



Climate Solutions

Mobilising finance
to give nature a market value
and transform
our energy system.

October 2021

FÜRSTLICH CASTELL'SCHE BANK

In cooperation with



Published ahead of
COP26 in Glasgow:



UN CLIMATE
CHANGE
CONFERENCE
UK 2021

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presentation

start



Foreword

As we approach 2022 it seems that more and more people are beginning to “wake up” to the reality of climate change and destruction of nature, and are taking responsibility for turning this ship around. The 2015 Paris Agreement set out a global framework for action on climate change for the first time. Six years later, and the largest ever survey on climate change published by the UN found that 64% of people across the world believe that we are now in a “climate emergency”.

This global shift in priorities is also impacting the finance industry. After decades of financial markets failing to take climate change and biodiversity into account, a growing number of investors are proclaiming that “sustainable is the new profitable”, moving environmental considerations from a “nice-to-have extra” to a core consideration.

It’s about time, too. Climate change is not a new phenomena. Syukuro Manabe and Klaus Hasselmann recently received a Nobel Prize for modelling human-induced climate change over half a century ago. As the COP26 in Glasgow commences, the stakes have never been higher. In order to achieve the Paris Agreement goal of net-zero by the end of the century many things will need to change – from how we produce energy, to the way we do business and travel.

The pandemic has shown us that our societies are capable of incredible shifts when faced with a crisis. The next decades will be about mobilising markets to facilitate this transition, “giving nature a value” in today’s marketplace and driving innovation through funding ESG (environmental, social, governmental) and climate tech initiatives.

We have compiled this report as a guide on how to create value and make an impact, with, and through, investments. We sought input and feedback from experts in ESG and impact investing and cooperated with Extantia for its execution.

It’s an uncomfortable truth that the financial sector has, for a long time, underestimated the relevance and impact of climate change and the destruction of nature. We now have a chance to change this story. With its immense power and impact – and the fiduciary duty of their intermediaries – finance can be a powerful tool in making change happen. We hope this presentation will show you how this might be achieved.

Christian Hille, CIO Fürstlich Castell'sche Bank

In cooperation with:



Extantia is a pioneering climate-tech platform uniting investors, scientists, and founders to identify and scale the companies that can get us to net zero.



The Challenge

How global warming and nature depletion are impacting life on our planet

[to chapter](#)

Global Initiatives & Perspectives

Goals and frameworks for collective action

[to chapter](#)

Market Solutions

Carbon markets, climate tech and strategies for investment

[to chapter](#)

Learn more

Authors, references & further information

[to appendix](#)



The Challenge

How global warming and nature depletion are impacting life on our planet

”

How is climate change affecting us today, and why is it important to act now?

Did you know ...?

[learn more](#)



Did you know ...?

A short trip from Germany to Mallorca may seem harmless but comes at hidden costs.

65,000 hectares

of fully grown forest are needed to offset all CO₂ emissions of all flights on this route.¹

This is about 2.7x the Bavarian Forest National Park.

Given our current pathway and behaviour, it is expected that by 2050 global warming will reach

+3.0°C

Compared to pre-industrial levels. By the same measurement, the world has already warmed by an approx. 1.1 °C (Germany: 1.6 °C).²

Protecting the environment is a critical task for humanity.

1.5bn people

depend on forests for their livelihoods.³

1) ICAO Carbon Emissions Calculator (2021); own calculations
2) IPCC (2021); Deutscher Wetterdienst (2020)
3) SYSTEMIQ (2019)

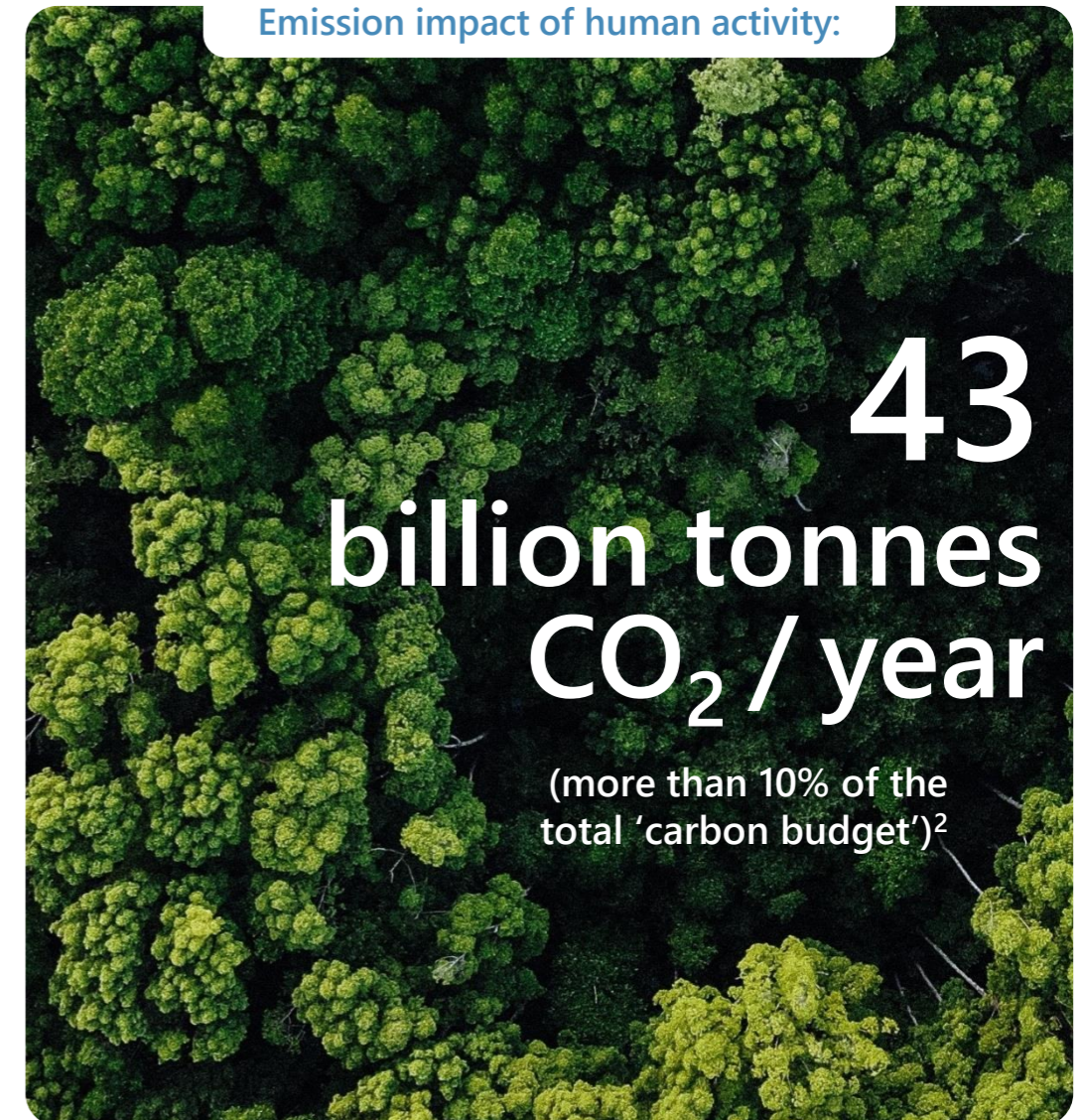
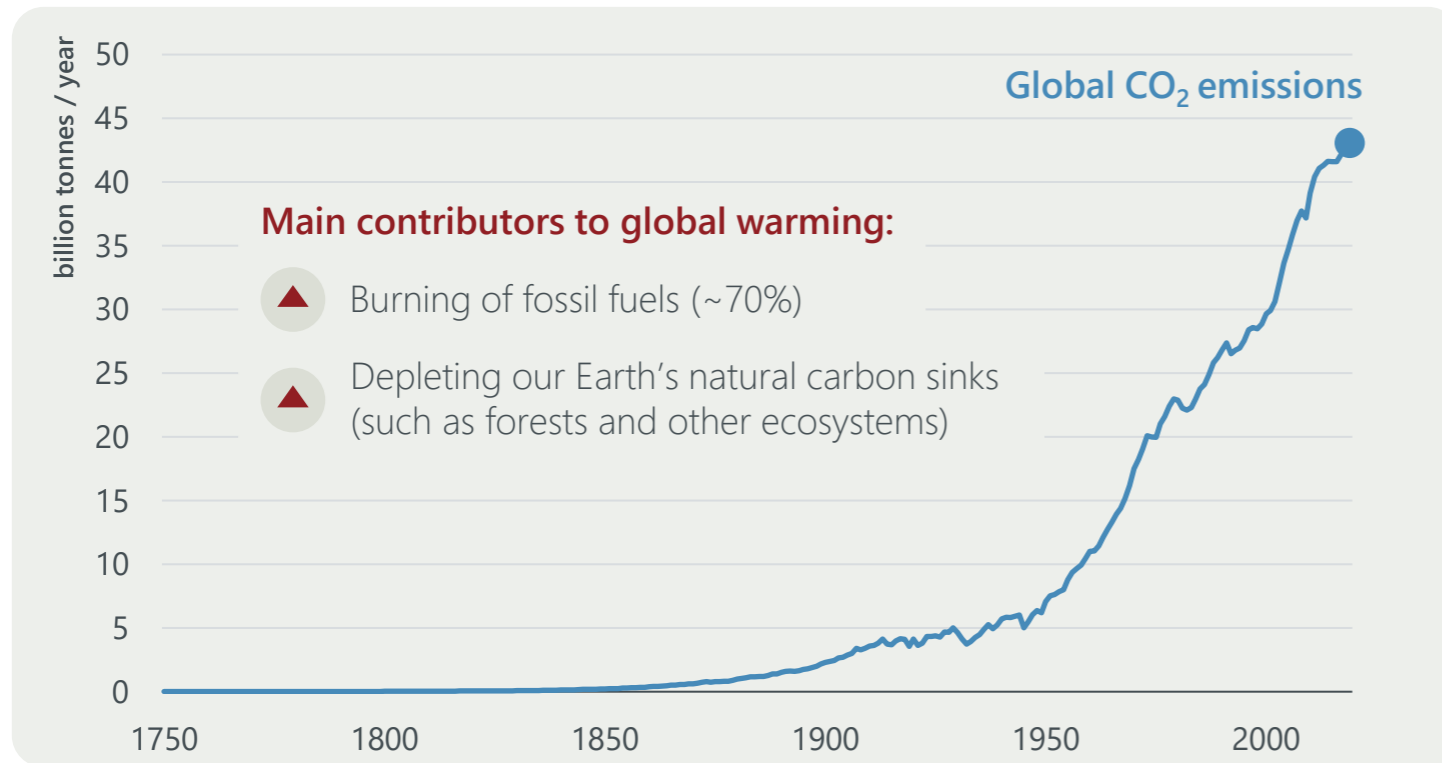


We are leaving a dangerous footprint ...

