BELLONA
EUROPA

THE CARBON CREDITS CONUNDRUM:

WHY GOVERNMENTS NEED TO REGULATE CARBON REMOVAL AND VOLUNTARY MARKETS

GUIDANCE DOCUMENT FOR POLICY MAKERS

AUGUST 2022

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Grateful thanks to the Children's Investment Fund Foundation for supporting our work on industrial climate action.

CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

DISCLAIMER

Authors:

Mark Preston Aragonès

Ana Šerdoner

Dr Samantha Eleanor Tanzer

Design and Layout:

Rebecka Larsson

Dr Samantha Eleanor Tanzer

EXECUTIVE SUMMARY

This briefing provides an overview of the current landscape of Carbon Dioxide Removal (CDR) in the context of existing voluntary carbon markets, the risks of insufficient regulation of CDR, and recommendations to ensure CDR is thoughtfully allocated and does not get in the way of efforts to reduce emissions. It outlines the status of voluntary and regulatory carbon markets which feature carbon credits from avoidance, reductions, and removals, and defines recommendations for the sound governance of CDR.

To understand policy needs for an adequate approach to Carbon Dioxide Removal (CDR), a clear understanding of the basic principles behind the way we account for emissions is paramount. While carbon accounting does not necessarily represent a one-to-one relationship with physical carbon flows, it allows us to quantify the fulfilment of that responsibility and to trade ownership responsibility and actions between actors. Therefore, an annex to this briefing clarifies the difference between avoidance, reductions and removals and the different way to allocate responsibilities for emissions.

The European Union's regulatory framework for CDR should ensure that removals are effectively managed and do not lead to setbacks in significant emission reductions or greenwashing. To do so, the policies should:

- Acknowledge that **emission reductions must be the overwhelming majority of climate action** and do not allow CDR deployment to be used as a substitute for feasible emission reductions.
- **Focus on rapid emission reduction targets**, with an additional and separate carbon removal target.
- **Treat removals stored in temporary biological sinks and permanent geological sinks separately** instead of treating different types of removals as interchangeable.
- **Aim for biological removals to balance biogenic emissions and geological removals balance geological emissions** to achieve economy-wide net-zero emissions.
- **Regulate advertising and marketing claims** to ensure that stakeholders (and their products) must always present disaggregated data and cannot claim climate neutrality on the basis of offsets.

The trading of reductions via offsetting may result in a responsibility being fulfilled on paper, but does not change the fact that carbon is still being emitted to the atmosphere. As long as atmospheric greenhouse gases are still increasing, we have a collective responsibility to act.

BACKGROUND

WE MUST STOP EMITTING GREENHOUSE GASES AS SOON AS POSSIBLE, AND EVEN THAT MAY NOT BE ENOUGH

Preventing further catastrophic climate change requires that we stop emitting greenhouse gases (GHGs) as soon as possible. This is an enormous task. The European Union alone emitted almost 3 billion tonnes of CO_2 in 2019. In recognition of this urgency, the EU adopted the European Climate Law, committing to reduce its domestic greenhouse gas emissions to "net zero" by 2050, with an interim target of net 55% reduction (relative to 1990) by 2030. This requires slashing annual net emissions by almost 1.3 gigatonnes (Gt) in the next seven years, and then by a further 2 gigatonnes in the two decades after that—a reduction rate more than triple that of the past thirty years. Importantly, the European Climate Law dictates that 52.8% of the 55% 2030 reduction (ca 1.25 Gt) must be in the form of reduced emissions, while 0.23 Gt can be in the form of CO_2 removals via the land sink.

