BRYAN, GARNIER & CO
Investment Banking for a Better Future

THE **CARBON** ECONOMY

How to address the greatest challenge humans have ever faced

CONTENT

Concern over the environment is greater than ever. As populations grow and economic development progresses, the risks of global warming and pollution will only increase. Unfortunately, we are headed in the wrong direction, full speed.

Fortunately, improved tools for reducing, measuring, verifying and reporting GHG emissions provide an opportunity to reverse this trend. Industrialists, regulators, consumers and carbon credit buyers are able to obtain a better insight into GHG emissions, how to reduce them, and how to progress towards carbon neutrality, before it's too late.

In this report, we explore the technologies that have the potential to reduce GHG emissions, improve their measurement, accounting, monitoring and certification. We also look at future developments and discuss why this is needed in the context of mounting pressure from consumers, investors and policymakers to fight climate change.

WE ARE HEADED **IN THE WRONG DIRECTION**, FULL SPEED

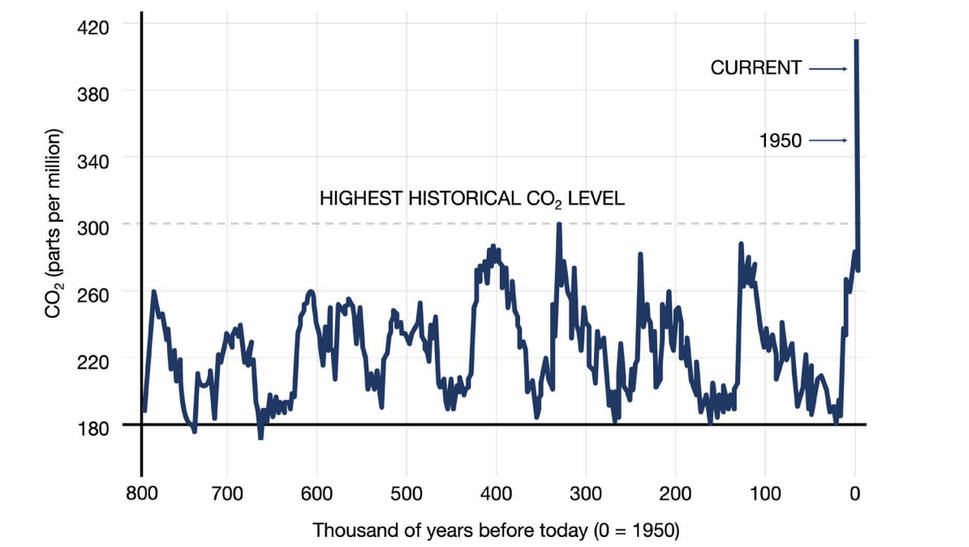
SECTION 1

Record levels of carbon dioxide in the atmosphere

According to the Intergovernmental Panel on Climate Change (IPCC), in 2017, human-induced warming reached approximately 1°C above pre-industrial levels.

Since the beginning of the industrial era, human activities have raised atmospheric concentrations of CO2 by about 50%. This is more than what occurred naturally over a 20,000 year period! The rise in global CO2 concentration since 2000 is about 20ppm per decade, which is 10 times faster than any sustained rise in CO2 over the past 800,000 years.

FIG 1: RISE IN CO2 CONCENTRATION IN THE ATMOSPHERE



Source: National Oceanic and Atmospheric Administration

Who is contributing ?

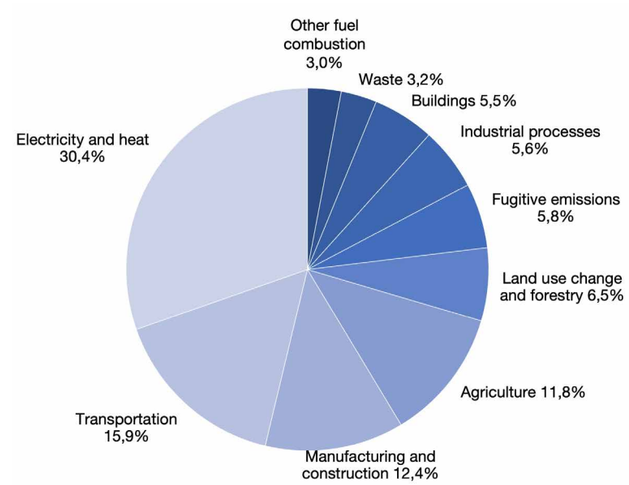
Energy accounts for nearly three-quarters of global greenhouse gas (GHG) emissions, followed by agriculture. Breaking down the energy sector into its sub-sectors, electricity and heat generation make up the largest portion of emissions, followed by transportation and manufacturing.

Carbon dioxide (CO2) is the biggest contributor to global warming, estimated to have caused c.65% of global warming since the pre-industrial era. The second most relevant GHG after CO2 is methane (CH4), responsible for 20-25% of warming over the same time span. Data for 2018, the most recent available, showed CO2 emissions at 36.4Gt, or 75% of total GHG emissions, while 8.3Gt of CO2 equivalent methane were emitted, accounting for 17% of total GHG emissions. Other GHG emissions come from nitrous oxide (NO2) and F-gas (fluorinated gases), representing respectively 6% and 2%.

Each GHG has a different impact on global warming. Some gases are more "effective" than others at making the planet warmer. Over 20 years, the global warming potential (GWP) of methane is 84 times higher than that of CO2!

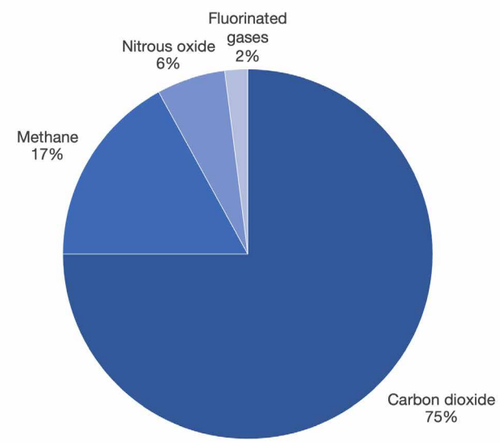
Methane has a strong GWP but fortunately does not stay long in the atmosphere, meaning that if methane emissions are slashed successfully, a positive effect could be observed quite soon. The lifetime of methane in the atmosphere is "only" 12 years, compared with around 500 years for carbon dioxide, more than 100 years for nitrous oxide and 50,000 years for carbon tetrafluoride.

FIG. 2: BREAKDOWN OF GHG EMISSIONS BY SECTOR



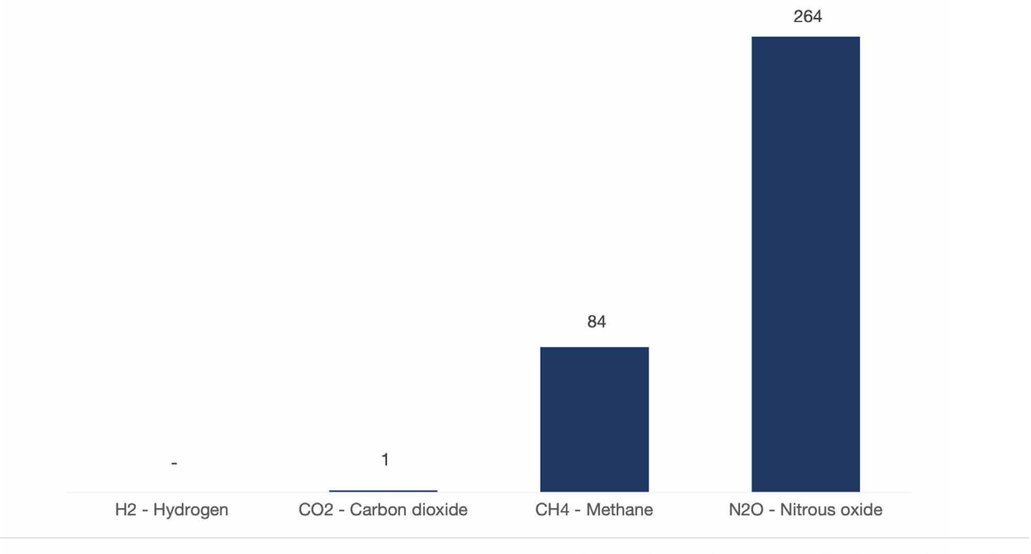
Source: Climate Watch

FIG. 3: BREAKDOWN OF GHG EMISSIONS BY GAS (CO2 EQUIVALENT)



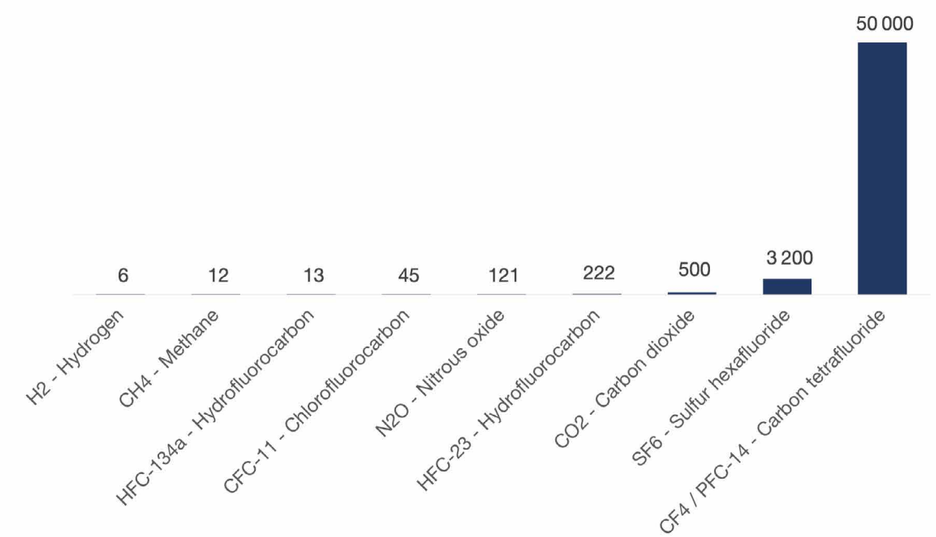
Source: Climate Watch

FIG. 4: GHG EMISSIONS LIFETIME IN THE ATMOSPHERE (YEARS)



Source: Climate Change 2013: The Physical Science Basis

FIG. 5: GHG EMISSIONS – GWP OVER 20 YEARS, CO2 AS THE BASELINE



Source: Climate Change 2013: The Physical Science Basis

MITIGATION PATHWAYS TO MAINTAIN GLOBAL WARMING **BELOW 1.5°C**

SECTION 2

Why are we talking about 1.5°C and 2.0°C ?

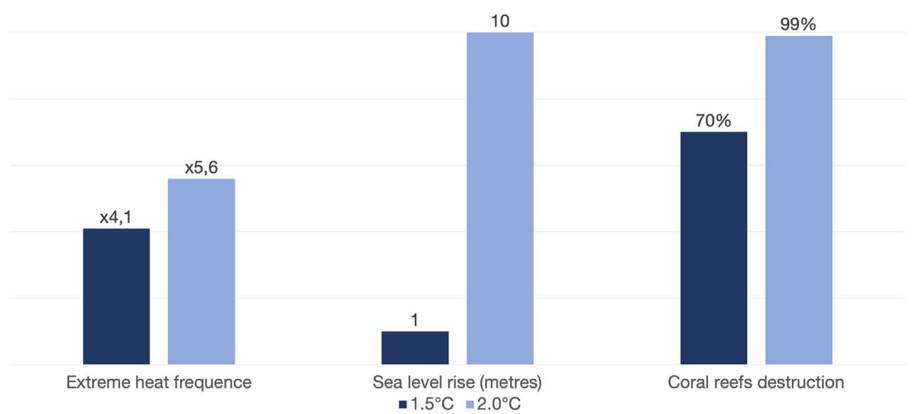
At COP21 in December 2015, 195 nations adopted the landmark Paris Agreement, the central aim of which is to strengthen the global response to the threat of climate change by “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels”.

Scientists consider that crossing the 1.5°C threshold risks unleashing exponential climate change effects on people, wildlife and ecosystems. However, scientists also agree on that we must set achievable goals that are not pipe dreams. François Gemenne, lead author of the IPCC, advocates about restoring trust and dialogue between the two hemispheres, adopting pragmatic targets to accelerate discussions on climate finance. While the threshold concentration for GHG corresponding to 1.5°C is 350ppm, we crossed it in the mid-80s and we are today around 417ppm, adding 2.6ppm each year. Therefore, vigorous discussions took place at COP27 in November 2022, with the EU and France arguing against changing the 1.5°C to a 2.0°C target, which was originally planned under the Paris agreement. For every incremental rise in global warming, changes in extremes become larger. For example, heatwaves would become both more frequent and more severe. According to the IPCC, an extreme heat event that occurred once per decade in a climate without human influence, would happen 4.1 times a decade at 1.5°C of warming, and 5.6 times at 2°C. Let warming spiral to 4°C, and such an event could occur 9.4 times per decade.

At 1.5°C, there’s a good chance we could prevent most of the Greenland and west Antarctic ice sheet from collapsing. That would help limit the rise the sea level to a few feet by 2100. However, if global warming reaches 2°C, ice sheets could collapse and sea levels could rise up to 10 metres.

Warming of 1.5°C would destroy at least 70% of coral reefs, but at 2°C more than 99% would be lost. That would destroy fish habitats and communities that rely on reefs for their food and livelihoods.