The Earth is 4.6 billion years old. Let's scale that to 46 years.

- + Human life has been here for **4 hours**.
- + Our industrial revolution began **1 minute ago**.

In this time we have depleted more than 33% of the world's forests and put around ~25% of the world's mammals at risk of extinction.¹



1) Ritchie, H. (2021); Ritchie, H. & Moser, M. (2021)
2) Based on maintaining a 50% chance of limiting global warming to 1.5°C



A budgeting approach to carbon emissions

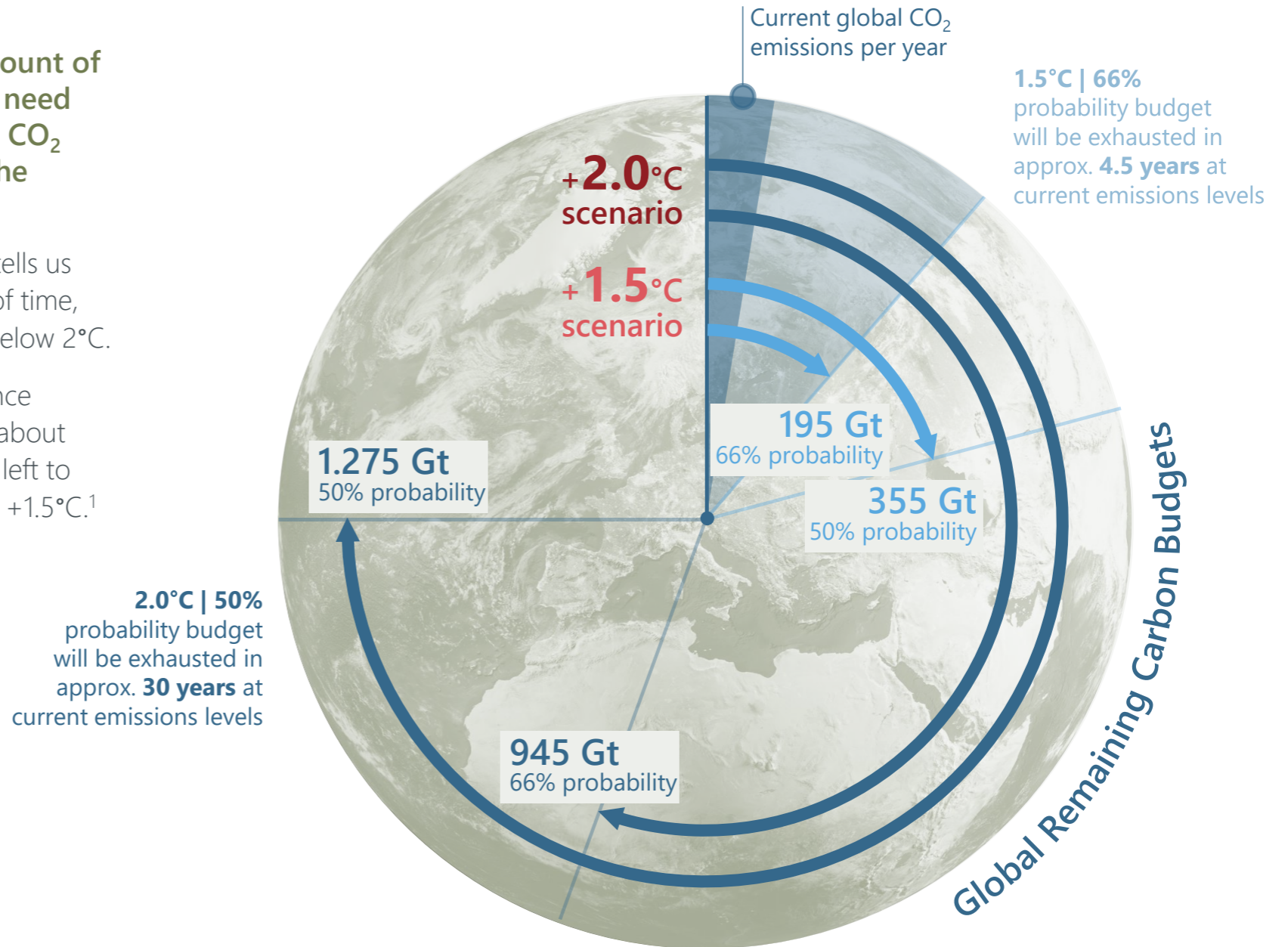
To stabilise global temperatures, only a limited amount of emissions can be released before global emissions need to reach net zero. A “carbon budget” regulates the CO₂ input to the atmosphere with output (storage) in the carbon reservoirs on land or in the ocean.

The remaining carbon budget, just like a financial budget, tells us how much CO₂ we have left to ‘spend’ in a given amount of time, in order to keep global temperature rise this century well below 2°C.

In 2021, we’ve already used up our budget for a 100% chance of limiting warming to 1.5°C. At current emissions levels of about 43 billion tonnes of CO₂ per year, we only have ~4.5 years left to have even a 66% chance of keeping climate change below +1.5°C.¹

The window is quickly shrinking.

High importance of **rapid and decisive action** regarding climate change mitigation.

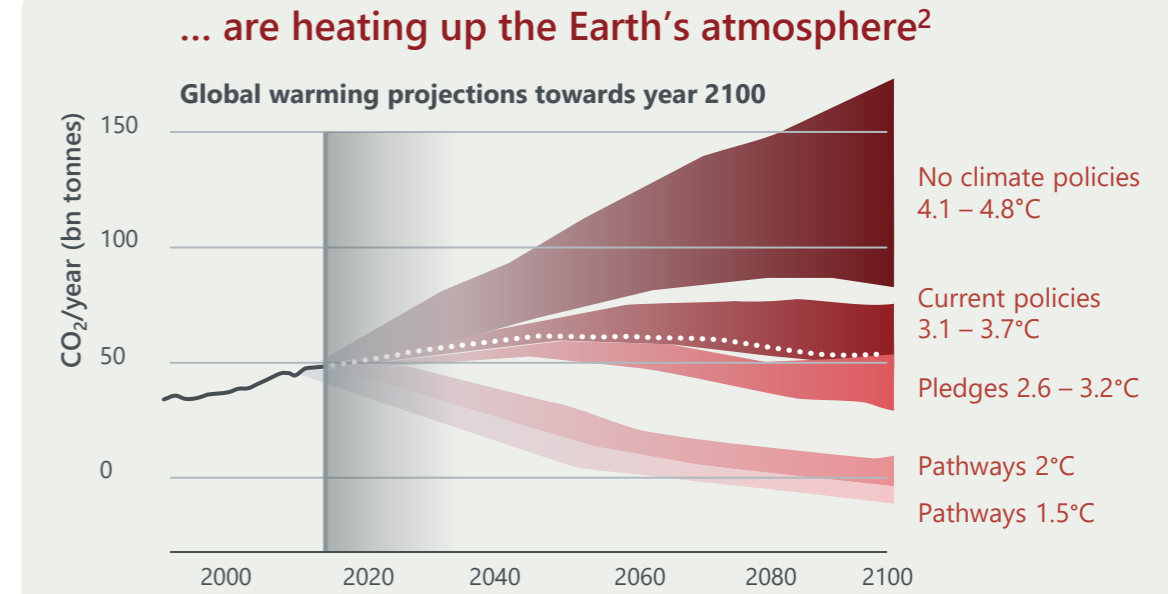
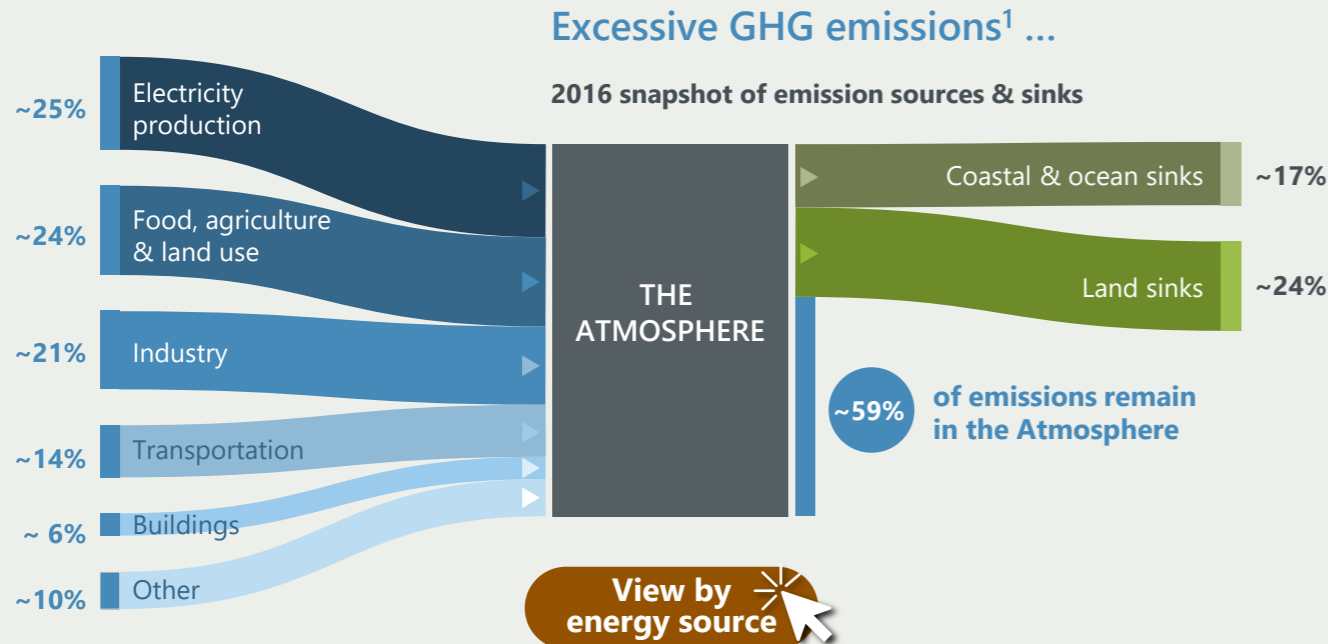


1) McSweeney, R. & Pearce, R. (2017)



What is causing the problem?

Human activity is changing the temperature on our planet by releasing high quantities of Greenhouse Gases (GHGs), such as carbon dioxide, into the atmosphere. At the same time, the parts of nature that use carbon and remove it from the atmosphere, such as forests and soil, are being degraded or destroyed. This inflicts severe damage to our environment in various ways.



