyers of low carbon credits or simply just buying up all the high-quality removal credits will do more harm than good over the long run. This shows the way to other corporate actors that want to play a more ambitious role than reaching their own net zero targets at a lowest cost and effort.

They can do so by:

- Supporting and scaling the permanent carbon removal and storage ecosystem;
- Becoming active players in developing the ecosystem around carbon removals technologies and solutions, rather than passive buyers, as well as prioritising R&D and novel pathways over the amount of CO_2 removed;
- Looking beyond volume and cost by helping start-ups to lower their costs as they learn by doing and scale-up;
- Including renewal clauses into contracts with the start-ups, to show long-term commitment and with a clear intention to support their long-term development;
- Acting in a transparent manner by publishing all results, methodologies, and purchase prices.

www.negative-emissions.org

supported by Breakthrough Energy and the
Carbon Drawdown Initiative