FIG. 6: IMPACT OF GLOBAL WARMING AT +1.5°C AND +2.0°C



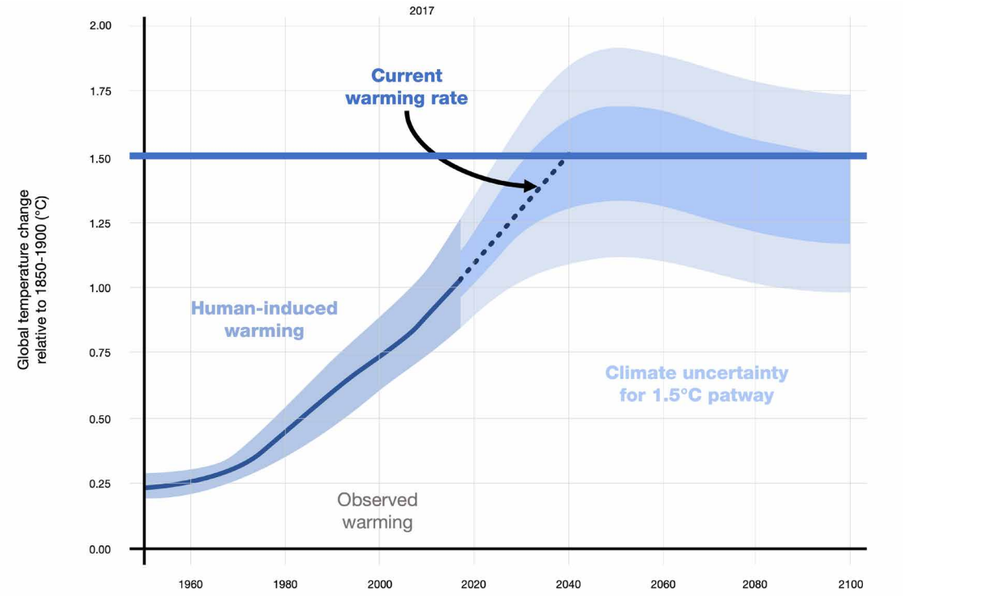
Sources: IPCC, Bryan, Garnier & Co

How close are we to 1.5°C?

In 2022, the global average temperature is estimated to be about 1.15°C [1.02-1.28] above the 1850-1900 average. According to the IPCC, human-induced warming reached 1°C above pre-industrial levels in around 2017 and, if this pace of warming continues, we could reach 1.5°C around 2035 to 2040. However, some regions have been warming faster than the global average. This means that warming in many regions has already exceeded 1.5°C above pre-industrial levels. Over a fifth of the global population lives in regions that have already experienced warming in at least one season that is greater than 1.5°C above preindustrial levels.

Limiting warming to 1.5°C implies reaching net zero CO2 emissions globally around 2050 and concurrent deep reductions in emissions of non-CO2 forcers, particularly methane.

FIG. 7: GLOBAL HUMAN-INDUCED WARMING RELATIVE TO 1850-1900



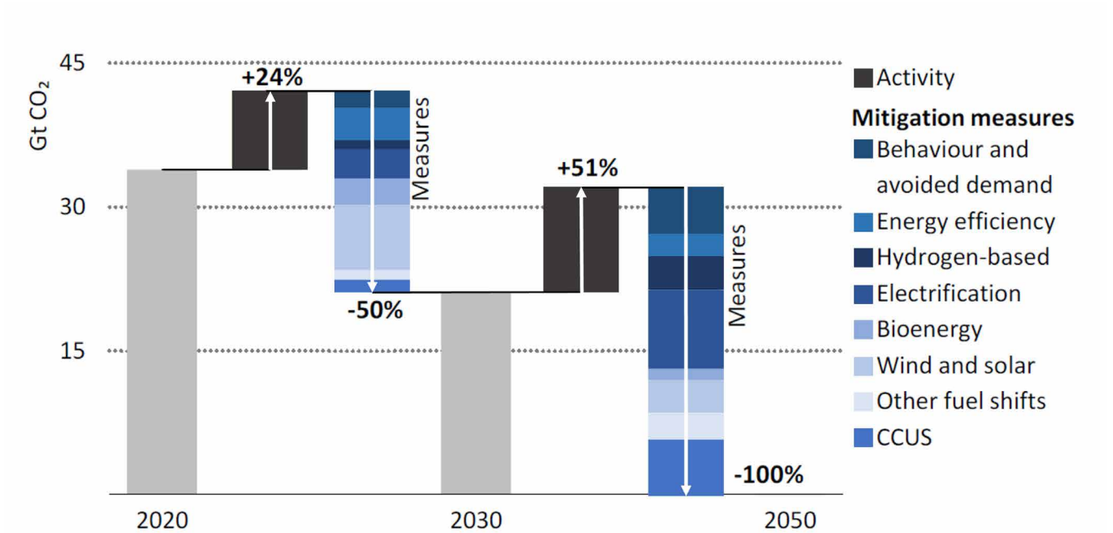
Source : IPCC

Mitigation pathway to limit global warming

The path to limit global warming to 1.5°C is narrow and requires immediate and massive deployment of all available clean and efficient technologies. We identify below the key pillars to achieve net zero emissions by 2050:

- **Energy efficiency** - Minimizing energy demand growth through improvements in energy efficiency makes a critical contribution. Energy efficiency measures are front‑loaded and play their largest role in curbing energy demand and emissions in the period to 2030. Although energy efficiency improves further after 2030, its contribution to overall emissions reductions falls as other mitigation measures play an expanding role.
- **Electrification** – Low-emissions electricity is one of the most important drivers of emissions reductions, accounting for around 20% of the total reduction achieved by 2050. Global electricity demand more than doubles between 2020 and 2050, driven by the electrification of the energy mix, the deployment of electric vehicles and green hydrogen production.
- **Renewables** – Wind power (onshore and offshore) and solar PV are key to reduce emissions from electricity supply. The share of renewables in total electricity generation globally increases from 29% in 2020 to over 60% in 2030 and to nearly 90% in 2050.
- **Carbon capture, utilisation and storage (CCUS)** - CCUS can facilitate the transition to net‑zero CO2 emissions by 1/ tackling emissions from existing assets, 2/ providing a way to address emissions from some of the most challenging sectors, 3/ providing a cost‑effective pathway to scale up low‑carbon hydrogen production rapidly and, 4/ allowing for CO2 removal from the atmosphere.
- **Hydrogen and H2-based fuels** - Global hydrogen use is expected to grow from less than 90 Mt in 2020 to more than 200 Mt in 2030. Around 35% of the hydrogen produced will stem from water electrolysis, 35% from low-carbon hydrogen (natural gas with CCUS) and the rest: 30%, still from Steam Methane Reformers (SMR – grey hydrogen). After 2030, low‑carbon hydrogen (green and blue) will expand rapidly in all sectors.
- **Bioenergy** - Bioenergy provides flexible low-emissions generation to complement generation from solar PV and wind, and removes CO2 from the atmosphere when equipped with CCUS. In 2050, electricity generation using bioenergy fuels could reach 3 300 TWh, or 5% of total electricity generation.
- **Behavioural change** - The wholescale transformation of the energy sector demonstrated in a net zero emission scenario cannot be achieved without the active and willing participation of citizens. It is ultimately people who drive demand for goods and services. Societal norms and personal choices will play a crucial role in steering the energy system onto a sustainable path. According to the IEA, 8% of emission reductions stem from behavioural changes and efficiency gains in materials that reduce energy demand, e.g. flying less for business purposes.

FIG. 8: EMISSION REDUCTIONS BY MITIGATION MEASURE



Source: IEA

PRESSURE ON THE ENVIRONMENTAL SUSTAINABILITY OF BUSINESSES **IS RISING**

SECTION 3

Regulators are toughening their stance

Sustainability is a growing issue for governments and regulators, especially in Europe. In December 2019, the European Commission (EC) launched the “European Green Deal”, with new measures and investments that aim to make the EU the first climate-neutral continent by 2050.

The European Central Bank (ECB) president, Christine Lagarde, has publicly said that she is pushing for climate change to be a mission-critical priority for the central bank, and is considering using monetary policy and bank supervision to fight climate change. This shift would require assessing which firms are more polluting than others.

In September 2020, the EC presented its revised environmental targets for 2030, calling for a reduction in GHG emissions of 50-55% compared to 1990 levels, while it was initially targeting a reduction of 40%. To achieve this new target, the EC will review all relevant climate and energy policy instruments.

At the same time, governments and regulators will apply additional constraints and standards on the sustainability of business operations. They will need the right tools to measure their environmental performance, moving away from a command-and-control approach, in which the mandate equipment changes and maintenance schedules, to performance or market-based emissions reduction schemes.

NGOs such as Greenpeace and The Children’s Fund will also want to be able to assess the sustainability of businesses more effectively, and will look for the best tools and measures to do this. The ability to measure environmental performance will be essential to put the right taxation mechanism in place.

Pressure from the investment community is on

Shareholder awareness is also increasing rapidly. Investors are placing sustainability at the core of their investment decisions. In a letter addressed to all CEOs, BlackRock CEO Larry Fink pointed out that “climate risk will impact both the physical world and the global system that finances economic growth”, concluding that “in the near future – and sooner than most anticipate – there will be a significant reallocation of capital”.

This echoes plans outlined by Christopher Hohn, head of London-based activist hedge fund TCI, to vote against the directors of companies that fail to reveal their carbon emissions.

It also reflects letters sent to some of the world’s largest GHG-emitting companies by Climate Action 100+, an investor group whose 518 members represent USD47tn in assets under management, requesting the implementation of a net-zero strategy for 2050 or earlier.

A fundamental reshaping of finance is underway. Companies that do not tackle the environmental issue may end up running short of capital. Investors will look for the best independent tools and ratings to properly assess the environmental impact of corporations, classify low-carbon-footprint investments and make the right choices.

All financial intermediaries will need the right methodology to identify environmental, social and governance (ESG) risks, report to supervisory authorities and publish their reports where necessary.

Pressure is also coming from consumers

Consumer concern and awareness is also growing, especially among the millennial generation. Consumer choices are increasingly driven by ecological concerns and sustainability. Technology and social networks enable and encourage consumers to make more environmentally-conscious choices and the change is happening fast. Products and brands are adapting, with greater focus on the ecological dimension of their communications, production and operations.

Companies have no choice but to adapt to this new environment

As pressure from all stakeholders increases, corporations face two main challenges. The first is to adapt their operations to be more environment-focused by changing their processes, providers and materials, and to control the results through appropriate measurements and monitoring. And the second is to adapt their communications to provide more insights and data on their actual ecological impact with the enriched, more reliable and more accurate ESG disclosures that growing investor scrutiny will require.

Data on carbon accounting will be of particular importance. The ability to measure CO2 and other GHG emissions in a reliable and accurate way, on a global scale and in a timely manner, is therefore key to mitigating global warming and climate change challenges.

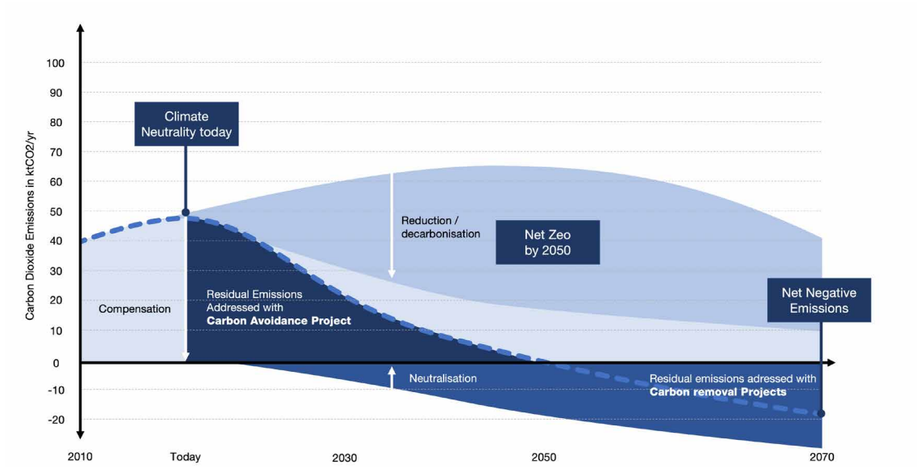
THE **CARBON NEUTRALITY** JOURNEY

SECTION 4

In recent years, the tech industry has delivered a broad range of solutions aimed at preventing, monitoring and reducing GHG emissions. Monitoring GHG and pollutant emissions and knowing their source is essential for implementing an efficient policy. The area has witnessed profound change as multiple hardware and software solutions have been developed.

The carbon neutrality journey is a multiple step process, mixing the reduction in GHG emissions with offsetting and carbon removal projects. We explore below the different steps of the net zero pathway.