The effects of global warming



Physical impacts

Extreme weather events, chronic sea level rises and heat



Food & water scarcity

Loss of soil fertility, freshwater and crop yield farming



Health issues

Increased risk of diseases and pandemics due to animal migration



Biodiversity loss

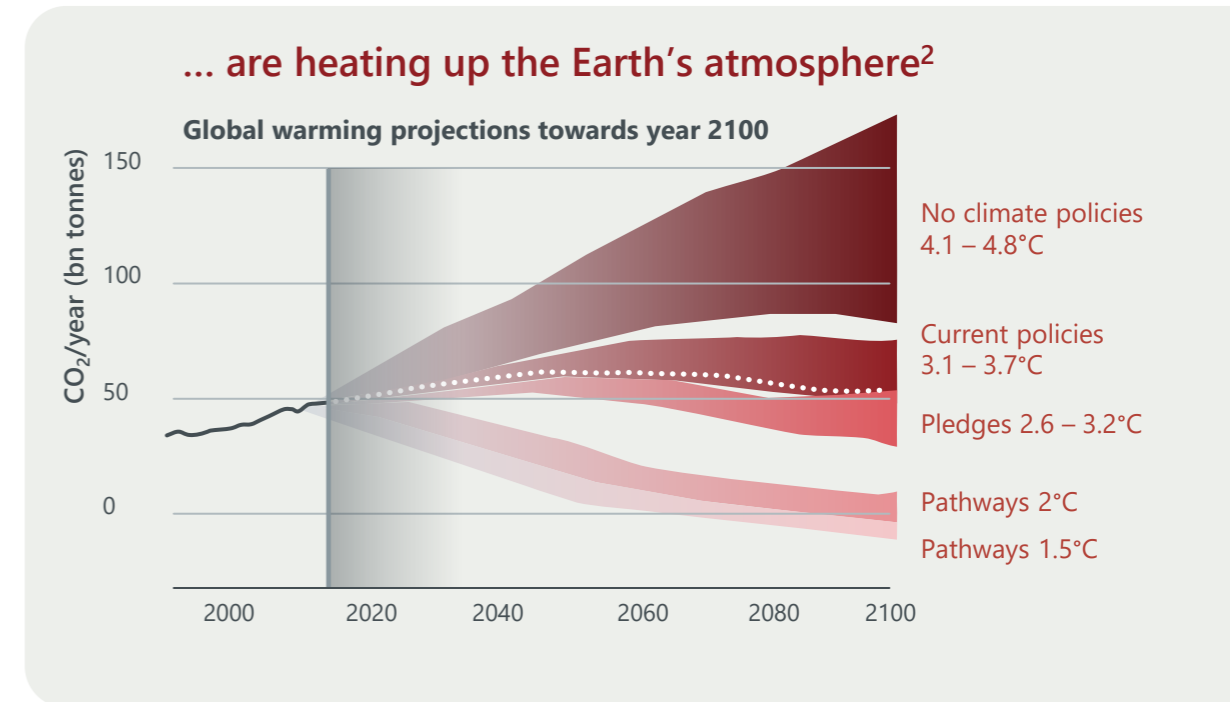
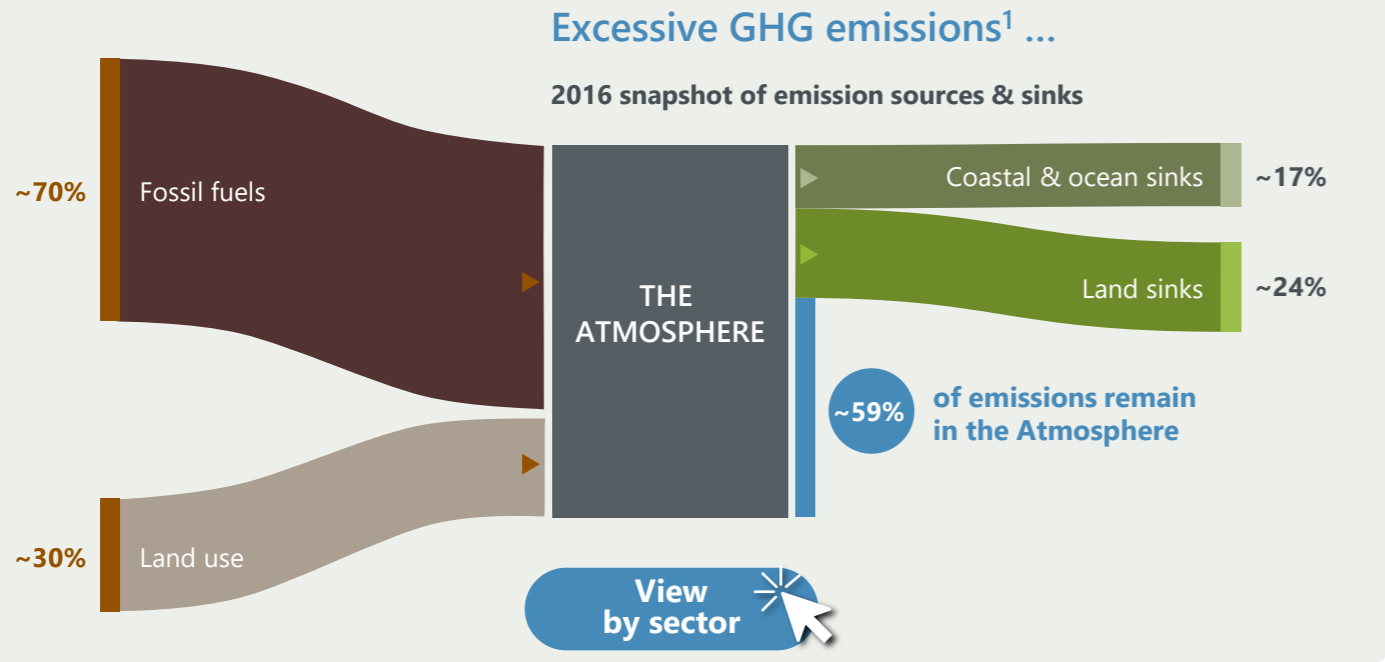
Species loss at 100 – 10,000 times the background extinction rate

1) Project Drawdown (2020)
2) Climate Action Tracker (2017)



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Tipping points and the need to act

Climate change is now considered one of the greatest threats to economic stability. There are estimates that extreme weather as a result of climate change **could cost the world \$2 billion per day by 2030**. The impact of GHG emissions combined with the destruction of ecosystems could eventually lead to a “tipping point” being reached. This is a point of no return where the combined effects of global warming result in a runaway series of unpredictable and irreversible events, with major implications for life and well-being on Earth.



The loss of just 25% of the Amazon trigger an irreversible transition towards a drier, savanna-like ecosystem. On average, 17% of the Amazon has already been lost. At the current rate, the “tipping point” could be reached in 2039.¹

This would have a severe impact on humanity. **The forest stores up to 120 billion metric tons of carbon, equivalent to almost 12 years of global emissions at current rates.** If cleared, much of that will go into the atmosphere.

Deforestation is also strongly interconnected with the melting of the Greenland ice sheet, which would cause sea levels to rise, and the degradation of frozen soil in the Arctic known as the permafrost, which would release greenhouse gases held in the ice as well as long-dormant diseases.



Coral bleaching occurs cyclically and is caused by exposure to hot water temperatures that turn the corals white and eventually kill them. There are estimates that since 1985, the world has lost over 50% of its coral cover. Of the five major global coral bleaching events since 1998, three occurred in the last five years (2016, 2017 and 2020).²

Bleaching events are happening too frequently, and the reefs are not able to recover from this mass mortality, transforming them to macroalgae. **At the moment, oceans are absorbing 30% of CO₂ emissions and almost all of the excess heat in the atmosphere.**

Coral reefs protect coastlines from storms and erosion, provide jobs for local communities and are a source of food and new medicines.

1) The Nature Conservancy (2019)
2) IPCC (2019)



Global Initiatives & Perspectives

Goals and frameworks
for collective action

*Did
you
know
...?*

[learn more](#)

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*What action is currently being
taken, and why is the 1.5°C
goal so important?*



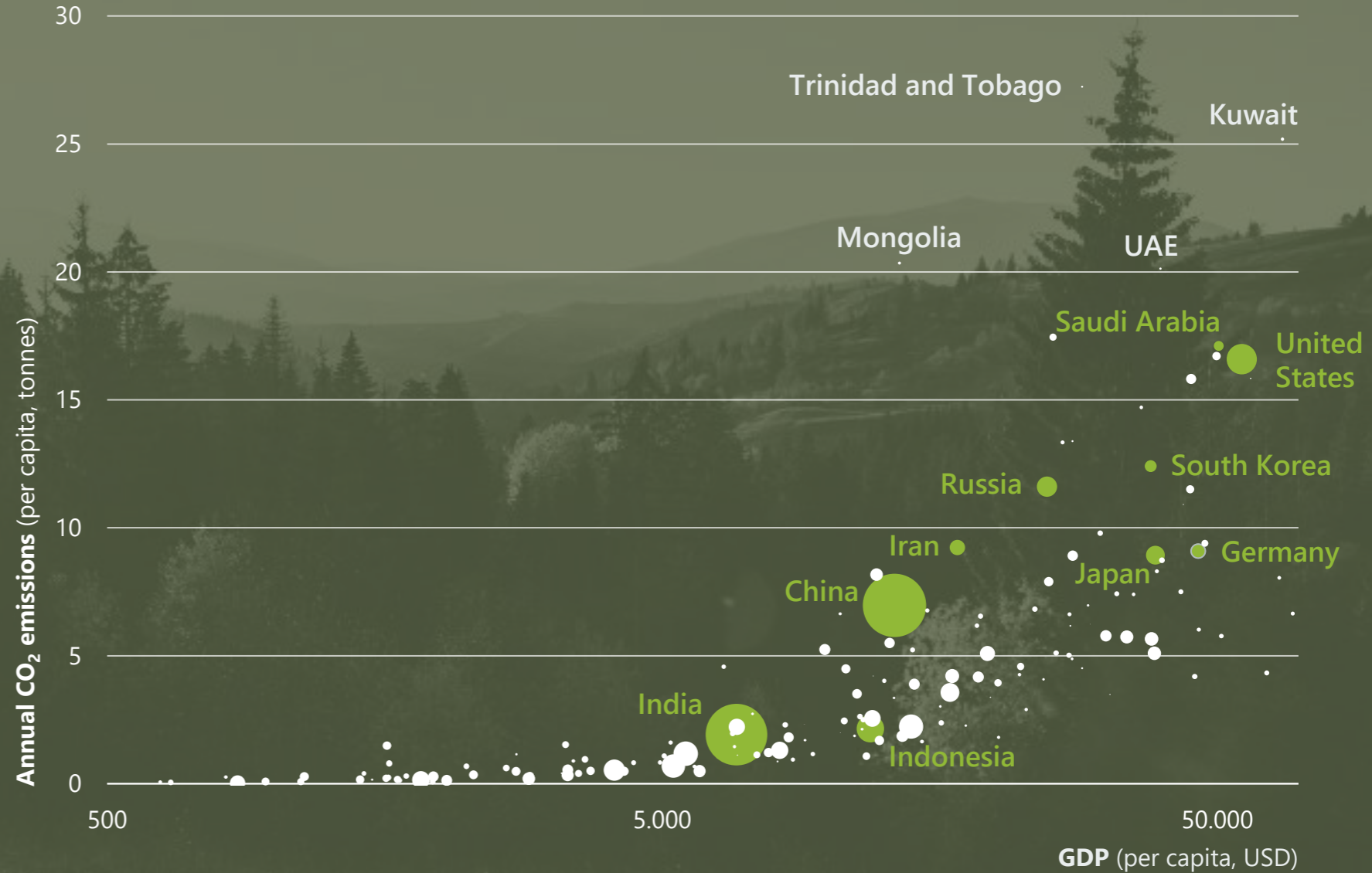
Did you know ...?