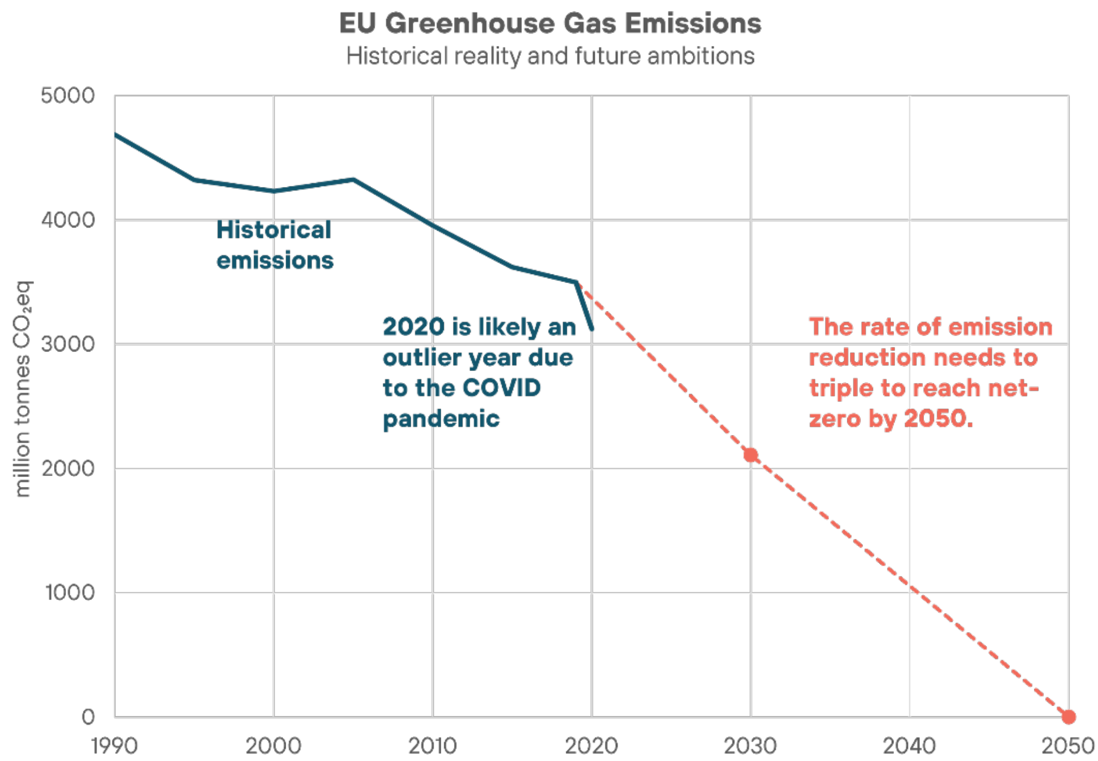


Figure 1. Historical greenhouse gas emissions (data from EEA) and the emission trajectory needed for EU Climate Law ambitions

What Does 'Net-Zero' Mean?

The Paris Agreement, adopted in 2015 by the Parties to the UNFCCC, aims for a balance between man-made emissions by sources and removals by sinks. The term 'net-zero' has come to represent this aim. The scientific community is in broad agreement that achieving 'net-zero' emissions at a global level will effectively halt further human influence on the climate.

A "net-zero" target does not necessarily mean that zero greenhouse gases are emitted. Rather, any greenhouse gases that are emitted must be matched by the removal of an equivalent amount of greenhouse gases, typically carbon dioxide, from the atmosphere. But how much carbon dioxide removal (CDR) will be available and what role it should play in EU policy is currently under intense discussion.

Bellona holds the view that an appropriate net-zero target apportions an overwhelming majority of the mitigation effort to reducing emissions and separately balances emissions and removals for the biological and geological carbon cycles.

What Does Carbon Dioxide Removal Mean?

For a carbon dioxide removal process to reduce atmospheric concentrations of CO_2, it must meet four minimum criteria, as defined in Tanzer & Ramirez (2019) and adopted by the Advisory Council of the European Zero Emission Technology and Innovation Platform:

1. Carbon dioxide is physically removed from the atmosphere.
2. The removed carbon dioxide is stored out of the atmosphere in a manner intended to be permanent.
3. Upstream and downstream greenhouse gas emissions, associated with the removal and storage process, are comprehensively estimated and included in the emission balance.
4. The total quantity of atmospheric carbon dioxide removed and permanently stored is greater than the total quantity of greenhouse gases emitted to the atmosphere

The point of carbon dioxide removal is to reduce atmospheric concentrations of greenhouse gases. This only happens if the removal is permanent, physical, and net of associated emissions.

– **Dr Samantha Eleanor Tanzer**
CDR Research & Technology Manager
Bellona Europa

How Does Carbon Dioxide Removal Fit In?