FIG. 9: THE CARBON NEUTRALITY JOURNEY



Source : South Pole

(1) Setting a goal

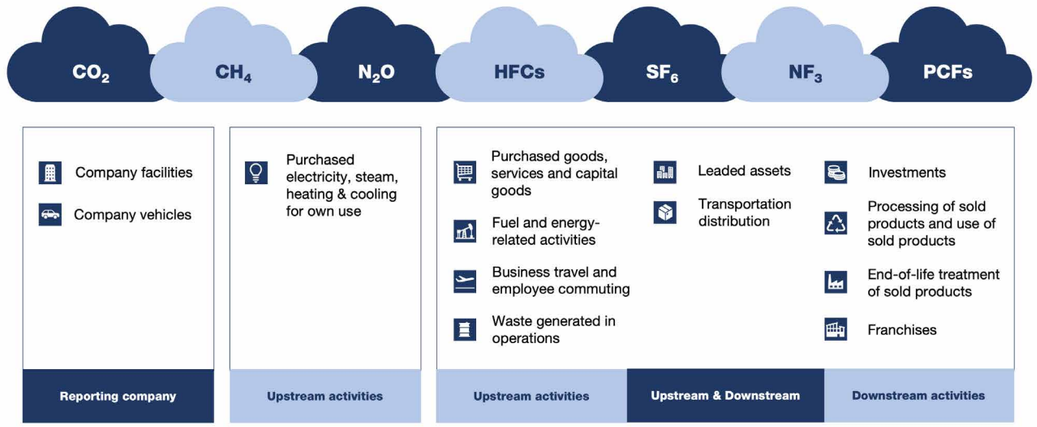
The first step in reducing GHG emissions is to classify them and set a target. The Green House Gas Protocol has a framework with emissions divided into three categories, Scopes 1, 2 and 3:

- Scope 1 corresponds to emissions that are generated directly, for example running boilers or furnaces,
- Scope 2 emissions are those that are created indirectly, through electricity or heat purchased to run the business,
- Scope 3 corresponds to emissions generated by the entire value chain. It is more tricky to measure because it includes all the company's emissions itself and also those the organisation is indirectly responsible for, up and down its value chain. Scope 3 captures the entire life cycle and value chain.

While Scope 1 and 2 data are relatively easy to acquire, since emissions are under control and hence fairly easy to reduce, it can be very difficult to measure Scope 3 data and reduce related emissions. For many businesses, Scope 3 emissions account for more than 70% of their carbon footprint so access to data is key.

Definitions of what constitutes net zero goals can change from one company to the next but businesses looking to adopt best practices will commit to tackling Scope 3 emissions. Mapping the emissions footprint by scope is a good way to start reducing it.

FIG. 10: DEFINITION OF SCOPE 1, 2 AND 3 EMISSIONS FOR CARBON ACCOUNTING



Source: Carbone4

(2) Understanding and measuring emissions

CASE STUDY:

A concrete example of the benefits of carbon accounting is IKEA. Many of IKEA's products are low-value but high-volume goods. Transport costs form a large part of the total cost of many of the products, which makes it important for the company to minimise transport, handling and warehouse costs wherever possible.

In order to lower logistics costs and increase efficiency in its transport and warehousing operations, IKEA launched an internal competition to reduce unnecessary air in product packaging. The "Air hunting competition" aimed to remove as much air as possible from packaging and thereby increase true product volume during transport and storage.

The ensuing development of the Glimma candle packaging method resulted in a 30% increase in product volume for each load unit. Thanks to this packaging development, transport and warehouse operations are now far more efficient and the impact on the environment has decreased significantly.

The next step in reducing emissions is to understand where they come from, how to measure and classify them, and then to establish a baseline. A range of software solutions has been developed to make sense of all the data being collected. We have identified two categories of solutions:

- **Sustainability platforms**, which aggregate operational data from companies, estimate their impact from an ESG standpoint, and help set targets for the future. This category includes companies such as Vaayu, whose platform connects to shops' point-of-sale systems, and calculates the carbon footprint of all daily transactions using the company's database of more than 600,000+ data points. Vaayu's platform offers retailers emissions benchmarking against their peers and details the carbon footprint of individual items. However, this carbon accounting is far more than a tick-box exercise. There are direct advantages for companies to measure and benchmark their environmental performance and take steps to improve on it. One such benefit is financial, reducing costs and improving margins.`

- **Data analytics technologies**, which collect a huge array of data and apply proprietary algorithms to extract actionable insights. In this field, companies operating in an area known as asset observation are emerging. Their solutions fuse data from a large array of sources, notably Earth observation satellites, with a focus on GHG-intensive assets such as oil & gas wells and pipelines, refineries, coal mines, or any other industrial facilities.

Alongside these tech solutions, we have identified consulting firms specialised in sustainability and carbon neutrality advisory. For example, Carbometrix, a French start-up which calculates the carbon footprint of any company and then helps clients implement a decarbonation strategy.

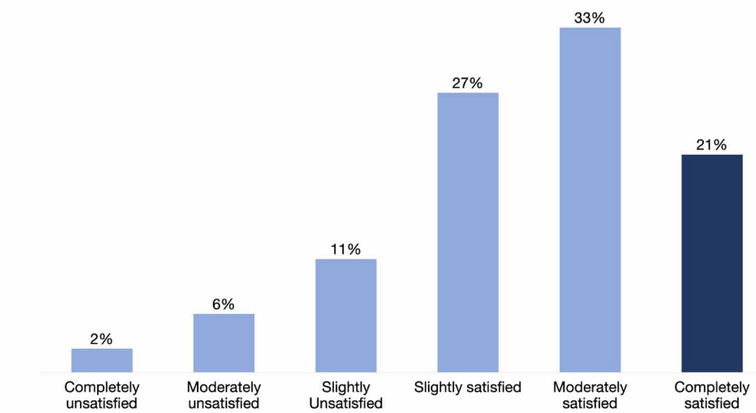
Software is important for data transparency and actionability, which are themselves crucial for organisations willing to improve their sustainability. However, the World Economic Forum reports that only 9% of companies are actively using software that supports data collection, analysis and reporting on their ESG activities.

According to an SAP Insights survey, only 21% of business executives said they were completely satisfied with the quality and availability of data collected for sustainability.

FIG. 11: MAPPING OF THE ECOSYSTEM

Source: Bryan, Garnier & Co

FIG. 12: DATA QUALITY IS STILL A CHALLENGE FOR ENVIRONMENTAL SUSTAINABILITY



Source: SAP

(3) Taking action

Once goals have been set and correctly understood, with emissions measured and reported, changes can be implemented to reduce them.

We have identified different categories of responses:

- **Mitigation** – efforts to reduce or prevent GHG emissions. Mitigation requires the use of new technologies, clean energy sources, reduced deforestation, sustainable agricultural methods, and changes in individual and collective behaviour,
- **Carbon dioxide removal (CDR)** - while most mitigation activities focus on reducing GHG emissions, CDR aims to reduce concentrations already in the atmosphere or about to be released into the atmosphere,
- **Adaptation** – actions taken to manage the impact of climate change. Adaptation solutions take many shapes and forms, depending on the context. Adaptation can range from building flood defences, setting up early warning systems for cyclones and switching to drought-resistant crops,
- **Remediation** – the aim is to temporarily reduce or offset warming. One such measure is solar radiation modification (SRM), also referred to as solar radiation management which involves changes increasing the amount of solar radiation reflected from the Earth to reduce the peak temperature.

Limiting warming to 1.5°C above pre-industrial levels requires systemic and definitive changes. Remediation and adaptation actions are only temporary or defensive measures, so we focus our research on mitigation and carbon dioxide removal solutions, which are those effectively able to fight climate change.

Mitigation solutions

One way to reduce GHG emissions is to stop burning coal and oil and switch massively to renewable energy. According to the NREL (National Renewable Energy Laboratory – a US research centre), over their lifetime, power plants running on natural gas emit c.450-460 grammes of CO_2 equivalent per kWh of electricity produced. Power plants running on coal are even more polluting, emitting c.1,000g of CO_2 equivalent per kWh. For comparison purposes, over their life cycle, emissions from solar, wind or nuclear technologies are considerably lower, generally around 10-50 g of CO_2 equivalent per kWh.

GHG emissions can also be reduced by changes in agriculture and breeding, transport, forest-management (reforestation and preservation) and waste management.

Insect-based products are a good example of these changes in agriculture and breeding. Insects are a sustainable alternative source of nutritional solutions for a widening range of feed and food applications. Momentum is strong across all applications, favoured by strong regulatory tailwinds in both Europe and the US, as well as increased awareness across the value chains addressed and with end-customers concerning sustainable food.

According to the European Commission, 88 million tons of food are wasted every year in Europe. Only a small quantity of this volume is effectively recycled, with most of it ending up in landfills or incinerators. Insects constitute a new promising recycling solution, and hence lower GHG emissions. Moreover, this alternative source of protein can help prevent over-fishing and deforestation for soy cultivation.

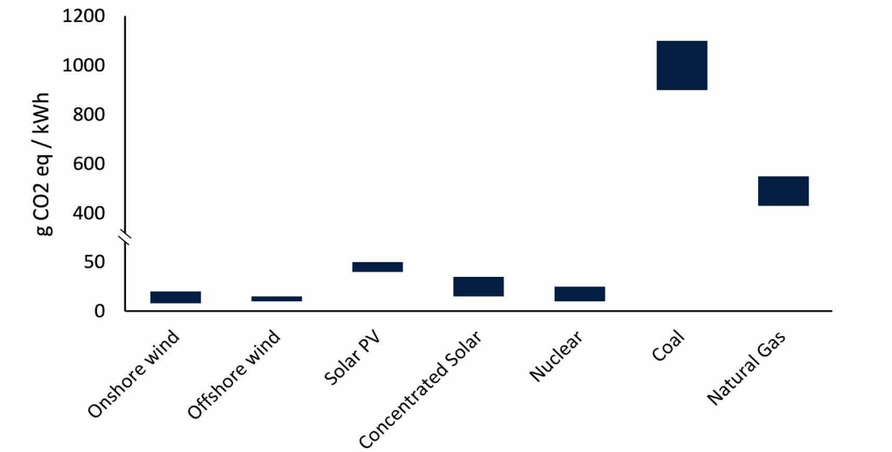
Protix for example, a company based in the Netherlands, produces natural and sustainable ingredients from insects.

15% to 25%
of greenhouse gases emissions are due to farming activities (FAO)

When it comes to waste management, the focus is often on new recycling solutions. Climate change and GHG emissions are hardly ever mentioned while waste, and landfills in particular, are a significant contributor to global GHG emissions, representing slightly more than 3% of global GHG emissions.

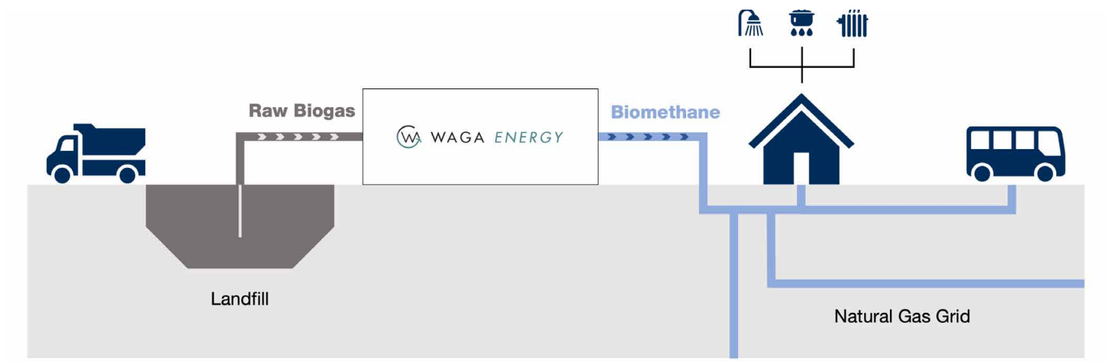
Waga Energy has developed a disruptive technology for the recovery of landfill gas, the biogas produced when organic matter decomposes in landfills. Waga Energy captures and purifies this biogas and transforms it into biomethane, a renewable substitute for natural fossil gas. This by-product generated from waste treatment is therefore transformed into clean, local and renewable energy. Biomethane can be stored and transported in existing gas infrastructures, and be used in a number of ways, including for heating, transport, industry, etc.

FIG. 13: LIFE CYCLE OF GHG EMISSIONS FROM ELECTRICITY GENERATION



Source: NREL

FIG. 14: LANDFILLS: HARNASSING A SOURCE OF RENEWABLE GAS



Source: Waga Energy

Other solutions to mitigate or reduce GHG emissions consist of developing carbon offset projects. Most of these concern forest conservation, which is great but unfortunately they provide little help in the fight against climate change. These projects are controversial and illustrate why the carbon market needs greater oversight, regulation, tracking and certification.

Each carbon credit generated by these forest conservation projects is supposed to represent a ton of carbon dioxide absorbed with the promise of payment intended to prompt forest owners to alter their practices and stop deforesting. However, forest owners are able to profit from weak rules in the carbon markets and garner payments for continuing the same forest practices they have used for decades. The problem is that these offset projects are generating credits while allowing customers to burn as much gas as they want and also to feel good about it, under the premise that they are funding some sort of change in practice. In the end, the atmosphere is losing out.

Carbon removal solutions

Sometimes, CO2 emissions cannot be avoided or are too hard to abate. Carbon dioxide removal solutions are useful to offset these emissions and achieve net zero. We differentiate two types of carbon capture: (1) from large point sources such as power plants or industrial facilities that use carbon-rich fuels, and (2) directly from the atmosphere.

Carbon capture from industrial or power plants has the advantage of working with a CO2-rich feedstock/input gas. Carbon dioxide typically represents between 5% and 15% of flue gases from power plants, depending on the fuel used. For comparison purposes, carbon dioxide concentration in the atmosphere is significantly lower/less concentrated, at around only 0.04%.