Two thirds (67%) of global GHG emissions are produced by just

10 countries¹

China	28%	Top-3 countries = 50%
United States	15%	
India	7%	
Russia	5%	Top-10 countries = 67%
Japan	3%	
Germany	2%	
Iran	2%	
South Korea	2%	
Saudi Arabia	2%	
Indonesia	2%	

A relative approach gives a different perspective²
Per-capita annual CO₂ emissions and GDP by country



1) Concerned Scientists (2020)
2) Our World in Data (2018)



An overview of global initiatives: The Paris Agreement

As countries begin to recover from the Coronavirus pandemic, there is an opportunity to promote policies that are more aligned with the goals of the 2015 Paris Agreement and UN Sustainable Development Goals (SDGs). A current focus of international climate action is on mobilising finance, including how to unleash the trillions in private and public sector finance required to secure a pathway to global net zero emissions.

The Paris Agreement

Conferences of the Parties (COP) have been held every year since 1995. In 2015 at the Paris COP21 conference world leaders reached the first ever global agreement on large-scale action against climate change, known as the Paris Agreement. The goals of the Paris Agreement are to:

- + Limit global warming to a **maximum of 2°C** by the end of the century, and **preferably 1.5°C**
- + Reach **net-zero emissions by 2050**



2020 UN BIODIVERSITY CONFERENCE
COP 15 - CP/MOP10-NP/MOP4
Ecological Civilization-Building a Shared Future for All Life on Earth
KUNMING-CHINA

In 2010, parties adopted the Strategic Plan for Biodiversity, a ten-year framework including the 20 "Aichi Biodiversity Targets". None of these targets were fully met by the deadline, and worldwide biodiversity continues to decline.

Coming next



Glasgow, UK
31 Oct – 12 Nov 2021

Other initiatives

Promoting transparency



Measurement/ranking of carbon removal solutions



Taskforces for setting environmental risk & financial disclosure standards



Framework for tackling climate change and global social issues (169 targets to reach by 2030)

Action plans



2030 roadmap and capital investment mobilisation for businesses



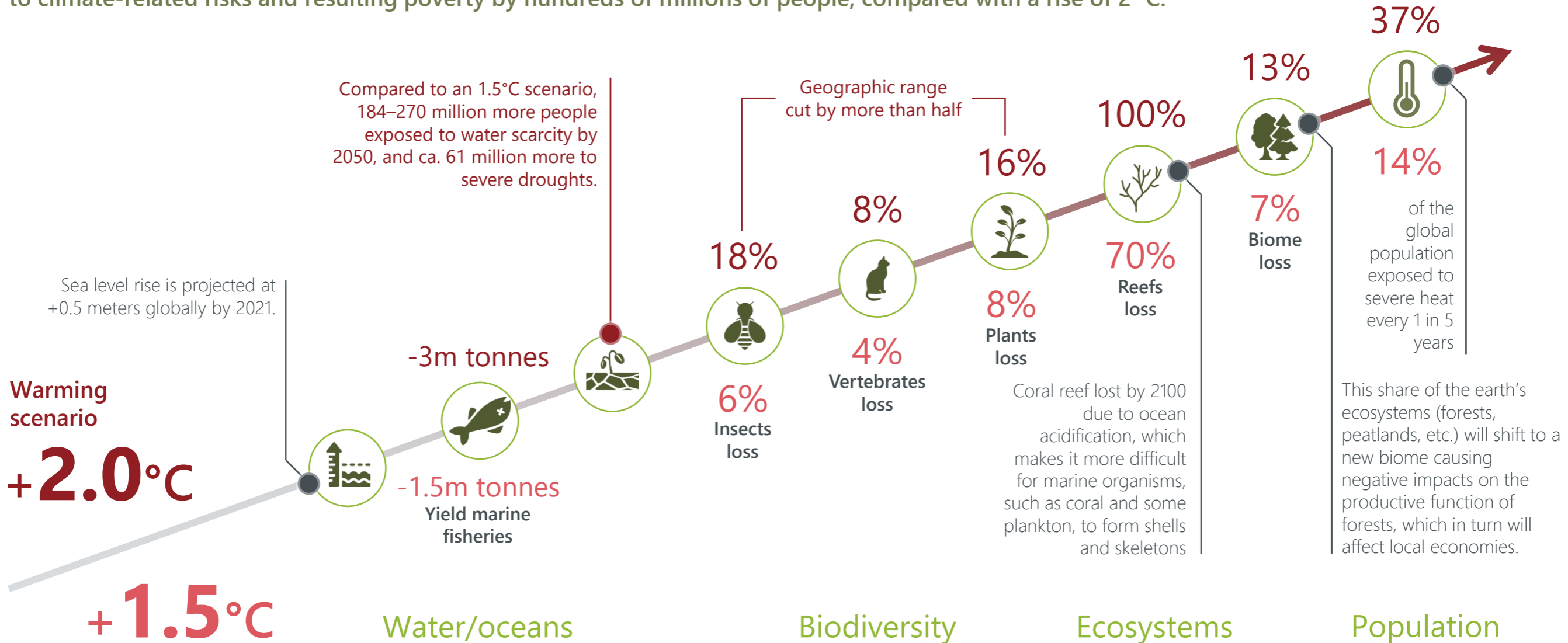
Net-zero pathways with over 1,200 committed companies as of today

Goal-setting



Why the Paris targets matter

Limiting warming to 1.5 °C could reduce the number of people worldwide who are exposed to climate-related risks and resulting poverty by hundreds of millions of people, compared with a rise of 2 °C.¹



1) Climate Council (2021)



Market Solutions

Carbon markets, climate tech and strategies for investment

”

How can existing market systems be used to mitigate climate change?

Did you know ...?

[learn more](#)



Did you know ...?

Meeting the Paris Agreement goals is expected to require

\$4.2 trn

in direct investments every year.¹

In the last five years, the global finance industry has extended

\$200 bn

of financing to agribusinesses linked to deforestation.²

An additional

\$600-825 bn

will need to be invested into conservation annually in order to close the biodiversity funding gap.³

We need to give nature a value: The Dasgupta Review:

Nature's value must be at the heart of economics

We can no longer afford for it to be absent from accounting systems that dictate national finances, or ignored by economic decision makers.

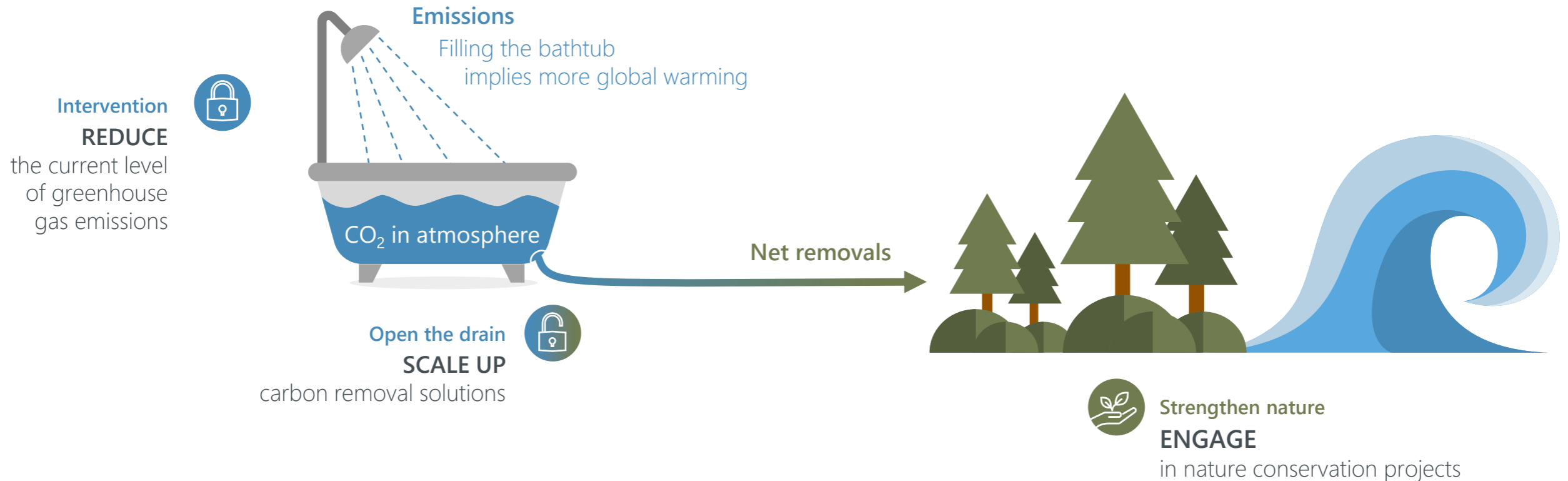
- 1) Climate Policy Initiative (2021)
- 2) Hodgson, C. & Morris, S. (2021)
- 3) Paulson Institute (2020)



How can the climate challenge be dealt with?

A visual analogy

Imagine the Earth's atmosphere as a bathtub overflowing as the water continues to run. The primary intervention is clear: Turn off the tap of greenhouse gases by bringing emissions to zero. In addition to curbing the source of the problem, we can also open the drain. That's where nature plays a vital role: absorbing and storing carbon through biological and chemical processes, effectively draining some of the excess out of the atmosphere.