Carbon dioxide removal is the physical, permanent, and net removal of greenhouse gases from the atmosphere. The latest IPCC report sees carbon dioxide removal as a necessary part of limiting global warming, with three sequential roles:

1. As supplement to rapid massive-scale reductions to get to net-zero faster
2. To maintain net-zero by compensating for residual emissions
3. To remove historical emissions

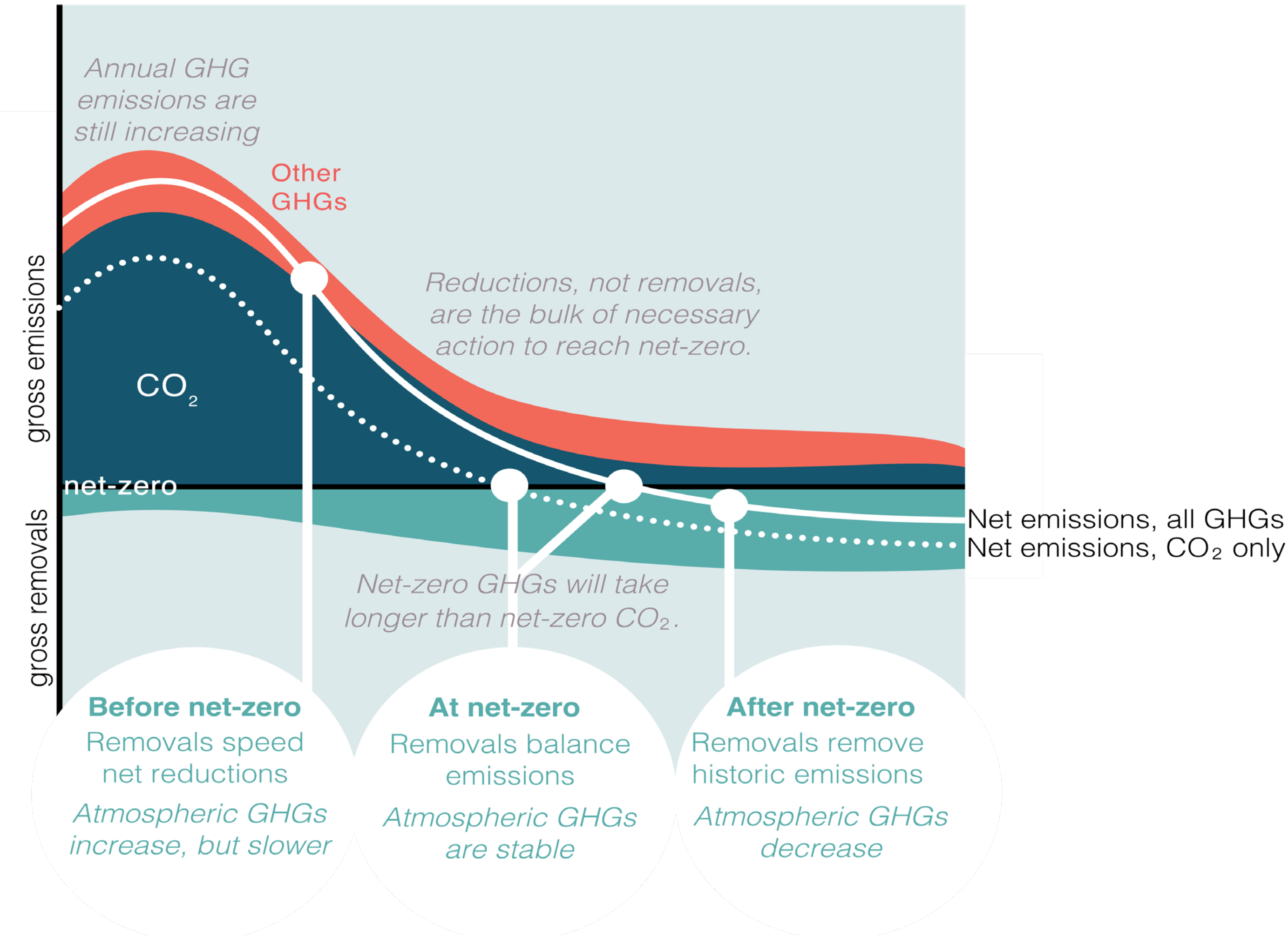


Figure 2. The three sequential roles of carbon dioxide removal in mitigating catastrophic climate change (Stylized rendering; adapted from IPCC 2022)

GLOSSARY

General terms

Carbon offsetting
Any emission avoidance, reductions, or removals that claim to compensate for emissions elsewhere.

Carbon credit
Any tradeable certificate representing the right to emit a set amount of greenhouse gases, typically in units of 1 tonne of CO_2 or CO_2eq.

Net-zero target
Any greenhouse gases that are emitted must be matched by the removal of an equivalent amount of greenhouse gases, typically carbon dioxide, from the atmosphere. Legally originates from the Paris Agreement: "achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases"

Key definitions for emission accounting types

Direct emissions accounting
Direct emission accounting assigns ownership of greenhouse gas emissions, and the responsibility to deal with them, to the emitter. Also known as "Scope 1" or "gate to gate" accounting.