FIG. 15: COMPOSITION OF FLUE GASES FROM POWER PLANTS VS ATMOSPHERE

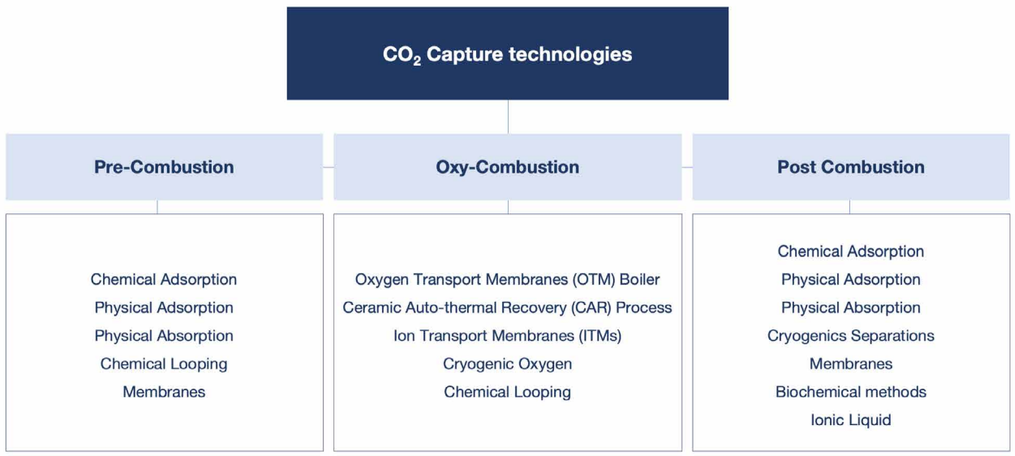
Gas constituents	Coal-fired power plant	Gas-fired power plant	Atmosphere
Nitrogen (N2)	70-75%	73-76%	78%
Carbon dioxide (CO2)	10-15%	4-5%	0.04%
Oxygen (O2)	3-4%	12-15%	21%
Other	6-17%	4-11%	<1%

Source : Global CCS Institute

Methods for direct CO2 capture can be classified in three main groups: (1) pre-combustion, (2) oxy-combustion, and (3) post-combustion. The post-combustion CO2 capture is the most common and easier to implement as a retrofit option.

One of the most common and cost-effective technologies is the post-combustion chemical absorption/solvent methods. Chemical absorption is highly efficient, low cost and mature. The most popular method is the amine solution.

FIG. 16: CARBON CAPTURE TECHNOLOGIES



Source: International Journal of Greenhouse Gas control

For emissions that cannot be captured directly, the solution might be to remove carbon dioxide from the air. We have identified two different technologies of Direct Air Capture (DAC): liquid and solid.

(1) Liquid DAC systems pass air through chemical solutions that remove carbon dioxide. The system releases chemicals back into the system by applying high-temperature heat while returning the rest of the air to the environment.

(2) Solid DAC systems use solid sorbent filters that chemically bind with carbon dioxide. Filters are heated and placed under vacuum to release carbon dioxide and store it.

We have also identified emerging DAC technologies that include electro-swing adsorption (ESA) and membrane-based DAC (m-DAC). However, their TRL is still too low to anticipate their deployment in a foreseeable future.

FIG. 17: DIRECT AIR CAPTURE TECHNOLOGIES

	Solid DAC	Liquid DAC
+	• Capex light • Modular • Operation can rely on low-carbon energy only • Likely to see cost reduction	• Opex light • Large-scale capture • Operation relies on commercial solvents • Technology adapted from exiting commercial units
–	• Energy/opex intensive • Manual maintenance required for adsorbent replacement	• Capex intensive • Usually relies on natural gas combustion for solvent regeneration, with potential for full electrification in the future

Source: Bryan, Garnier & Co

As the technology has yet to be demonstrated at large scale, the future cost of DAC is uncertain. According to the IEA, capture cost ranges from USD100/t to USD1,000/t. That said, DAC is receiving increasing attention and support and costs are decreasing rapidly.

There are currently 19 DAC plants operating worldwide, capturing an average of 0.01 MtCO2/year. A 1 Mt CO2/year capture plant is in advanced development in the US. In the Net Zero Emissions by 2050 Scenario, DAC is scaled up to capture more than 85 Mt CO2/year by 2030 and ~980 Mt CO2/year by 2050. This level of deployment will require huge investment efforts.

As DAC technologies mature, investors are taking increasingly interest in the sector. In April 2022, Climeworks announced a USD650m fundraising to scale up its technology. The company currently operates the world's largest DAC facility in Iceland, where trapped CO2 is injected deep underground and stored permanently. At present, the plant can only capture about 4,000 tons each year, roughly equivalent to the annual emissions of 600 people living in Europe.

FIG. 18: CLIMEWORKS' DAC SYSTEM

Source: Climeworks

(4) Reporting and certifying progress

Once climate actions have been implement to reduce emissions and compensate for other unabated emissions, progress can be reported and tracked. However, as already mentioned, some projects have been the subject of public scandals. Some even have the reputation of being unreliable or having a negative impact on the local environment and climate change, resulting in companies being accused of greenwashing.

We believe this is due to:

- A lack of international and local regulations,
- Most carbon credit certification organisations do not fully check certain claims that project developers make,
- A lack of independent data providers looking into the historic and current performance of carbon projects,
- Complex methodologies that create opacity on a project's effective impact,
- The need for deep technical expertise to assess how well carbon projects perform.

Buyers and traders of carbon credits with little visibility on their quality have led to the development of voluntary carbon markets (VCM), with carbon credit rating platforms emerging to provide data and transparency on project performances.

In November 2022, the first EU-wide voluntary framework to reliably certify high-quality carbon removals has been adopted by the European Commission. It sets out rules for the independent verification of carbon removals, as well as certification schemes that can be used to demonstrate compliance with the EU framework. The below 4-criteria are key in its foundations, incentivizing and harmonizing voluntary certifiers standards to the upside:

- Quantification: Carbon removal activities need to be measured accurately and deliver unambiguous benefits for the climate;
- Additionality: Carbon removal activities need to go beyond existing practices and what is required by law;
- Long-term storage: Certificates are linked to the duration of carbon storage so as to ensure permanent storage;
- Sustainability: Carbon removal activities must preserve or contribute to sustainability objectives such as climate change adaptation, circular economy, water and marine resources, and biodiversity.

FIG. 19: UNEXHAUSTIVE VOLUNTARY CARBON CERTIFIERS

Source: Bryan, Garnier & Co

Carbon rating companies such as Sylvera (a French start-up) assess the likelihood that the credits issued by a project have delivered on their claims. Insight into the quality of carbon credits enables buyers and traders to act with greater confidence, driving funds towards high-quality projects and helping the development of VCMs.

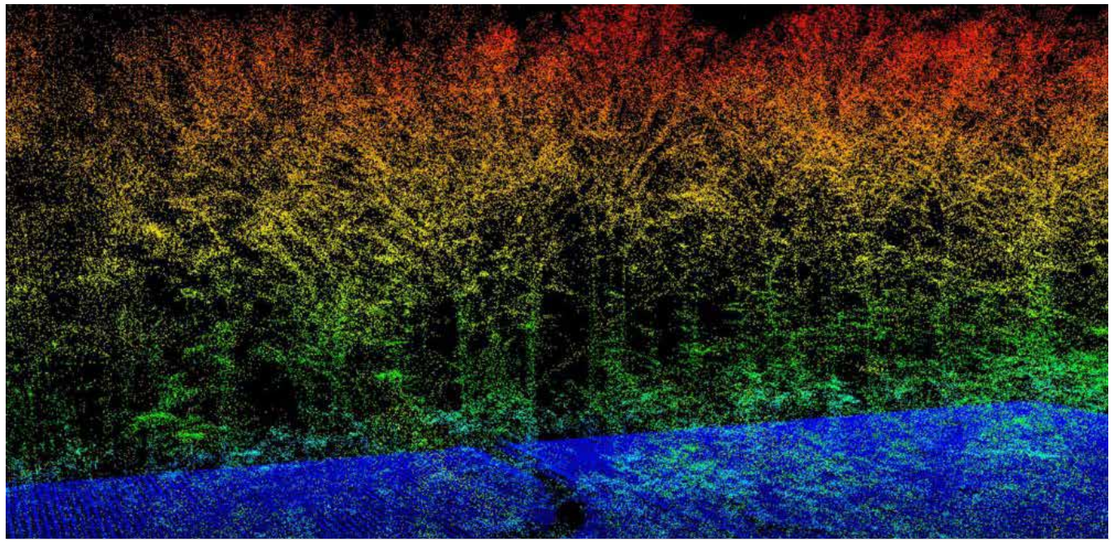
Carbon credit ratings use different criteria, including, but not limited to, the quantity of CO_2 captured. Ratings also factor in: (1) the permanence of GHG avoidance/removal, (2) the risk of over-crediting carbon credits, assessing the reasonable nature of the project's claimed baseline, and (3) co-benefits for biodiversity and local communities.

FIG. 20: SYLVERA'S CARBON RATING SYSTEM

Source: Sylvera

Assessing and tracking the quality of a project requires high-tech solutions and deep know-how in AI and data analysis. For example, Pachama, a Californian start-up, uses machine learning models using satellite imagery, LiDAR imaging, and other data to identify key forest characteristics that are used to estimate their carbon offset potential. Pachama also offers a marketplace for organisations willing to offset their emissions.

FIG. 21: LIDAR IMAGING TO MEASURE FORESTS CHARACTERISTICS



Source: Pachama

FIG. 22: MAPPING THE ECOSYSTEM THROUGH THE DIFFERENT STEPS

Source: Bryan, Garnier & Co

FIG. 23: RECENT TRANSACTIONS IN THE ECOSYSTEM

Source: Bryan, Garnier & Co

CARBON MARKETS

SECTION 5

Carbon markets can be divided into two categories: (1) regulated, compliance carbon markets, and (2) unregulated, voluntary carbon markets (VCMs).

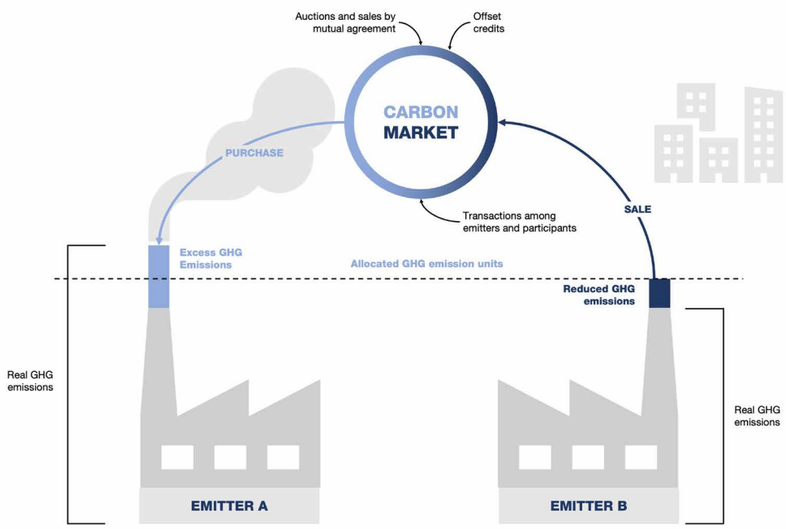
Compliance carbon markets

In the 1980s, the US had a major problem with its power stations emitting large amounts of sulphur dioxide (SO2) into the atmosphere. Sulphur dioxide fell back to Earth as acid rain causing harm to the environment and infrastructure. Since there was no incentive for power plants to stop emitting sulphur dioxide, in 1990, the US government launched an experiment by passing a law to force polluters to pay for their emissions. This new system was called "cap-and-trade". It proved to be efficient with acid rain levels decreasing by more than 20%.

In 1997, the Kyoto protocol suggested applying this concept to carbon emissions to fight climate change. In the following years, different countries and regions set up their own carbon markets, implementing the "cap-and-trade" system.

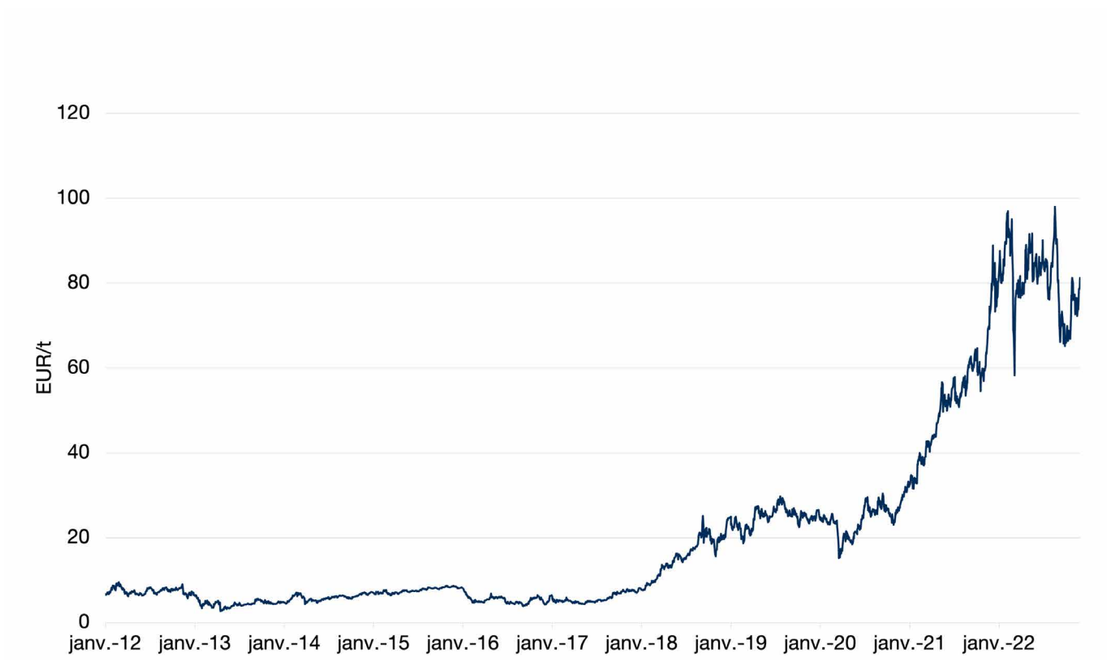
In the "cap-and-trade" system, the government sets a cap on the amount of CO2 that can be emitted into the atmosphere. Carbon credits are distributed for free to industrials, based on their historical emissions. If a company does not use all of its allowance, it can sell the excess to other companies. If a company needs more permits, it can buy them from those with excess carbon credits. Each year, allowances are adjusted downwards so the price of credits becomes more expensive, thereby creating incentives for industrialists to innovate and reduce their emissions.