Climate solutions toolbox

When it comes to the goals of the Paris Climate Agreement and the necessity of decarbonisation on a global scale by the middle of the century, industrialised countries such as Germany are particularly challenged. A diverse set of tools are needed to help us in mitigating climate change and empowering nature again:

ESG Investing has consolidated as an effective way to create **sustainable growth** and have a long-term impact on society and the environment. It allows the investors to identify material risks and obtain positive returns.

Investment Strategies **D**

Climate Technology **C**

There are a broad range of technologies being developed with the objective of helping to decarbonise different sectors of our economy in order to meet the Paris Agreement objectives. Including **Clean Energy Systems, Materials and Circular Economy.**



A Compliance Carbon Markets

These are **mandatory schemes** that enforce specific sectors of the economy to comply with a regulatory act to reduce their emissions.

B Voluntary Carbon Markets

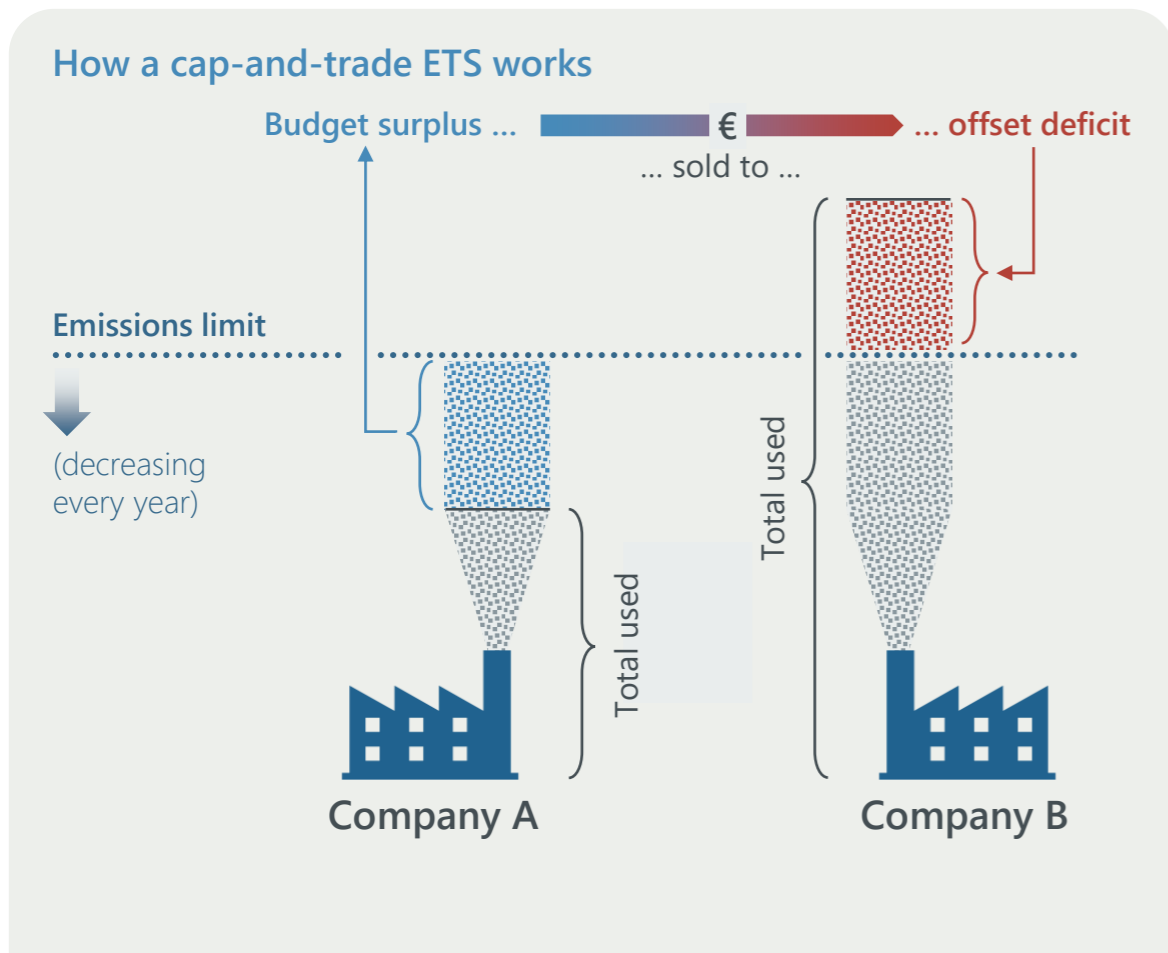
Aims to tackle climate change by driving resources to projects¹ that leverage the power of nature to deliver **independently verified** and additional **emissions reductions** on a global scale. Including **regenerative land use and Oceans.**

1) Voluntary Carbon Markets give nature a monetary value, which is closely linked with the key recommendations of the Dasgupta Review



A Compliance Carbon Markets

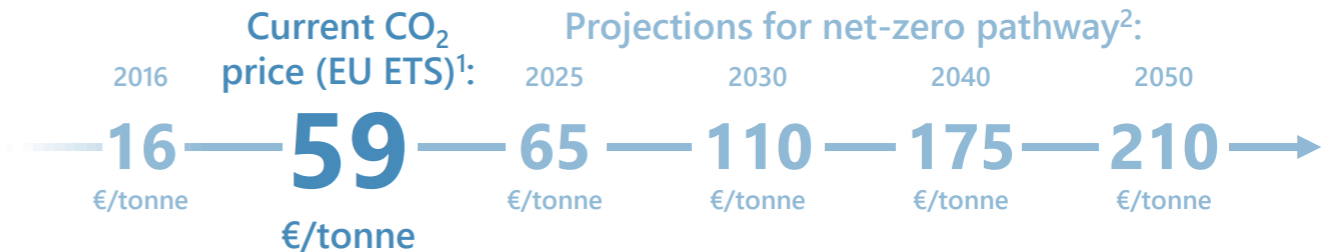
In economic terms, carbon emissions represent a market failure because the market incentives do not take into account the negative externalities associated with climate change. To mitigate this issue, we need to put a price on carbon emissions that reflects the costs of climate change imposed on the planet and the people who live on it. In practice this is achieved either through a carbon tax or through compliance carbon markets (Emissions Trading Schemes, ETS) based on so-called 'cap-and-trade mechanisms'.



As with most markets, price and supply are inversely related, meaning that **carbon prices will increase** as the carbon emissions limit (the "cap") continues to be lowered each year.

Through the cap-and-trade mechanism, emissions budgets are shaped into a scarce resource, providing **economic incentives for polluters** to reduce their environmental liabilities.

The two largest compliance markets in the World are the **European Union Emission Trading Scheme (EU ETS)** and the more recently launched **China's National ETS**, which will manage 30% of the country's emissions.

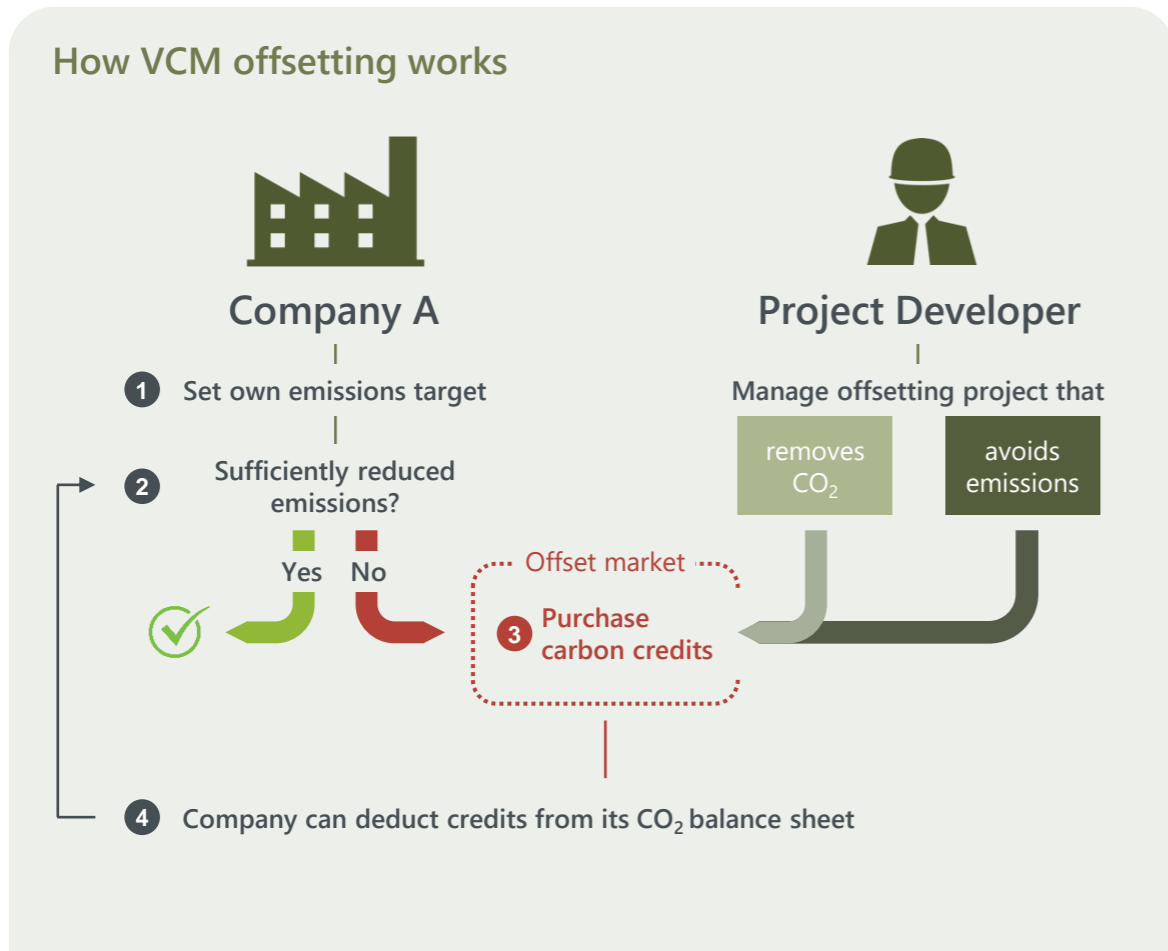


1) Trading Economics (2021) 2) Bloomberg Ltd. (2021); expert estimates



B Voluntary Carbon Markets

Voluntary carbon markets (VCMs) can play a critical role in scaling and accelerating climate action. Corporations enter these voluntary markets to achieve self-determined emissions goals. They channel significant private sector finance into projects with high potential to restore or protect the natural capital of the planet (and therefore act as carbon sinks), with the final objective of reducing or avoiding greenhouse gas emissions. Apart from net emissions reductions, VCM projects can carry beneficial side-effects such as biodiversity protection, localised economic support or improved air quality and health.