Consumption-inclusive emissions accounting
Consumption-inclusive emission accounting assigns ownership of emissions, and the responsibility to deal with them, to the consumer (including responsibility for emissions they emit directly). Also known as "Scope 1, 2, and upstream Scope 3" or "cradle to gate" accounting.

Comprehensive emission accounting
Comprehensive emission accounting assigns to an entity its direct emissions, all upstream emissions associated with its consumption, as well as all downstream emissions associated with the use and disposal of any products or waste it produces. This includes the responsibility to deal with the emissions. Also known as "Scope 1, 2, and Scope 3" or "cradle to grave" accounting.

Key definitions for describing climate action

Avoidance of emissions
An activity that is assumed to result in fewer greenhouse gases being emitted than in a counterfactual scenario. However, since the amount of GHG avoided is dependent on the selection of a counterfactual scenario—what would hypothetically have happened otherwise—the exact amount of emission avoidance is inherently unverifiable and easily manipulated.

Examples include avoided deforestation or displacement of fossil fuel consumption.

Reduction of emissions
Reductions occur when a change in a greenhouse-gas-emitting activity results in that activity emitting less greenhouse gases than it did before or in a reduction of the activity which emits greenhouse gases.

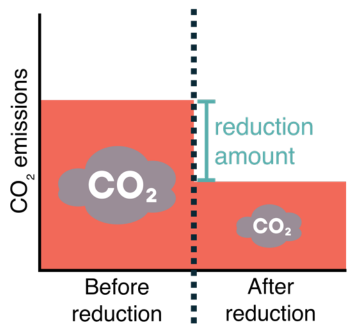
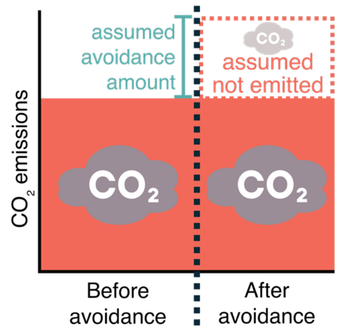
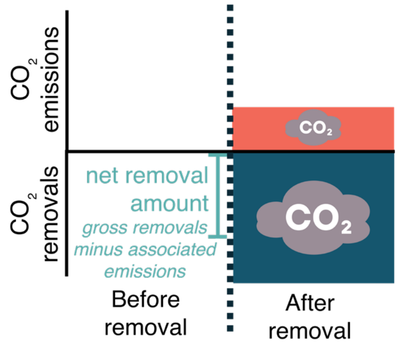
- Absolute emission reductions occur when the total amount of GHGs emitted decreases compared to a historical baseline.
- Relative emission reductions occur when the amount of GHGs emitted per unit decreases (e.g., per GJ of energy generated, per tonne of product, per capita, per euro of GDP).

Examples include adding CCS to a cement plant or reducing the output of cement.

Removal of CO_2
Carbon Dioxide Removal can be achieved when greenhouse gases are physically and permanently removed from the atmosphere.

1. Carbon dioxide is physically removed from the atmosphere.
2. The removed carbon dioxide is permanently stored.
3. All associated emissions are comprehensively estimated and included in the assessment.
4. The total quantity of atmospheric carbon dioxide removed and permanently stored is greater than the total quantity of greenhouse gases emitted to the atmosphere.

Examples include capturing the CO_2 from biomass conversion and storing it geologically.

Reduction	Avoidance	Removal
occurs when: a change in a greenhouse-gas-emitting-activity results in that activity emitting fewer GHGs than it did before or less of that activity occurring.	**occurs when:** an activity is assumed to result in fewer GHG emissions than in a counterfactual scenario.	**occurs when:** greenhouse gases, such as CO_2 are physically and permanently[1] removed from the atmosphere.
is measured in: kg CO_2(eq) not emitted compared to a measured historical baseline	**is measured in:** kg CO_2(eq) that are assumed would have been emitted otherwise.	**are measured in:** *net* kg CO_2(eq) removed from the atmosphere (kg removed minus kg emitted in the removal and storage process and supply chains)
has the net effect that: the amount of GHGs in the atmosphere increases (as GHGs are still emitted), but less quickly than it did before[2].	**has the net effect that:** the amount of GHGs in the atmosphere is assumed to increase slower than it would have if the avoidance had not occurred. The net effect of emission avoidance is inherently unverifiable	**has the net effect of:** the amount of physical CO_2 in the atmosphere decreases
		

1 If the extracted atmospheric CO_2 is at any point re-released into the atmosphere, it is not a removal, but rather a delayed emission.
2 A total reduction results in no increase of atmospheric GHGs, reductions by themselves cannot result in a decrease of atmospheric GHGs

CARBON REMOVAL IN EU CLIMATE POLICY

While removals via the land sink, such as changes in land management and forestry practices, have long been covered by EU climate policy, only recently have other types of removals been considered. The 2050 goal of climate neutrality of the EU Climate Law has led to renewed discussions about the role of CDR in EU climate policy and considerations of whether to include CDR in various existing mechanisms such as the Emission Trading System.