FIG. 24: THE "CAP-AND-TRADE" CARBON SYSTEM



Source: Ministère de l'Environnement et de la Lutte contre les changements climatiques – Gouvernement du Québec

FIG. 25: PRICE OF CARBON ON THE EU ETS



Source : Reuters

The EU has set its own emissions trading system called EU ETS. The system covers CO2 emissions from:

- Electricity and heat generation,
- Energy-intensive industry sectors including oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals,
- Commercial aviation within the European Economic Area.

Participation in the EU ETS is mandatory for companies in these sectors, but:

- in some sectors, only installations above a certain size are included,
- certain small installations can be excluded if governments put in place fiscal or other measures that will cut their emissions by an equivalent amount,
- in the aviation sector, until 31 December 2023, the EU ETS will apply only to flights between airports located in the European Economic Area.

The EU ETS has proven to be an effective system with the installations covered reducing emissions by about 35% between 2005 and 2019. However, given the urgency to fight climate change, it is necessary to adapt the EU ETS to make it even more efficient.

In May 2022, Members of the European Parliament (MEPs) voted in favour of amendments to the EU ETS. The system should be reformed and its scope enlarged. Specifically, the reform will include:

- New ETS II for buildings and road transport – citizens not to be included before 2029,
- Free allowances to be phased out from 2026 and disappear by 2030,
- A bonus-malus system to be introduced from 2025,
- Extension to maritime transport,
- Revenues to be used exclusively for climate action in EU and member states.

The COP26 climate summit in Glasgow formalized cooperation between regional regulated trading systems, such as the EU ETS, with the adoption of Article 6 of the Paris Agreement. It sets the framework to operationalize the functioning of international and voluntary carbon markets through two mechanisms:

- Article 6.2 establishes a market in which countries can trade emissions reductions between each other to achieve their carbon emissions reduction goals through bilateral or multilateral agreements. Credits under Article 6.2 are already traded between countries, such as Switzerland and Japan.
- Article 6.4 aims to create a global registry for UN-recognised credits overseen by a Supervisory Body, where project developers will request to register their projects with the Supervisory Body. Credits under Article 6.4 will likely take a few years to be issued and traded.

FIG. 26: COP26 KEY TAKEAWAYS – ARTICLE 6 EXPLAINER

Article 6.2
Article 6.2 provides for bilateral or multilateral 'cooperative approaches' to be established directly between countries for the purpose of trading Internationally Traded Mitigation Outcomes (ITMOs) between jurisdictions.
These approaches would take the form of formal agreements, noting the Australian Government's Indo-Pacific Offsets Scheme as one recent example, that will provide for cooperative approaches between Australia and regional partners (now formally including Fiji and PNG).

Article 6.4
Article 6.4 provides a 'top-down' global platform for the crediting of emissions reductions (A6.4 ERs) by all countries, with oversight by a 'Supervisory Body' and a secretariat housed within the UNFCCC Secretariat.
Often described as the 'Sustainable Development Mechanism', the 6.4 market will replace the Clean Development Mechanism (CDM) that previously operated under the Kyoto Protocol (succeeded by the Paris Agreement from 2020), and will enable all countries to use markets to enhance multi-stakeholder investment in NDC ambition.

Article 6.8
Article 6.8 provides for the facilitation and coordination of non-market approaches (NMAs) to be undertaken by countries and other stakeholders to drive emissions reduction.

NMAs can loosely be defined as:
- Voluntary collective actions that are not reliant on market/transaction-based approaches; and
- Collaboration on mitiqation, adapation, finance, technology development/transfer, and capacity building (not covered by paris Agreement, Kyoto or UNFCCC activities).

Double Counting
Where two countries both try to 'count' an emissions reduction until as their own. Double counting inflates the level of climate action undertaken, decreases integrity of carbon markets, and disincentivizes countries form taking action.

Key issue: How to set up Article 6 rules that avoided double counting and ensured high integrity.

Corresponding Adjustments
When transferred emissions reductions are deducted from a host country's national GHG inventory and added to the purchasing country's inventory. This ensures emissions reductions are not double counted by the host country.

Key issue: How CAs could be made, and wether they would apply to activities contributing to (inside) NDCs or used for other mitigation purposes.

Transition of the CDM
Process by which the Kyoto Protocol's Clean Development Mechanism (due to end in 2020) would transition into or be suceeded by the new Article 6.4 crediting mechanism.

Key issue: To what extend should existing CDM structures, project methods, and already issued CERs (of varying vintages) be used under of transferred to the new 6.4 mechanism.

Share of Proceeds
A levy applied to carbon market transactions, to be used as a source of adapation finance for least-developed and vulnerable states impacted by climate change.

Key issue: Whether a share of proceeds should be applied to bilateral of multilateral transactions under the 6.2 mechanism (nothing it is already mandated under the Article 6.4 mechanism)

General Article 6 Abbreviation

- A6.4ER - Article 6.4 Emissions Reductions
- CA - Corresponding Adjustments
- CDM - Clean Development Mechanism
- CER - Certified Emissions Reduction
- ITMO - Internationally Traded Mitigation Outcome
- NDC - Nationally Determined Contribution
- NMA - Non-Market Approach
- SoP - Share of Proceeds

Source: Carbon Markets Institute

The progress made on the Article 6 and notably paragraph 6.4 points to the increasing convergence between the global regulatory framework within Paris Agreement and the voluntary carbon markets (VCMs).

Voluntary Carbon markets (VCMS)

Some players are still excluded from compliance markets such as the EU ETS (small installations, sector not yet included in the scope…) but have pledged to offset their GHG emissions by participating in carbon markets voluntarily.

Voluntary carbon markets allow industrial groups to offset their emissions by purchasing carbon credits generated by projects aimed at removing or reducing GHG emissions from the atmosphere. Companies can participate in VCMs either individually or as part of an industry-wide scheme, such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which was set up by the aviation sector to offset its greenhouse gas emissions. International airline operators taking part in CORSIA have pledged to offset all the CO2 emissions they produce above a baseline 2019 level.

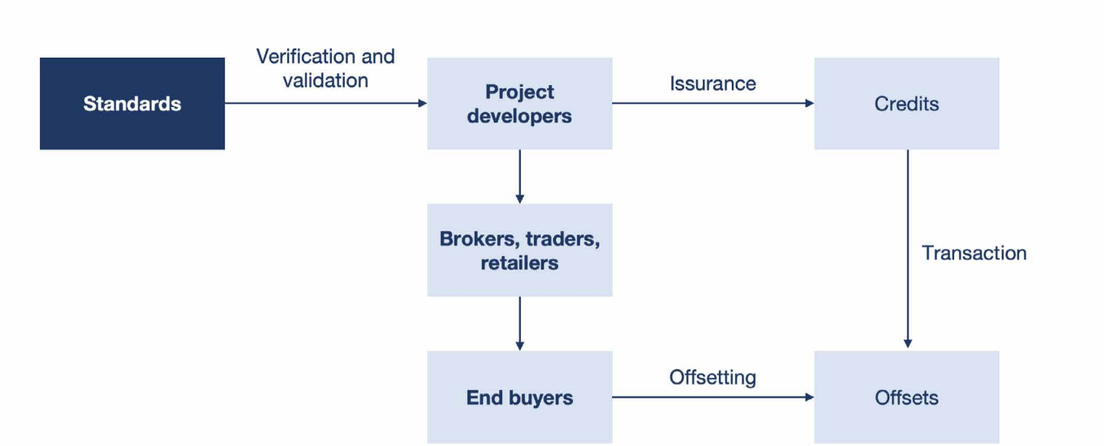
While compliance markets are currently limited to specific regions, VCM credits have the potential to be accessed by every sector of the economy instead of a limited number of industries and geographies.

Carbon credits traded on the voluntary market are not tailored to any regulatory requirement. The quality of the supply is relying on the adopted industry crediting programs – carbon standards such as VERRA and Gold Standard. We expect these standards to become almost interchangeable in the future with the roll-out of the first emissions-reduction credits under the Article 6.4 pertaining the agreement on the requirements for methodologies. The Supervisory Body overseeing the subject drew first recommendations in November this year and is scheduled to reconvene in 2023.If they meet the existing VCM guidance in terms of type of credits companies should use and reach the scale to dictate the pricing, 6.4 ERs (emissions-reduction credits) will become the main mechanism of voluntary offsetting and increase supply integrity.

We have identified five types of player that structure VCMs:

- **Project developers** represent the upstream part of the market, developing the projects that will generate carbon credits. Projects range from hydro plants, cookstoves, preventing deforestation, carbon capture and sequestration,
- **Carbon credit buyers** represent the downstream part of the market, buying carbon credits to offset their GHG emissions. Tech companies such as Apple and Google were among the early buyers of carbon credits but we now see more sectors, including finance, joining the market to achieve their net-zero targets or looking for a way to hedge against the financial risks posed by the energy transition,
- **Retail traders** purchase large amounts of credits directly from suppliers, bundle the credits into portfolios and sell them on to end-buyers, with a commission fee. Most transactions are over-the-counter deals but we see some exchange platforms emerging. Among the largest are the New York-based Xpansiv CBL and Singapore based AirCarbon Exchange (ACX). These platforms aim to simplify and facilitate the trade of carbon credits by creating standard products,
- **Brokers** buy carbon credits from retail traders and market them to end-buyers, usually with a commission fee,
- **Standards and certification agents** certify that a particular project meets its stated objectives and the stated volume of emissions. Standards have a series of methodologies, or requirements, for each type of carbon project.

FIG. 27: STRUCTURE OF VOLUNTARY CARBON MARKETS



Source: S&P Global Platts

Putting a price on carbon credits is far from straightforward, mostly because of the wide variety of credits on the market and the number of factors influencing the price. However, we observe that removal credits tend to trade at a premium to avoidance credits. This is due to the higher level of investment required by the underlying project but also because there is high demand for this type of credit, which is considered to be a more powerful tool in the fight against climate change.

The price of one carbon credit can vary from a few cents per ton of CO2 emissions to USD15-20/ton for reforestation projects to USD300/t for tech-based removal projects such as CCS.

WHAT TO DO WITH **CAPTURED CARBON**?

SECTION 6

So far, CO2 is mostly used for Enhanced Oil Recovery

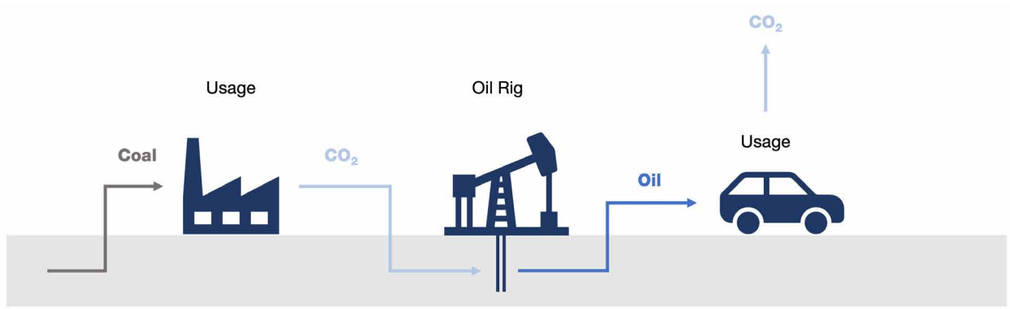
Carbon capture is a crucial tool to reach Net Zero by 2050, providing a way to balance emissions that are hard to abate, including from long-distance transport and heavy industry.

According to the IEA, in 2020, 21 CCUS facilities were operating around the world and virtually all the CO2 captured came from natural gas processing plants at 27 Mt out of c. 40 Mt. The deployment of carbon capture projects has been concentrated in the US, which is home to almost half of all operating facilities.

Once captured, most of this CO2 is used in a process known as Enhanced Oil Recovery (EOR), whereby carbon dioxide is injected underground to extract more oil since adding CO2 increases the overall pressure of an oil reservoir, forcing the oil towards production wells.

When CO2 is injected underground for EOR, around 90-95 of it remains underground, trapped in the geologic formation where the oil was once trapped. However, capturing carbon dioxide from natural gas processing plants to then extract more oil cannot be considered as the way to go to achieve Net Zero.

FIG. 28: CCUS AND EOR



Source: IEA

Growing momentum around CCUS

Until recently, CCUS projects were not advancing as fast as they needed due to commercial considerations and a lack of policy support. With no incentives or emission penalty, CCUS simply makes no sense. CO2 has no significant value as an industrial input, except for EOR, which is the only form of large-scale, permanent carbon sequestration that currently makes a profit.