Types of VCM projects:

Removal / sequestration	Avoidance / reduction
<ul style="list-style-type: none"> + Reforestation is the process of planting trees in a forest where the number of trees has decreased. + Afforestation is when trees are planted to create a new forest. This practice remains controversial as it inevitably leads to the destruction of a previous non-forest ecosystem. + Improved Forest management¹ (IFM) + Technology-based removal of CO₂ from the atmosphere and storage in the geosphere or in a secure and controlled place. Examples are BECCS or DACCS. 	<ul style="list-style-type: none"> + Avoided conversion, i.e. limiting the loss of nature and the emissions associated with this process, e.g. REDD+ projects (see case study on next page). + Technology-based reduction of emissions from existing sources which do not have financial incentives or regulatory requirements to decarbonize.

1) Offset credits are issued for actual carbon stocks relative to a baseline plus accrued growth. The baseline reflects the most intensive timber management possible on the property and regional stocking averages.



B Voluntary Carbon Markets

Case Study

The Katingan Mentaya Project is a REDD+ (reducing emissions from deforestation and land degradation) project that protects and restores a vast area of peatland ecosystems in Indonesia, **offering local communities sustainable sources of income while mitigating global climate change.**

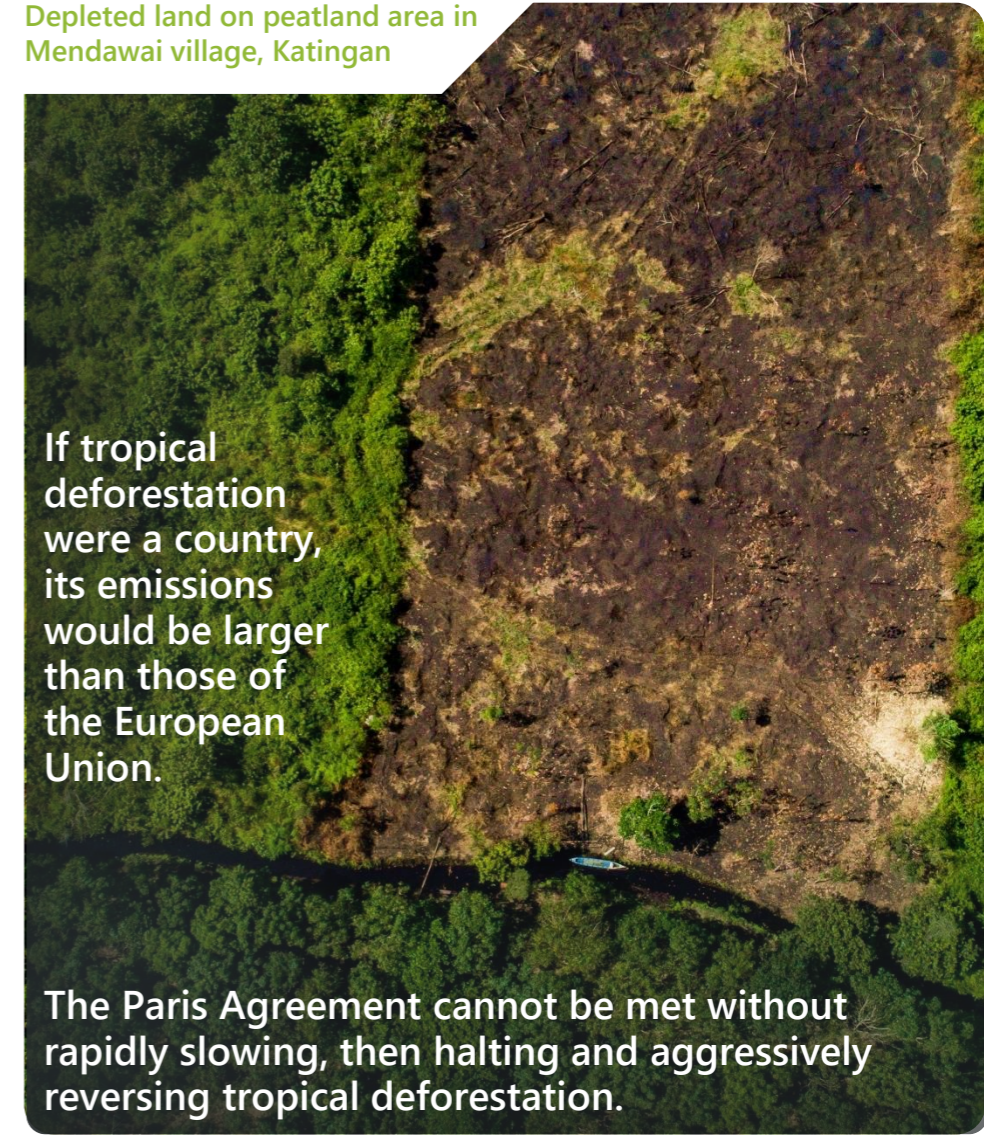
The area was under threat of conversion to an industrial acacia plantation. In the absence of the protection & restoration project, the zone would have been cleared of forest and the peat drained, gradually releasing the vast carbon stocks into the atmosphere.

It is the **largest REDD+ project in the world.** The carbon credits that it generates are certified by **VERRA** and are equivalent to taking 2,000,000 cars off the road each year. Among its credit buyers there are companies such as Volkswagen, Bank of America or Bentley.

Key characteristics

<p>Emissions avoided (annually) 7.5 Million tonnes of CO₂</p> <p>Area Covered 149,800 hectares</p>	<p>Geography Indonesia (Borneo)</p> <p>Link to SDGs</p>   	<p>Co-benefits</p> <ol style="list-style-type: none"> Over 500 local women and men employed Protecting 44 endangered animal species (5 of them critically) Reducing contamination of river water by replacing river latrines with land latrines
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Depleted land on peatland area in Mendawai village, Katingan



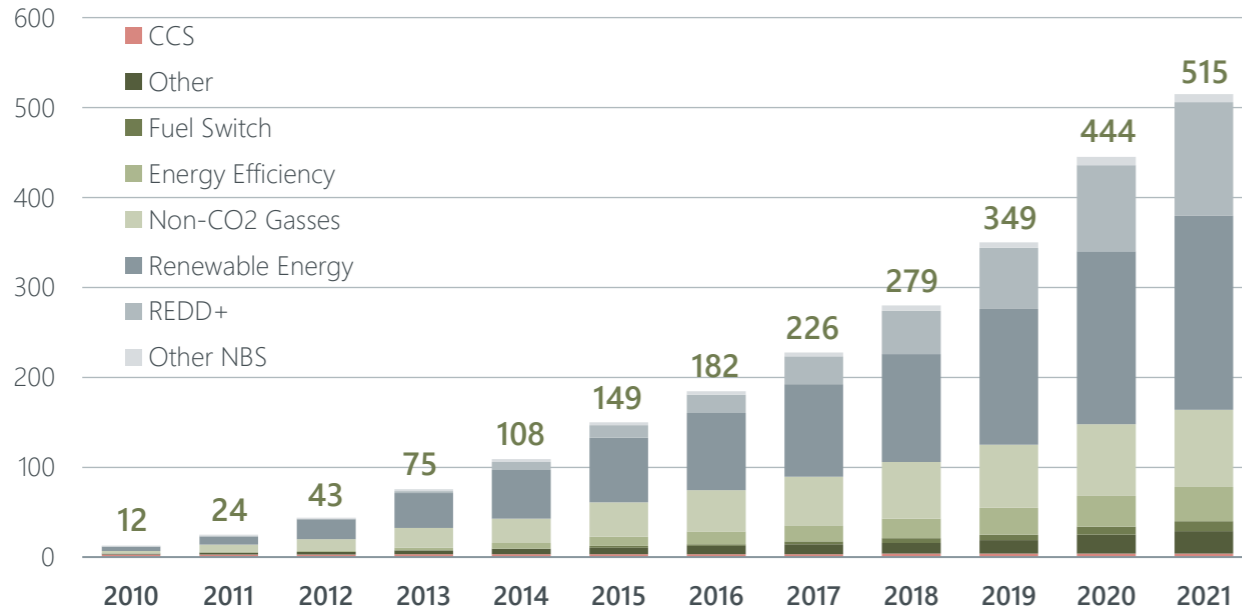
If tropical deforestation were a country, its emissions would be larger than those of the European Union.

The Paris Agreement cannot be met without rapidly slowing, then halting and aggressively reversing tropical deforestation.



B Voluntary Carbon Markets

Cumulative purchased VCM credits by project type¹ (in Mio.)



Current state of the market

- + Current price is insufficient to drive climate action
- + Demand is expected to increase 5x or even 10x over the next decade as companies seek to deliver on their net zero emissions pledges.
- + Projected price by 2030: € 50 per tonne CO₂, which would help to scale up nature-based solutions and incentivise emissions reduction.

Current CO₂ price³ **10-15** €/tonne

2030 forecast³ **50** €/tonne

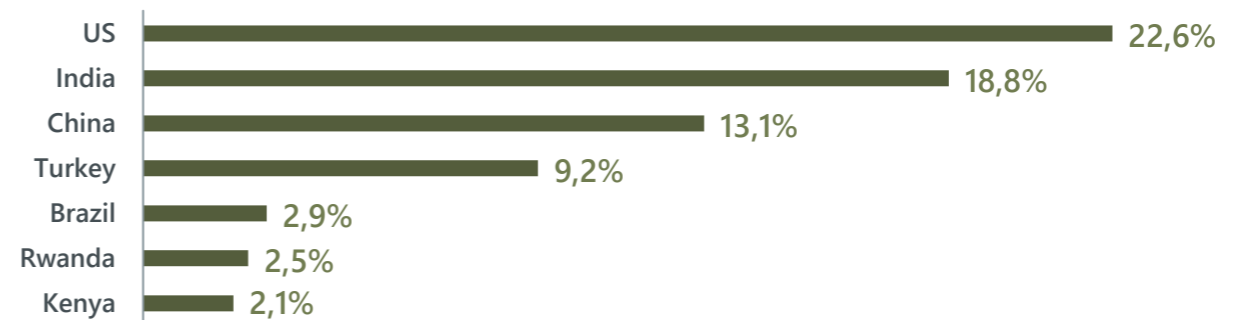
Location, location, location

Since most of global rainforest areas are in developing and emerging countries, they are well suited for nature-based VCM projects.

However, voluntary offset investments today are not distributed equally across the globe. Climate finance is often deployed to more established and well-known markets such as the United States.

The two countries with the highest potential for low-cost nature climate solutions are Brazil and Indonesia (each of them having a 15% share of global potential). Yet Brazil only accounts for the 2.9% of global voluntary offset projects and Indonesia does not even appear in the top-10.