As a first step, the European Commission announced a Carbon Removal Certification Mechanism, expected to be proposed by the end of 2022, and which will form the carbon accounting backbone of future CDR policy

Beyond recognising the need for technology-based removals, the Climate Law also made the significant step of setting a *de facto* separate 2030 target for removals via the land sink of 225 million tons of CO_2 per year. Should the land sink exceed this target, the EU would still need to reduce annual emissions by at least 52.8% below 1990 levels. The separation of the reduction and removal targets is essential to ensure emission reduction efforts remain undiluted by removals. It sets a vital precedent in the way CDR should be handled in climate policy at all levels of governance.

The Focus On ‘Carbon Farming’ Is Harming The Discussion On Carbon Removal

A notable development in EU policy discussions on CDR is the significant focus on so-called ‘Carbon Farming’. The broad stated aim is to generate new revenue streams for land managers who increase the amount of carbon removed and stored on their land. However, the concept of ‘Carbon Farming’ is interpreted differently according to the interests of the stakeholders using it. Increasingly, the discussions pertain to approaches which increase or preserve the carbon content of soils but do not explicitly rule out approaches on above-ground biomass.

While agricultural lands have the theoretical potential to remove and store large amounts of carbon, such storage is unlikely to be long-lasting without perpetual maintenance and monitoring, due to the relatively short timespans of the short-term biological carbon cycle. This high risk of reversal—of stored carbon being re-emitted—is of particular concern where the business model relies on Carbon Farming being used to provide a credit or certificate which is then used to make emission reduction claims or meet carbon accounting objectives.

If Carbon Farming removal certificates can be purchased to “balance out” fossil emissions, a later reversal of the carbon storage (e.g., from drought or fire) could result in a perverse outcome where a carbon removal certificate is issued but no carbon has been removed or reduced. Developing effective monitoring for soil carbon flows remains an essential task but is unlikely to overcome the challenges posed by the reversibility of natural sinks, particularly since climate-related stress factors are likely to increase and further complicate land-based removals as well as monitoring. Should these quantification obstacles be overcome, it may be possible to explore mechanisms which can handle the risk of reversal.

To limit the carbon accounting risk posed by reversals, and to avoid promoting "carbon tunnel vision" that ignores the variety of vital services provided by well-managed land, sustainable land stewardship should instead be incentivised for its non-carbon benefits such as restoring biodiversity, increasing water retention in soils, improving agricultural yields, reducing dependence of fossil inputs, and increasing the climate resilience of the land sink.

Carbon Removal Certification Mechanism: Carbon Removal Is Not Ready For Carbon Markets

The Carbon Removal Certification Mechanism (CRC-M) is being drafted by the European Commission and is expected to be proposed by the end of 2022. While its eventual role in EU climate policy is unclear, the primary ambition of the CRC-M is to reliably quantify and monitor the flows of carbon to ensure that CO_2 is being removed from the atmosphere. This is an essential component for any scheme seeking to incentivise carbon removal.

The current scope of the CRC-M is not yet defined, such as which removal options will be included or how they will be distinguished. As a first instance, the CRC-M will need to clearly distinguish between emission reductions and carbon removals. At the same time, it will need to distinguish between the various levels of storage permanence between CDR methods, perhaps by distinguishing the various carbon sinks, namely the land and geological sinks.

While the upcoming CRC-M policy proposal will not yet specify how these certificates will be used, the Commission has shown a willingness to discuss the possible use of the voluntary carbon market and other offsetting schemes to generate funding for removals and as a way to develop the methodologies for the certification mechanism. Bellona, and other NGO representatives, have strong reservations about the role of offsetting, particularly if different types of removal are deemed equivalent, as only the permanent storage of atmospheric CO_2 should be used to balance out a fossil greenhouse gas emission: a permanent removal for a permanent emission.