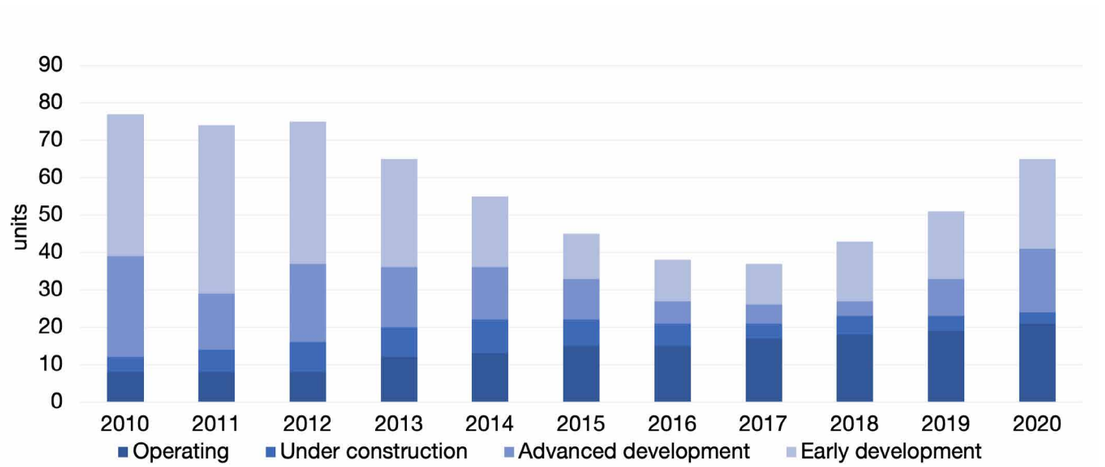
The significant capex effort associated with technical challenges and risks to install or scale up facilities has also played a role. Moreover, CCUS is often viewed as a fossil fuel technology that competes with renewable energy for investment, although in practice there are synergies with renewables.

Carbon capture is not a new technology but we observe growing interest, underpinned by strengthened climate targets and stronger incentives. Also, CCUS costs have been declining, new business models that can improve the financial viability of CCUS have emerged and technologies are advancing and attracting interest from policy makers and investors (cf. Climeworks last fundraising – USD 650m).

Note that there is decreasing reliance on EOR. Less than 50% of the planned facilities are linked to EOR, with a shift towards dedicated CO2 storage.

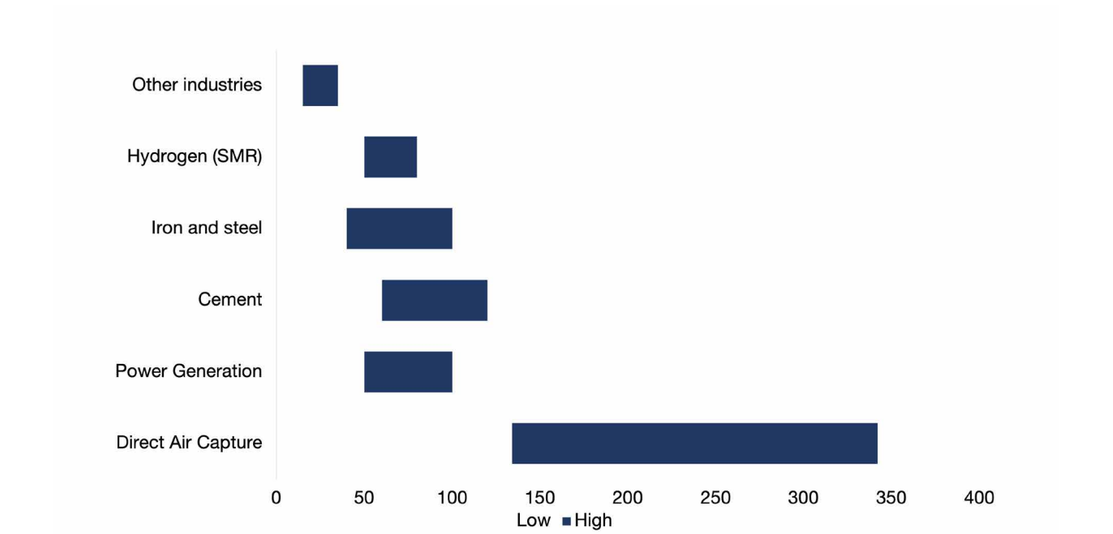
CCUS technologies have achieved significant cost reductions, contributing to growing momentum. According to the IEA, the cost of CO2 capture in the power sector has fallen by 35% through its evolution from the first to the second large-scale CCUS facility, and this trend is set to continue as the market expands.

FIG. 29: CCUS FACILITIES OPERATING AND IN DEVELOPMENT



Source: IEA

FIG.30: LEVELISED COST OF CO2 CAPTURE BY SECTOR



Source: IEA

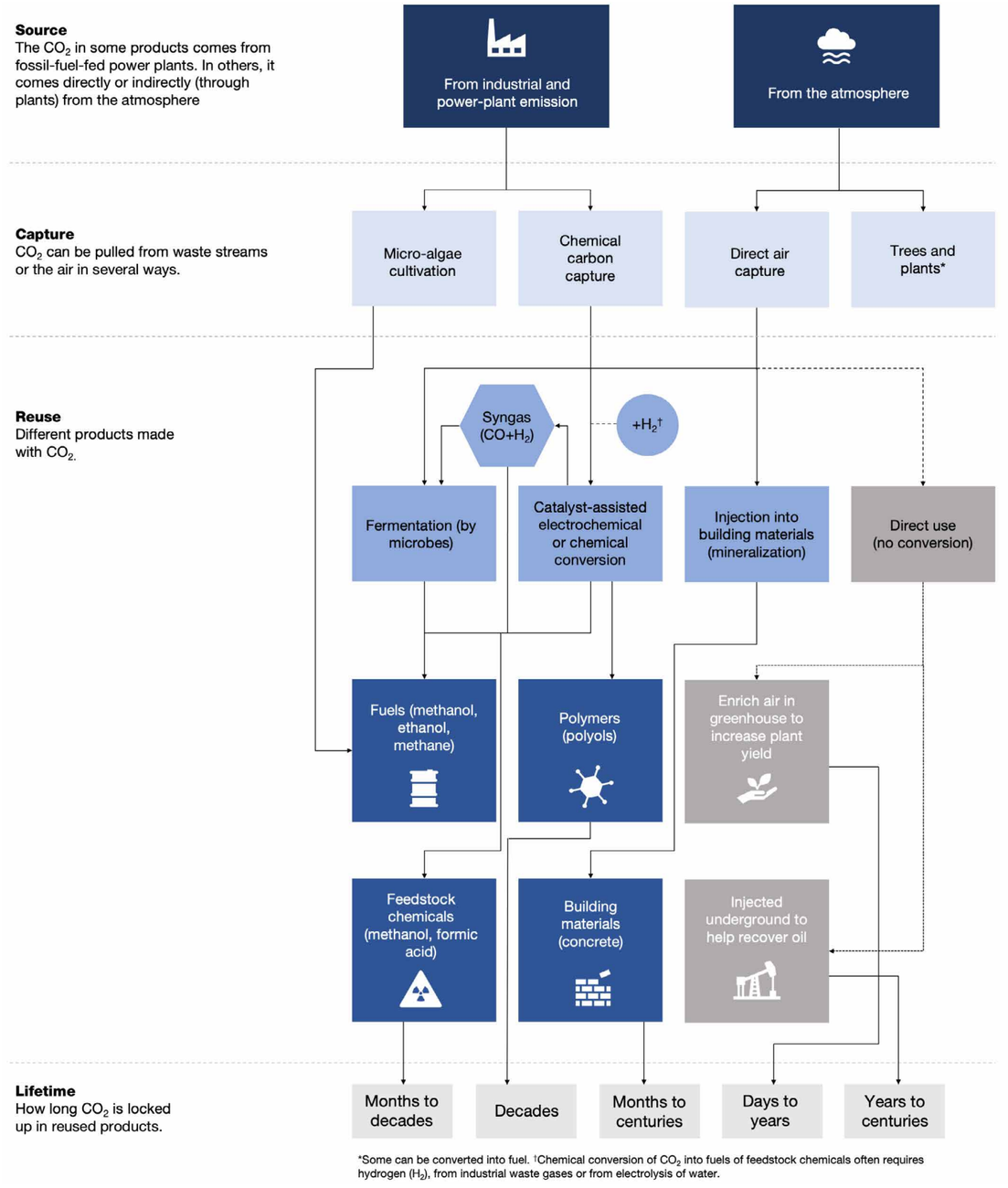
Innovative solutions to upcycle CO2

Although EOR can have synergies with renewables, it cannot really be considered a sustainable application for CCUS, new solutions must be developed to upcycle/recycle CO2. We have identified companies trying to turn carbon dioxide into valuable products. Approaches range from biological processes to using electrochemical cells or catalysts.

Many players combine CO^2 with hydrogen to make fuels and commodity chemicals (methanol, ethanol, methane…). Syngas (a fuel gas mixture consisting primarily of hydrogen, carbon monoxide and very often some carbon dioxide) is conventionally made by an energy-intensive process that crushes methane and water together at high temperatures and pressures.

However, it is unclear whether these products recycled from industrial CO^2 emissions actually protect the climate - because CO^2 will still be released into the atmosphere in the short term. Moreover, carbon capture is still quite expensive, and hence so are products made that way. To maximise climate benefits, it is more efficient to lock recycled CO^2 into products that last for decades. Concrete and building materials are good ways to have permanent sequestration of CO2 in the product.

FIG. 31: REUSING CARBON DIOXIDE



Source: Nature

INTERVIEWS WITH **INDUSTRY LEADERS**

SECTION 7

Stuart Lemmon
Managing Director at EcoAct

You are undoubtedly one of the earliest pioneers of the modern carbon economy. Can you please tell me about your journey in the industry? How did it develop over the past two decades?

EcoAct and I have been in this market for over 20 years. Back in 2005, when Carbon Clear (note: acquired by EcoAct in 2017) was founded, we were focusing on how to sell carbon management to corporate boards.

In 2015, ten years after the founding of both Carbon Clear and EcoAct, the Intergovernmental Panel on Climate Change (IPCC) delivered its Fifth Assessment report. It was this report that put an end to uncertainties on the potential impact of climate change, and which then gave way to the Paris Agreement. From this point everyone started to take climate more seriously, particularly large governments, and momentum in the sector really began.

Another step-change that followed was after the release of the guidelines of the Task Force on Climate-related Financial Disclosures (TCFD) in 2017. These recommendations changed the corporate appetite for sustainability services as investors acknowledged the long-term impact of climate change on the value of their capital and demanded to see better climate disclosures. It was a major boost to the market back in 2016-2017 which brought around growth for climate businesses like EcoAct.

These factors alongside increasing climate impacts in recent years (record breaking heatwaves, floods and droughts) and coupled with growing public concern and climate protest have given rise to the extremely dynamic and demanding environmental market which we are seeing today.

Speaking about the demand, how would you describe the current situation with offsetting emissions?

Currently demand in the carbon market is high, driven both by regulation and corporate public commitments. Supply, however, is slow to respond to that as it takes a couple of years to bring projects to life, particularly when considering the time taken for projects to undergo the feasibility assessments, secure funding, and pass audits to achieve certification by the standards. Thus, the market is currently facing a bottleneck on that front. This situation is further demonstrated by the unprecedented price hikes in credits, where the same projects can trade +20% YoY, which is of course an issue for large credit consumers such as big corporates.

One of the solutions to this which is gaining in popularity is customers opting to develop their own offsetting projects. It has benefits across the whole value chain, as it allows corporates to secure the supply and the price, as well as promotes capital flows into new climate technologies.

Do you think that current macroeconomic climate and geopolitical situation may halt the investments and, more generally, the customer spend on sustainability solutions?

If we look back to the financial crisis of 2008, sustainability was considered a discretionary spend item. Therefore corporate spending on sustainability was impacted. During covid, however, the situation was different. We saw a lot of businesses continue to grow and little evidence that the appetite to tackle sustainability was being diminished. This marked a significant shift in the perception of sustainability spend towards “must-have” rather than something ”nice-to-have”.

Today, there is widespread recognition of the need to reach net-zero. Every year, EcoAct undertakes research into corporate climate disclosures, and we see now that the majority of large businesses are committing to reach this global goal. Even though the other geopolitical challenges threaten the speed of progress, - Ukraine, energy crisis and rising costs of living - climate is still high on the agenda and is here to stay.

We do anticipate that the market will cool to some extent, as there are more organizations now on their transition journeys rather than starting out. But the core services, such as climate strategy, footprint measurement and target setting will be here to stay. However, the expectation is now that companies must also grapple with their entire value chains in order to achieve net-zero which will require increased effort and expertise.

Let’s talk about EcoAct. How do you differentiate yourself in the market?

There are few direct competitors that offer the breadth of services as a climate change consultancy. We position ourselves as a one-stop-shop for climate-related sustainability, able to guide organizations along the full journey to net-zero and support them in science-aligned climate action. All this is further boosted by the digital expertise of our parent company, Atos.

Our core offering very much relies on the length of our experience, the depth of our knowledge and our scientific rigour. We have a strong R&D team providing technical understanding of the underlying emissions and translating this into solutions to support our customers and drive progress in corporate actions.

As part of our comprehensive offering, we are also experts in carbon offsetting and nature and technology-based climate solutions, acting as retailer and project developer. We have developed our proprietary EcoScore methodology, which has been proven over more than a decade to select the highest quality credits and guide credible offsetting strategy, which we are particularly valued for by our customers.