Most popular locations for voluntary offset projects²



Established standards for VCM projects

Gold Standard



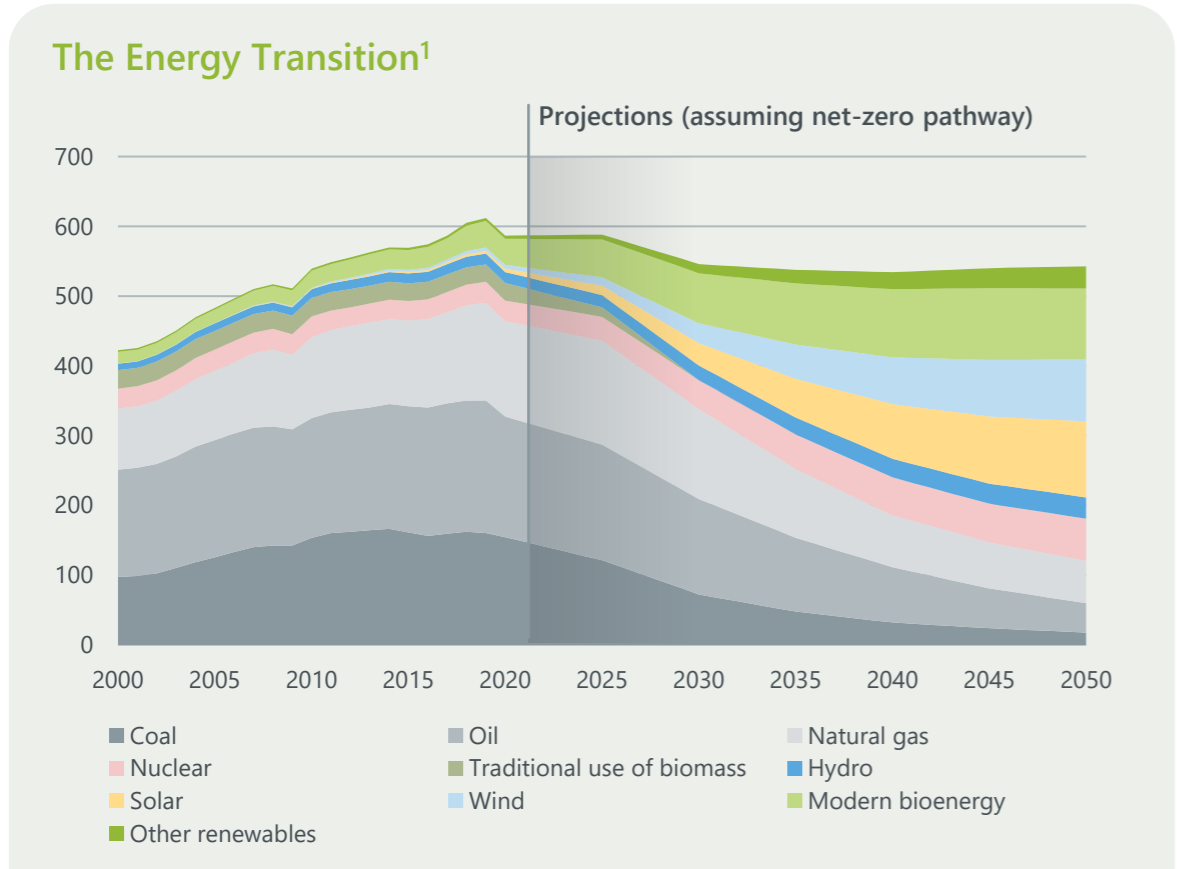
1) Trove Intelligence (2021)
 2) Gross, A. (2020)
 3) Expert estimates



C Climate technology

Climate tech is an umbrella term for solutions to reduce greenhouse gas emissions by utilising technology across energy, transport, the built environment, industrial processes, food and land use, as well as active removal of CO₂ from the atmosphere.

According to Project Drawdown, reforestation, scaling renewable energy, improving the energy efficiency of existing sectors and changes in behaviour, such as switching to plant-rich diets, are the highest impact solutions we have today. The most well-known technological solutions like carbon capture and storage do not yet exist at a level that is scalable without significant investment, however technological solutions will likely arrive in many different forms (see next slide).



1) IEA (2021)

Innovative nature-based technology solutions



Carbon Capture and Storage (CCS)

Decarbonisation filter for industrial emissions. Currently 42 large scale CCS plants are in operation or under development, but achieving the Paris goals may require >1000 facilities by 2050.



Bioenergy with Carbon Capture and Storage (BECCS)

Plants absorb CO₂ and convert it into biomass. This has the potential to remove 5 Gt CO₂ per year.



Green hydrogen

Electrolyser-produced fuel is used to decarbonise high-polluting sectors such as steel, cement or passenger transport. >300bn \$ of investments are expected until 2030.



Vertical farming

70–95% less water and >90% less land intensive harvesting with up to 80% higher yields. It could help reduce agriculture emissions and enhance global food security.



Extantia deep-dive: Super hot rock energy



Net-zero by 2050 means that we must transform the entire energy system, while at the same time doubling its capacity to provide electricity and heat to power green tech.

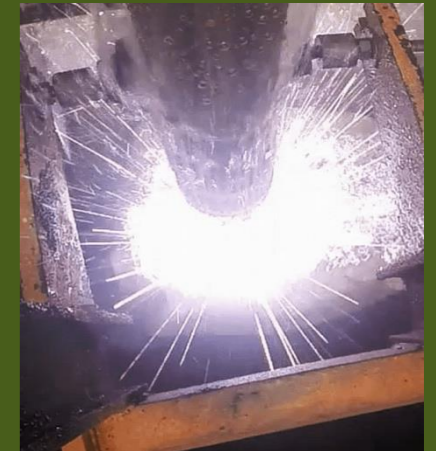
Super Hot Rock Energy

Very few technologies can completely replace fossil fuels, and even fewer again could be commercialised in the next 10 years. Super hot rock energy meets both criteria. It's a form of geothermal energy production that generates electricity using heat from deep in the Earth's crust. Super hot rock systems inject water into a well, deeper than 10km where the intense pressure and heat transforms the water into a state that holds immense amounts of energy. This superhot water then gets returned to the surface where it's used to power turbines that generate electricity.

Super hot rocks are some of the hardest, hottest substances on the planet. Drilling into them with existing equipment is difficult and very slow. With sufficient funding however, energy from this technology could provide always-on, zero-carbon power anywhere in the world. In addition, the immense heat of the process means it could also support zero-carbon hydrogen fuel production.

Next steps

- ✓ Drill bits that can cut through hard rock and resist extreme temperatures
- ✓ Heat resistant well materials
- ✓ Design deep heat reservoirs



Tech: Plasma Drill Bit

GA Drilling's innovative drill, PlasmaBit, doesn't break or wear down, like a standard drill, when exposed to extreme temperatures or crystalline rock. This is because PlasmaBit

uses a stream of pulsed plasma, similar in composition to lightning, to mill away hard rock.

GA Drilling has tested the technology in lab simulations that approximate the heat and pressure found in the deep crust. They are now preparing to drill a 5 km well to prove their technology in real-world conditions.

Extantia invested with GA Drilling in 2021 and believe that this is one of the key technologies that can commercialise rapidly and help enable a revolution in energy production.



D ESG Investing

Historically there has been an investment trade-off between profitability and sustainability. Today, ESG (environmental, social, governance) criteria are an integral part of the investment process. They aim to provide growth opportunities, lead to cheaper capital raising, mitigate climate risk and lead to positive social or decision-making outcomes.

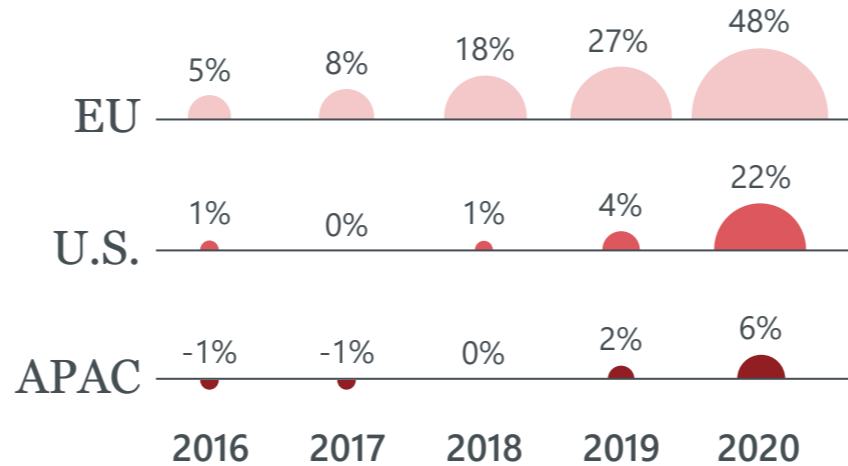
ESG considerations increasingly affect the ability of companies to operate and generate profits due to pressure from regulators and consumers alike. This represents opportunities for investors to capture the innovative trend, build more resilient portfolios and contribute to a more sustainable future.

What measures do ESG investors use?

E nvironmental				
	Carbon emissions	Water stress	Biodiversity exposure	...
	S ocial			
Data privacy		Controversial sourcing	Community relations	...
G overnance				
	Business ethics	Employee treatment	Transparency	...

ESG is changing the nature of investment flows¹

Share of Total Net Flows into Sustainable Strategies



How does ESG achieve impact?

The EU Action Plan on Financing Sustainable Growth serves as a unifying framework for sustainable investing in Europe. It aims to:

- 1 Reorient capital flows towards sustainable investment
- 2 Manage financial risks from climate change and other ESG issues
- 3 Foster transparency and long-termism

1) Visual Capitalist / J.P.Morgan Asset Management (2021)



D ESG Investing: Challenges

Companies should avoid **exclusively focusing on improving ESG ratings**. Doing this puts them at risk of allocating more resources to “checking boxes” than developing a strategy that is tailored to the company’s unique outlook and exposure to risk.

Focusing only on ratings

As a result of a lack of a companywide strategy some companies may end up adopting **different standards without clear reasoning** for the discrepancies in business practices.

Inconsistencies across the firm

Companies should not make the mistake of **attempting to improve their image** by focusing only on their communications and public relations strategy.

Treating ESG solely as a communications effort

Lack of effective monitoring of ESG performance impedes the company’s ability to make progress or receive full credit for its ongoing initiatives through proper reporting.

Lack of assessment and monitoring

An ESG strategy that does not consider the company’s strategic objectives and **does not inform the main corporate strategy** fails to serve its purpose.

Disconnecting ESG objectives from wider business strategy



ESG Investing: Positive Trends

Climate change will be a dominant theme as governments across the globe introduce more climate-related regulations. As a result, we can expect **commitments to net-zero emissions by companies and investors to become standard practice** by the end of the decade.