Most of our clients are large publicly listed organizations. We help them interpret their data, find flaws, set sustainability targets, act on them, and communicate on them properly. The latter gained a lot of traction recently, since the communities, and especially investors, became much more knowledgeable on the topic. There is now a much higher degree of sensitivity of what is being shared in the public domain. In other words, tolerance towards greenwashing is much lower than it was before. Therefore, it is key to ensure the reliability of the underlying assessments, which drives demand for high-quality expertise-based consulting.

As we touched upon data gathering and emissions accounting, how do you approach this at EcoAct?

Typically, the business model of EcoAct has always been

system-agnostic. Since we are not focused on software development, but rather on interpreting the data and ensuring it is collected from all the relevant sources, what we do is select the best platform for our clients and manage it as a service. This service provides two benefits for the client: technical expertise of EcoAct to achieve the required level of granularity in the calculations and a software system that automates the data collection.

What we are seeing today is the boom in the supply of the SaaS carbon accounting solutions which offer real-time customizable visualisations and dashboards. Most such new solutions are based on the one-fits-all assessment methodology, which can potentially oversimplify the calculations and lead to rather aggregated results due to omitting data, locations, interpretations, and context. That is why it is important to add a layer of supervision, especially in the context of EcoAct target customers, who are large and complex organizations.

How did the acquisition by Atos back in 2020 change the way you approach your customers and digital offering in particular?

At EcoAct we always believed that Net Zero should not be managed by a standalone isolated team within a business, but rather be something embedded within every business line. Digital transformation provides the link between different strategies and operations teams, and EcoAct together with Atos are at the forefront of this transformation.

Strategic alignment with Atos brought two key levers: significant scale of our own digital tools we use to deliver decarbonization services, such as climate risk assessment, to our clients and expansion of the portfolio towards digital.

According to the estimates made by the World Economic Forum, digital technology and its optimization has the potential to cut global emissions by 15%. Together with Atos we developed an end-to-end portfolio that incorporates climate strategy, target-setting, emissions calculation and our other climate advisory services with digital innovations such as Digital Twin, low-carbon data-centres and smart factories. This offering which also includes our voluntary carbon offsetting expertise, enables us to support companies at all stages of the net-zero journey.

Looking into the future, where would you like to see EcoAct and the industry in the next 10 years?

From an industry perspective, we are seeing ongoing consolidation of the market, and a shortage of sustainability management skills. We also see a strong flow of investment turning towards project development in the offsetting market and increasing focus on biodiversity and related social challenges. I would expect both these trends to drive the market in the next years, which is very necessary to bring more disruptive solutions in both emissions reduction and offset in order not to miss the rapidly closing window to maintain a habitable planet. Every single action counts, every lever we can pull we must pull because the climate emergency is too big and too urgent.

Speaking about EcoAct, if I look back 10 years, I see several clients we still work with today. This is testament to our ability over the years to expand and adapt our services to fit the evolving needs of our customers and remain at the forefront of our sector. We are working to maintain this pace and further ensure our ability to react to market changes rapidly and effectively. For this we are currently developing a Climate Academy, which is aimed at addressing the talent scarcity in the market as well as scaling our project development offering with a much larger portfolio of reduction and removal credits.

Garzay Ahmadi
Founder of GO2 Markets

With GO2 Markets being the industry player since its establishment as early as 2013, what was the key catalyst for the carbon economy to gain global traction and where does it sit today?

Carbon markets were brought to the global level on the back of two key catalysts: legislation and corporate appetite for emissions reduction. The former to this day plays a big role in how emissions and carbon credits are accounted for, while the latter focuses on the volumes of the potential reductions and tools available to act on them. This combination influenced the emergence of regional ETS (Emissions Trading Systems) with first-of-its-kind established in Europe and today strongly developing across the globe with more still to come.

Does growing amount of regional ETS complexify the current carbon offset market? How does this impact consumers?

Of course, multiple ETS acting on different macro-regulatory standards based on own interpretations of Article 6 of the Paris Agreement make it challenging to address the global market. For instance, if today you want to support a multinational corporate client with their carbon offset needs, you need to perform an extensive due diligence and run multiple checks on the underlying project economics, such as geography of impact, territorial eligibility, regional versus national versus international eligibility, before pushing it into credits portfolio. This analysis requires specific skills and knowledge, thus pushing customer demand towards more sophisticated services and improving the overall quality of the credits trading market.

I understand that GO2 Markets has its roots in carbon credits trading market. Can you please tell us a bit more about your company journey and how you are addressing today's quality challenge?

We started from the wholesale carbon trading, then quickly moved into renewable energy solutions, energy efficiency certificates and more recently developed a biogas certificates offering. In the offset space, we are much more focused on emissions removals and long-term CO2 storage solutions.
However, its our belief that the climate problem cannot be solved by solely buying carbon credits, but the way we do business also needs to change. That is why today we are growing our consulting offering to help corporates calculate and decarbonize entire scope of their emissions.

These two capabilities combined allow us to adapt rapidly to the continuously evolving regulatory environments across the globe while ensuring highest quality of products and services delivered to our clients, as well as go one step further in the impact tools we can offer. For instance, we have recently designed and implemented an insetting project for one of our clients, which not only generated carbon credits but also supplied raw materials for the company.

With the current scope of offerings, what would be your estimate of the contribution of GO2 Markets to 1.5°C initiative under the Paris Agreement?

To put it in numbers, this year GO2 Markets facilitated:
- 35 million tons of CO2 reductions
- 100 million MWh of renewable energy transacted
- 35 million MWh of energy efficiency measures implemented
- Helped major multinational companies to understand and improve their ESG

Moreover, we got a chance to work on a major solar park construction project in Germany and a few more in South America facilitating its implementation and leading the fundraising efforts.

We also develop a Rainforest conservation project in the Republic of Congo where we participate in the project development and long-term conservation and restauration of peatlands in the second largest rainforest in the world in order to avoid deforestation, improve the living conditions of local communities and keep the biodiversity.

Let's talk about the pricing. I have heard figures that in carbon credits, a single ton sells from EUR4 to EUR800. What is driving such pricing controversy?
The price of one ton of carbon generated through a voluntary offsetting project depends on the underlying economics of such project. Today, there are projects which date back to 1960s such as hydro dams for example. They still produce carbon credits but don't require any significant additional investment, and therefore are trading at a cheaper rate compared to the ones generated through new technologies for long-term carbon capture and storage or other new NBS (Nature Based Solutions) initiatives. These are admittedly less scaled and need significant investment, thus driving the price of ton higher.

How does this translate into the demand from a customer?

Demand for offsets varies for each client depending on their intentions and environmental commitments. To put it in simple terms, if they want to go beyond traditional avoidance and make an impact, let's say, on their supply chain, then they select the project which is requires investment, and therefore is more expensive.

It does not however mean that corporates always opt in for the pricier options. Today customers prefer to maintain a pool of 5-to-15 projects that best address their overall climate ambition and at the same time allow to reduce the average price of carbon to match a desired budget level.

At GO2 Markets, we are tailoring clients' portfolios to their SDGs (Sustainable Development Goals) and geographies of impact. If the company emits a lot in methane, we will focus on it and propose projects to reduce this specific emission. Alternatively, if the company is trying to reduce CO2 emissions from employees' commute, we will turn to fuel-switch projects in the countries of its operations.

There is always a correlation between the geographic footprint of operations, the volume of emissions that need to be offset and how they were generated. Simply put, it does not necessarily make sense to invest in the neutrality project in Mexico, while you are looking to compensate for your emissions in Germany. The approach to tackle this complexity with detail and precision plays a big role in how competitive you can be in this market.

Talking about competition, what is your view on the current landscape and how do you think it will evolve in the future?

Continuously growing demand keeps bringing multiple players to the market, each addressing the sustainability topics differently. We see this variety as an asset, as it helps the industry innovate as we watch and learn from each other, discover things we can do better. It also triggered the important evolution in the funding available to back new technologies in carbon sequestration, which were not possible to implement in the past. Overall, I believe this situation will accelerate the necessary scientific breakthrough and in turn bring scale we need to reach the goal of limiting global warming faster.

If you look forward in five to ten years, what would you consider as successful market evolution and where would you like to see GO2 Markets?

I hope that in 10 years there will be strong work done on the nature restoration, and notably though scale of long-term sequestration technologies such as biochar and mangrove. These not only allow for a large carbon storage capacity, but since also being nature-based, promote engagement of local communities and support biodiversity.

Speaking about energy goals, hydrogen has a great potential to stabilize power needs in the next 10 years. The biggest game-changer however would be the breakthrough of the nuclear fusion tests, as it will completely change the way industry operates today.

Finally, on a corporate climate action side, I foresee the change in their consumer behaviour towards more regenerative economy. At GO2 Markets we already see a lot of clients, especially in chemicals industry, who are increasingly looking to shift towards circular consumption by optimizing the way they use and re-use plastics, probes, and other replaceable materials, connect their waste to the supply chain of another corporate. This model is similar to what is happening now in biogas with household and agricultural scrap being used to create biomethane and organic fertilizer.

As for GO2 Markets, we are aiming to become the reference one-stop-shop decarbonization player through growing our presence across the globe and introducing new offerings for our clients to improve their ESGs, which is key to differentiate from competition today.

planA

Lubomila Jordanova

Co-Founder and CEO of Plan A

Can you please tell me a bit about Plan A and its journey?

I founded Plan A in 2017 with the aim and vision to connect the dots between science and technology, in an effort to enable businesses to lead the sustainable transformation of our economy. Over the last few years we grew rapidly to over 120 people across Germany, France, Nordics, and the UK.

Today, we enable thousands of businesses to decarbonise and align to policy using our certified SaaS platform. The Plan A Platform is a powerful corporate carbon accounting, decarbonisation, and ESG reporting SaaS solution, helping businesses and organisations to tackle broad sustainability agenda from assessing current status-quo to implementing improvement measures to reduce emissions and improve the ESG performance. For instance, on the policy-tracking side, we built an algorithm helping our clients seamlessly map applicable legislation, such as the European Green Deal or Task Force on Climate-Related Financial Disclosures (TCFD), and automate the preparation of the respective reports.

If you were to estimate the impact your solution brought to the climate, what would be a good indicator?

At Plan A we are focused on catering to enterprise and midsize companies and have strong references across various sectors such as Deutsche Bank, BNP Paribas, N26, GANNI, BMW and Apax. Overall, we have served over 1,000 customers to date, for which we facilitated 2%-7% emissions reductions each on an annual basis and provided a strong collaboration instrument to address Scope 3.

What are the features of Plan A Platform your customers are most excited about and how this is different from competition?

Our main differentiator is our focus on decarbonisation. We are the only company in the market that automates emissions reduction planning for clients and goes beyond selling carbon credits trading with a full suite of collaboration solutions to engage with upstream and downstream stakeholders, such as suppliers. This provides businesses with a unique means to pro-actively influence the largest portion of carbon emissions, which is generated from Scope 3 interactions.

On the technical side, Plan A Platform has an optimal data architecture, which enables the model to run rapidly and without any onboarding period.

We are also the first carbon management and ESG platform to be granted a TÜV Rheinland certificate for our methodology, which proves our deeply rooted scientific approach and further strengthens our value proposition based on trust and quality.

Speaking about source of the data on the platform, how do you address the input problem to estimate footprint of your customers?

Our platform works with both spend-based and acti

vity-based methods, as well as a mix of the two. In other words, we can combine physical data from invoices and real-life resource consumption measurements such as electricity metres, to provide businesses with the most tangible estimates of their carbon footprint. The method selected for each of our customers depends on the level of maturity of their data collection practices and is tailored to achieve the highest level of accuracy.

We are not, however, relying on financial data, as it leads to not very precise results based on our research into various methodologies.

What is your view on the current market trends in the corporate carbon footprint software space?

One fantastic development is the speed of the development of the regulations around ESG and climate change for businesses. Europe is very advanced in comparison to other regions. More developed economies are catching up and introducing standards into their legislations with more recent examples of Japan rolling out TCFD regulations and the USA strengthening its climate policy.
Looking at the nature of offerings, today the market is still incredibly immature with a lot of focus on offsetting and related technology, including the corporate carbon software space. There are a number of issues with offsetting today, such as longevity and quality, which defeat the purpose of climate action. We are continuing to face a 300% increase in climate-risk associated costs, and it destroys our infrastructure. To address this, businesses need to change the nature of their operations towards more sustainable production and reduce as much as possible the amount of the residual emissions needed to be compensated, especially within Scope 3 value chain emissions.

How are corporates taking on the challenge to reduce Scope 3 emissions?

Today we are seeing a strong industry push from large organisations for their suppliers to set tangible decarbonisation targets. A good example is one of our clients BMW, who recently asked its suppliers to be able to provide evidence of their footprints and measures to reduce carbon emissions. Unless compliant, the suppliers will no longer be selected to work with the company. This approach supports BMW's initiative to reduce its Scope 3 emissions, and broadly represents what would it take to make value chain footprint management possible.

Plan A developed collaborative functionalities on the platform encouraging our customers to add their suppliers, investors, and other third-party stakeholders in order to better address Scope 3 categories.

What is the next carbon challenge you are planning to address at Plan A?

For the upcoming years our priority at Plan A is scaling what we have. Our business model is full SaaS and aligned to the wide range of modules available on the platform.