Disclosures on ESG factors will become **standardised** and widespread by the end of the decade.

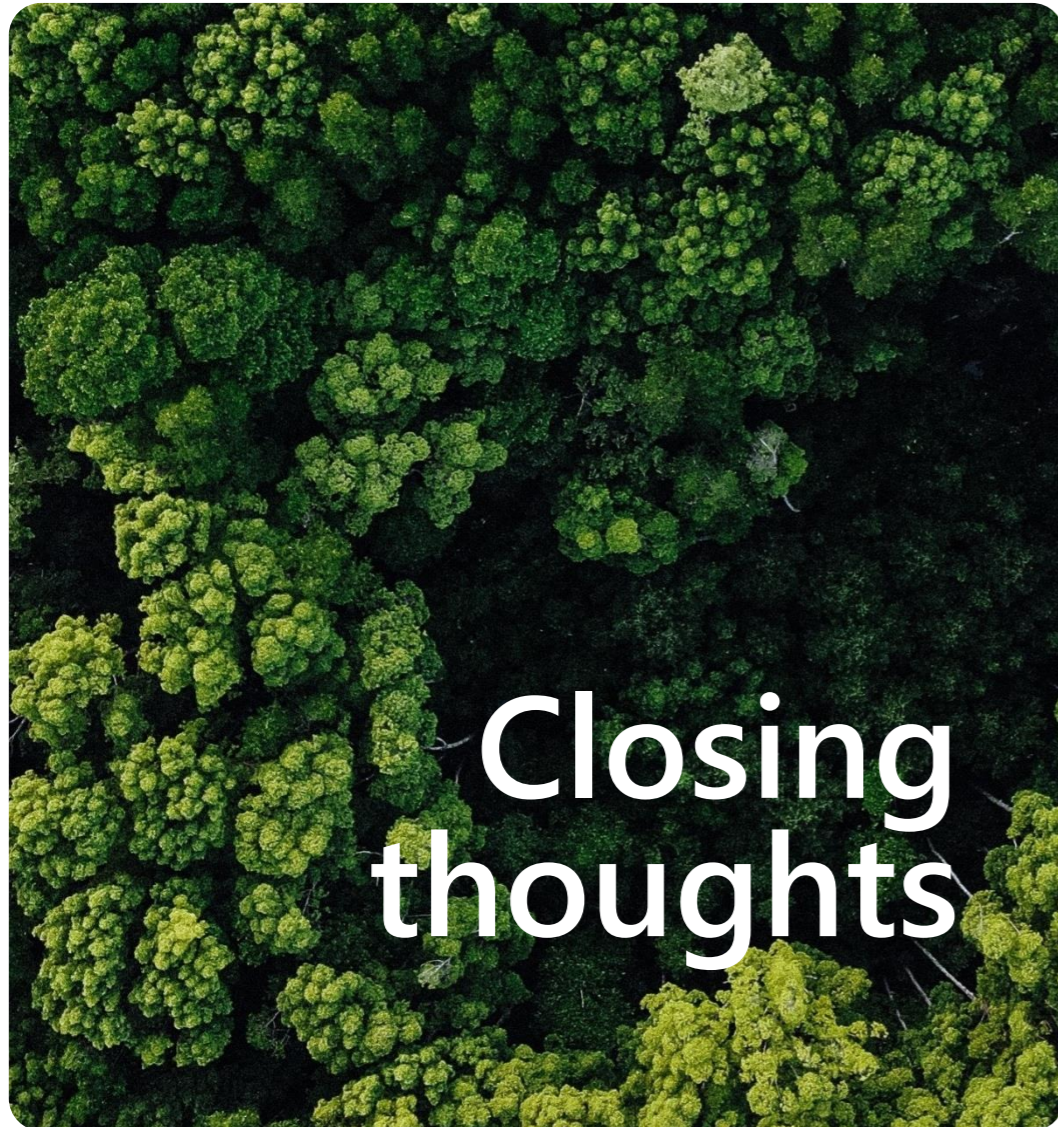
We can expect asset managers to transition from ESG stewardship, to ESG integration. Enhanced ESG disclosures will begin to pave the way for investment professionals to better incorporate ESG risk assessments into their investment decisions. **Corporate Engagement** and proxy voting will move beyond the proposals listed on the meeting agenda as more investors systematically assess companies based on ESG.



Despite recent U.S. regulatory actions that may make it more difficult for shareholders to file resolutions, **ESG-related shareholder activism** will continue to rise in the 2020s

Data and technology will drive significant changes in our ability to measure, calculate and monitor ESG factors. **Better visibility on challenging metrics**, such as resource consumption and biodiversity, will likely allow for the creation and enhancement of international frameworks and targets on several key issues related to the Paris Climate Agreement..

In addition to boardroom diversity, the focus for companies and investors will shift toward **diversity across the organisation**, from the C-suite to the general workforce.



Climate change and biodiversity loss are increasingly threatening nature, human lives, livelihoods and well-being around the world. Both are caused by human economic activities, and neither will be successfully resolved until we look at how to reform our economic activities to properly support and enable the flourishing of life on Earth.

We are in unprecedented times, and the decisions we take over the next two to three years will determine our growth and climate future. The work will be to research, test and develop a variety of solutions, unlocking both public and private finance to give nature a value, fuel innovation and forge our way towards a greener and more climate resilient economy.

The value of protecting and restoring nature is substantially larger than the price of destroying it.

This is our ‘use it or lose it’ moment: the decisions we take over the next 2-3 years will determine our growth and climate future.



Appendix

Authors, references
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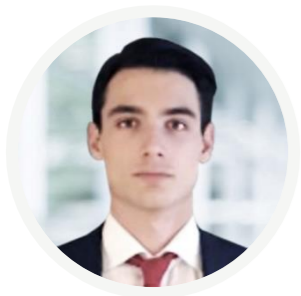


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About Extantia

Founded in 2021 by a group of experienced investors, entrepreneurs and scientists, Extantia is a pioneering VC in the climate-tech space. The firm’s mission is to identify and scale breakthrough technologies that slash carbon emissions while driving superior returns.

To achieve this, Extantia backs exceptional tech companies and fund managers, who are assessed by a first-in-kind measurement and reporting methodology to determine their CO₂e savings potential by 2050. Alongside commercial metrics, only companies that can make a significant dent in the 52 billion tonnes of CO₂e emitted per year are considered for investment.

Recognising that the climate crisis does not stop at national borders, Extantia also uses its global “Net Zero Circle” of decision-makers to unite founders, investors, policymakers and world-class scientists. This network is designed to drive mutually reinforcing connections, provide access to co-investments and share actionable best practices to buy us time to avert a crisis.

Extantia has established a track record in backing high-performing companies across various decarbonisation themes including geothermal energy, green hydrogen, renewable petrochemicals and electric vehicle battery upcycling. They are currently raising for their second fund to multiply this impact an at even larger scale.



Appendix

The link between cities and climate change

Cities create over 70% of global CO₂ emissions. Over half of the world's urban greenhouse gas emissions come from just 25 mega-cities, 23 of which are located in China. Frankfurt appears 33rd on the list of the cities with more total emissions, contributing to 0.05 Gigatonnes of CO₂e per year.

Thus, cities share a big responsibility for the decarbonisation of the global economy. The two main sources of greenhouse gas emissions in cities come from:

- + Stationary energy: electricity and fuel consumption by residential, commercial, industrial and institutional buildings.
- + Transportation sector: road-based transportation, railways or aviation.

The **C40 Cities Climate Leadership Group** is a group of 97 cities that represent one quarter of the global economy. The network supports cities in their decarbonisation efforts by working across multiple sectors and initiative areas.

Since cities are one of the biggest causes of climate change, they can host a big array of solutions. Using renewable energy sources and deploying smart mobility systems powered by electricity or hydrogen will be crucial.





Appendix

Key takeaways of the IPCC 6th Report

The Intergovernmental Panel on Climate Change is a UN organisation founded in 1988. The IPCC provides the best and most important objective scientific opinion on climate change. Recently the IPCC released its 6th Report, which outlined the following:

- + **Humans are causing climate change:** Although this fact has been known for many years, scientists have now agreed that this statement is unequivocal and therefore there is total agreement that our activities and way of life are detrimental for our climate.
- + Human influence has warmed the climate at a rate that is **unprecedented** in at least the last 2000 years.
- + **The range of possible outcomes is shrinking and extreme weather events will increase:** The impact of extreme climate events will accelerate and harm more vulnerable countries. This will be especially accentuated with floods and droughts affecting the agriculture sector.
- + **Global warming of 1.5°C and 2°C will be exceeded during the 21st century** unless deep reductions in CO₂ and other greenhouse gas emissions occur in the coming decades.
- + Many changes due to past and future greenhouse gas emissions are **irreversible for centuries to millennia**, especially changes in the ocean, ice sheets and global sea level.
- + Changes in several climatic impact-drivers would be **more widespread at 2°C compared to 1.5°C** global warming and even more widespread and/or pronounced for higher warming levels.
- + From a physical science perspective, limiting human-induced global warming to a specific level requires **limiting cumulative CO₂ emissions, reaching at least net zero CO₂ emissions, along with strong reductions in other greenhouse gas emissions.**





Appendix

Additional carbon negative technologies

Over the last years it has been made clear that we will not only need to reduce our emissions but also remove carbon from the atmosphere to reach the net-zero objectives. These removal technologies, called NETs, go from nature-based solutions, such as reforestation, to technologically-advanced tools such as Direct Air Carbon Capture and Storage (DACCS). Some of these have already been presented in the Climate Tech section, but here are some other promising solutions:

- + **DACCS: Direct Air Carbon Capture and Storage (DACCS)** employs large installations of ventilators that capture the air of the area and, through chemical reactions, separate the CO₂. The CO₂ can then be stored safely later. The potential to remove carbon from the atmosphere can be up to **5 Gt CO₂ per year**. However, it requires vast amounts of energy and is an expensive technology. Therefore, companies and governments must invest in it to scale it up and reduce costs.
- + **Enhanced Weathering:** Enhanced weathering is a theoretical proposal to remove CO₂ from the atmosphere by spreading minerals that absorb it on land areas. Costs are similar to BECCS (50–200 \$/tCO₂) and this offers a high removal capacity of up to to **4 Gt CO₂ per year**, apart from co-benefits such as improved soil conditions that in turn can improve crop yields.
- + **Soil Carbon Sequestration:** SCS is a result of sustainable agriculture techniques, which is one of the most efficient ways to reduce and remove carbon. Its removal potential is high (**5 Gt CO₂ per year**), and its costs are minor compared to other technologies. Improving soil respiration is one of the techniques for SCS.