From the technology standpoint, we already operate with a high level of automation and our own APIs. We are continuously working to identify implementation gaps to ensure highest quality emissions estimates provided by the platform.
Commercially, we would like to see more supply chain and financial sponsors engagement on the platform. This would bring the biggest impact at scale to the race against climate change.

In five years from now, which climate achievement would you consider a success?

Industry will need to mature at a few levels. First comes qualitative education to boost understanding of the difference between "climate positive" and "net zero" across wide groups of stakeholders beyond ESG teams and consultants. Second step would rely upon businesses becoming more mature in their climate strategies and driving the collaborative side of the decarbonisation targets across their value chains. This will align Scope 3 targets between all stakeholders and become the largest reduction lever to reach 1.5°C target set in the Paris Agreement.

puro•earth

Antti Vihavainen
Co-Founder and CEO of Puro.earth

As a pure-play carbon removal specialist, can you please tell me about the current state of the industry? What are its key challenges?

Since the climate change started drawing public attention in response to the cascades of events caused by rising temperatures across the globe, people realized the urgent need to act. This trend massively scaled the demand for emissions reduction and compensation techniques, which at that time were still in early stages of conceptualization. Consequently, it led to the emergence of multiple players offering variety of solutions at different quality standards.

Today we witness the most fragmented state of the market where offset solutions differ significantly depending on quality and geography. This is further complexified by the emergence of multiple regional systems, such as separation of APAC market, which is currently moving towards establishment of its own regional carbon markets. Too many and different standards are counterproductive from the value proposition perspective and more importantly halt consumers from taking efficient and impactful climate actions.

To solve this problem, we need to make sure the standards are aligned. ICVCM (Integrity Council for the Voluntary Carbon Market) is already working on it through raising the quality bar of carbon credits worldwide with their Core Carbon Principles (CCPs) initiative.

How do you think such harmonization would impact the current ecosystem of players?

As I mentioned earlier, the most promising solution to harmonize the market, in my opinion, is being developed by ICVCM. The core of their guidance for harmonization lies within enforcing definitive global threshold standards for carbon credits to generate genuine reductions and removals. It is essentially based on the quality principle and will shift the value chain towards players able to provide high-quality supply at scale.

How do you position Puro.earth in the current state of the decarbonization value chain?

Puro.earth gained traction with the growing prominence of carbon removal and maturing demand for quality offsets. 95% of people that approach us already did a lengthy journey towards decarbonization. They already figured out how to reduce their emissions, announced their SBTi (Science Based Targets initiative) commitments, and probably already used some offset credits to compensate for their environmental footprint. When they need more than just avoidance-based credits, customers come to Puro.earth.

Puro.earth supports its customers in the selection of the removal-based credits for their portfolio coherent with geography and product preferences and ensures their long-term availability and dollar price. What strongly differentiates us from the other carbon marketplaces is that we are focusing exclusively on offset projects that adsorb additional CO2 back from the atmosphere such as DACCS, BECCS and carbonation. We have also recently expanded our portfolio with enhanced weathering projects, which are based on our ground-breaking Enhanced Rock Weathering methodology.

I also note that Nasdaq took a majority stake in Puro.earth back in June 2021. Can you please tell me about the highlights of this partnership and how did it impact your current offerings?

This investment and strategic partnership with Nasdaq brought us the necessary support to scale the offering towards its 4,000+ corporate clients installed base and expand into new carbon removal technologies. Today, we are proud to say that we contribute to around 500 thousand tons of CO2 being removed from the atmosphere.

In addition, through this collaboration, Nasdaq launched the first-of-its-kind CORC (CO2 Removal Certificate) Carbon Removal Price Index to help corporates understand the true cost of neutralizing their emissions. It is a composite index that monitors the price of all CORC transactions, as well as carbon credits based on biochar and bio-based construction materials projects.

In the future we will add more sub-indexes as other carbon removal technologies mature.

Since we touched upon the removal technologies, what are the most promising ones to develop at scale in the next 5-10 years in your view?

In five years, we will be in 2027. In 2025-2026 there is going to be a large number of BECCS facilities opened. That said, I would expect the first million tons of CO2 to be removed through BECCS and enhanced weathering at that point. It would probably trigger greater involvement of private sector to accelerate the development of both technologies and drive the capital inflows.

What I would personally consider a great achievement, is if by 2027 we saw five million tons of CO2 removed by both BECCS and smart weathering. This is an attainable goal, which in part relies upon the harmonization of standards as we discussed earlier and regulatory incentives. Overall, it will definitely be a landmark breakthrough from technological perspective and for our planet.

You did not mention DACCS. Do you think it will take longer to reach significant advancement of this technology?

DACCS is an interesting methodology for carbon removal, but I am not sure its heyday could be within the next 5 years, perhaps 10. However, it will not mature unless focus and investment is targeted there as well.

There are so many lower-hanging fruits that could and should be tapped into. Starting with biomass waste streams, which has a potential to be turned into a powerful tool for CO2 capture and storage on the back of investments (de-facto carbon credits).

In general, turning liabilities into assets by turning waste into carbon credits is a very promising stream since it offers many alternatives based on the variety of discarded materials across regions and businesses. On our level at Puro.earth we are seeing the

big increase in demand for such solutions from clients and believe this will drive significant growth of the carbon economy in the coming years.

Do you envisage any digital technologies to help the industry develop further?

Today the Web3 advocates say that gathering data in blockchain will solve the trustworthiness issue within the credit trading markets. We at Puro.earth don't fully believe in blockchain as a silver bullet since it does not provide buyers with the tools necessary to assess and compare complex and technical data behind offsetting projects while constructing their portfolios. It will of course greatly increase the transparency of the data leading to issuance of credits but without high quality, scientifically reviewed methodologies, climate impact is not guaranteed.

Talking about the future of Puro.earth, where would you like to see yourself in the next years?

We would like to be the ones stimulating net-negative emissions and actively developing the offset requirements with the goal to become a global reference for pioneering carbon removal standards and navigating marketplaces. At Puro.earth we understand the hurdles of the system as we had to build the marketplace before and would like to promote the connection between the players from the likes of Watershed, Patch, Cloverly and CO2.com in the US, running their own marketplaces, to those developing projects generating carbon credits, such as our suppliers.

LanzaTech

Freya Burton

Chief Sustainability Officer at LanzaTech

With Lanzatech being among the leading industry players, what was the key catalyst for the carbon economy to gain global traction and where does it sit today?

Today, the carbon economy is growing and people are becoming more aware of how carbon plays a key part in their lives. No longer just thinking about carbon as a source of fuel, but also as integral to the things we use everyday, from textiles, packaging, footwear and other things.

How did we get here? Several things have happened at the same time.

- More technologies are coming online, helping grow visibility of what's possible (LanzaTech, twelve, carbon engineering, Climeworks to name a few),
- This is no longer just a lab curiosity, but you can see commercial site and buy actual products in stores,
- Climate change and awareness of our carbon problem is now in mainstream media, no longer relegated to special niche climate sections of some outlets. People are more aware than ever of the need to rethink how we do things. Especially the next generation of consumers. This then makes it existential for consumer brands to align with these values,
- ESG funds from investors/banks/VCs etc looking to close green premium gap, support new technologies and get plants built.

How does Lanzatech support its customers in their sustainability ambitions?

LanzaTech supports customers in several ways. We ask people how the procure, use and dispose of carbon, so along the supply chain we can have an impact. We can work with upstream customers who have emissions they want to reduce/eliminate such as a steel mill and we can work downstream with consumer goods companies, looking to reduce the carbon footprint of their supply chain. We don't double count the carbon reductions, but we can give our customers a choice as to what to do with and where to source their carbon. For example, we can work with a clothing company who would like to find new ways of making polyester yarn. Today it comes entirely from virgin fossil inputs. With LanzaTech, we can replace part of the supply chain with ingredients sources from recycled carbon. This helps the customer, reduce the carbon in their supply chain. In addition, we have customers who want to move away from plant-based materials that can impact land use change, biodiversity and water use. For this reason, they use recycled carbon and this way we can help them meet additional sustainability goals beyond carbon.

What is your largest market today ? In the future ?

At present, our commercialized Carbon Capture and Transformation (CCT) gas fermentation platform technology produces sustainable ethanol from multiple gaseous feedstock sources. Although a viable product for the fuels market, we view ethanol as an intermediate product that can be further refined and upgraded to numerous high-value chemicals and materials such as PET, MEG, Ethylene, etc. Therefore, we view our end markets span a broad cross

section of the trillion dollar chemicals market. Our sustainable ethanol can also be utilized in the production of sustainable aviation fuel and renewable diesel via the LanzaJet alcohol-to-jet technology platform. We are constantly developing new microbes/biocatalyst to be used in our gas fermentation platform in order to produce various chemicals directly from the feedstock source rather than first going to ethanol and then upgrading to other chemicals. A good recent example is the direct production of ethylene from CO2.

In addition to the products we produce and the markets they serve, we serve the broader industrial decarbonization market. As a licensor of our CCT technology, our customers are industrial emitters and waste aggregators looking for profitable solutions to decarbonize their processes and footprint. Our solution broadly serves the heavy industrial complex with a wide-ranging customer base.

What is the biggest challenge to capture and recycle carbon ?

There are a number of challenges today, from securing financing for all the technologies to scale in the right time frame and also the right regulatory frameworks to create a secure market for products made from recycled carbon. Today there is an imbalance of support for CCU applications vs CCS. In some jurisdictions, carbon credits are given to only CCS applications and the benefit of reusing carbon for making durable goods is lost. Some environmental advocates and policymakers inaccurately portray all CCUS applications as perpetuating the use of fossil fuels. Our central premise is that carbon utilization, particularly from waste feedstocks, will be critical in a truly sustainable circular economy and actually the only way to transition away from virgin fossil fuel production and use. There is progress being made but it is slow.

Another challenge for many CCU applications is that we still need the economies of scale for direct air capture and green hydrogen production. This is why a solution like LanzaTech's.

NÉOLITHE

Nicolas Cruaud

Co-Founder and CEO of Néolithe

Can you please walk me through the story behind creation of Néolithe and how did it evolve over the past years?

With the goal to reinvent waste treatment industry and reduce its CO2 footprint, 3 years ago two other associates and I founded Néolithe. By bringing together the knowledge of minerals combined with the application of cutting-edge industrial technologies we developed an efficient fossilization process to turn non-recyclable waste, which up until now have been either buried or incinerated, into mineral resource equivalent to traditional aggregates widely used in infrastructure.

Since foundation, we raised €23m in funding, grew our employees base to reach 130 people, and established an industrial scale plant processing 10 tons of waste per day.

How does Néolithe technology contribute to the carbon emissions reduction and what are its key features?

Each year France produces around 30 million tons of non-recyclable refuse, which is either incinerated or stored in landfills. This activity is responsible for around 6% of annual carbon emissions of the country. When we approached reduction of these emissions at Néolithe, our main goal was to create the treatment solution such that it is carbon-negative by nature, or in other words – it captures more CO2 than it emits.

Our innovative process is based on three-step approach: waste sorting, fossilization, and formation into an industrial-grade aggregate through the combination of powdered waste with water and the proprietary binder. This binder is a key component of the chemical process, which allows to produce a coherent new mineral, which we call Anthropocite, certified under the reference industry standards, such as Technical Evaluation of Products and Materials (ETPM).

Can you share with me a few examples of Anthropocite applications in the industry?

With the certification I mentioned earlier, Anthropocite has proven technical and mechanical features of traditional aggregates, and as an example, can be used in road sub-bases and concrete. We recently poured concrete composed of Anthropocite aggregates as the foundation of one of our buildings.

In addition, our technology is not solely directed to the end use, but also entails benefits throughout the whole industrial value chain. It provides an alternative route to the sorting facilities, which so far are heavily dependent on landfills and thus underlying regulations.

Speaking about regulations, what is the state-of-the-art of the industry today and how does it impact the overall market conditions?

Legislative base in waste management is relatively established and continuously tightened, for instance introducing the obligation to reduce landfill capacities by 50%, which was recently voted in France. Similar policies are also adopted across the globe.

These objectives drove the prices of landfills higher, which in turn gave rise to alternative technologies making them cost-competitive. Such trend created a strong momentum for Néolithe, and I believe will benefit the overall climate ambition not only from emissions reduction perspective, but also through promoting circularity.

Looking at the competition, how would you describe the main players and what do you consider to be your unique differentiator?

Since we are focused exclusively on treatment of non-recyclable refuse, we don't see many competitors operating at scale at this time. There are a few players in the space, who are targeting material recovery, especially in mix plastics, such as Le Pavé or Arqlite. We don't consider this as competition as we are not taking the same waste as an input.

At Néolithe, we differentiate ourselves through a combination of value chain circularity applications and a carbon sink approach to waste management. Our fossilization technology allows to remove around 250 kilograms of CO2 per ton of treated refuse, while landfills result into around 250 kilograms of CO2 emissions per ton.

What is your plan for Néolithe in the next years?

In the short term, we are planning to scale our industrial facilities and open 25 new plants across France next year with the overall ambition to reach 2.5 million tons waste treatment capacity by 2027. In addition, we are aiming to expand operations across Europe and enter Asia, notably Japan, given its market potential. Such scale will position us as a leading player on both domestic and international markets, as well as establish fossilization technology as a reference solution.

From a long-term perspective, we are continuously working on improving the existing solution with the goal to achieve highest quality of waste sorting by separating the powdered refuse further into recyclable waste and further contributing to the UN goal on sustainable consumption and production.

BRYAN, GARNIER & CO

Investment Banking for a Better Future

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