Carbon Markets (Eu Ets) Are Not Ready For Carbon Removal

Compliance markets are often discussed as a key tool to incentivise the deployment of CDR. In 2019, the EU ETS was valued at around 683 billion euros[3]. In the EU, there have been discussions of including CDR into the EU ETS. However, there are still many obstacles before CDR should be included into compliance markets.

The primary objective of the ETS is to reduce fossil CO_2 emissions from large stationary installations. As a result, the ETS currently only regulates fossil emissions, with atmospheric CO_2 out of scope and biogenic CO_2 specifically exempted. The current system seeks to optimise mitigation efforts by financially rewarding emission reductions at the expense of installations which fail to reduce their emissions.

Currently, emissions from biomass, or biogenic CO_2, are 'zero-rated' in the ETS on the basis that the climate impact on the land sink is handled upstream in the RED and LULUCF[4] files. Therefore, the system incentivises a switch from fossil carbon to biogenic carbon without handling the biogenic CO_2 emissions. However, assumption of carbon neutrality for biomass is highly questionable as any emitted CO_2, regardless of origin, remains in the atmosphere until it is removed naturally or by human activity. All emissions of CO_2 into the atmosphere should be minimised, not just fossil emissions[5].

3 The price of an ETS allowance has since grown significantly, further inflating the value

4 The Renewable Energy Directive establishes sustainability criteria for eligible sources of biomass while the LULUCF Regulation aims toto take account of the change in the land sink when biomass is extracted.

5 While biogenic CO_2 originates from the atmosphere, the removal happens over multiple decades while the emission is an instantaneous reversal. This time gap between the emission and the removal of CO_2 by regrowing biomass is often referred to as the 'carbon payback period'.

The inclusion of removals into the EU ETS would be a significant departure from the existing system and would require deep analysis on the implications of broadening the scope to such an extent and including a whole new set of industrial installations. Critically, the ETS is a cap-and-trade system which ensures that emissions are kept below an ever-decreasing threshold. Introducing a new category of activities to balance out emissions would run the risk of undermining the 'cap' in the trade system by allowing removals to produce new allowances and undermine incentives to reduce emissions at a system level. In the short- to medium-term, it will be vital that the emission cap is lowered to a sufficient extent that removals will not get in the way of reducing emissions.

The limited amount of removals means that individual entities can't achieve carbon neutrality without focusing on significant emission reductions first.

– **Ana Šerdoner**
Senior Manager Industry & Energy Systems
Bellona Europa

VOLUNTARY CARBON MARKET CANNOT RELIABLY DEVELOP CDR

The Voluntary Carbon Market (VCM) is often touted as a potential source of income for climate-related technologies which do not currently have a viable business model under existing compliance mechanisms. In the absence of sufficient policy, CDR has seen substantial interest from the voluntary market, as can be seen in the noticeable increase in private funding being set aside for CDR-related mechanisms. Examples include the Request for Proposals from Microsoft, the Frontier Advanced Market Commitment led by Stripe, the NextGen CDR Facility led by South Pole, and the Puro.earth carbon removal marketplace[6] to name a few. Collectively, over $1 billion of private funding is committed to purchasing carbon removals by 2030, generally for the purposes of offsetting continued corporate emissions. This amounts to around 0.2% the current value of the EU ETS[7]. To date, approximately $153 million of private funding has been spent on CDR, amounting to 0.02% of the ETS' value.

As a voluntary market, the VCM is largely unregulated. The basis of its existence is to supply funding to projects which would otherwise not be viable (i.e., going beyond what is incentivised or required by policymakers). Despite the financial support promised to CDR, the existence of the VCM reflects the absence of sufficiently stringent policy or compliance mechanisms to incentivise activities which have a beneficial impact on climate mitigation. At the same time, the absence of regulation and standardisation in the VCM has led to an extremely broad range in the quality and cost of carbon credits available on the market.

Currently, the benefit derived from purchasing credits in the VCM is only for marketing purposes: to portray oneself as taking responsibility for their climate impact. Typically, the buyer uses the credits to make claims that their own emissions are "offset" by the avoidance, reduction, or in exceptional cases, removal of carbon from the atmosphere implied by the credits. Since the market is unregulated, the varying nuances of the quality of emission reduction represented by the carbon credits are sublimated, often poorly, into the price of the credit. And since the VCM is inherently voluntary, there is little 'willingness to pay', which incentivises low-quality, low-cost credits.

In general, credits sold on the VCM are excessively cheap, with some credits being sold for less than $1/tonne and more than half being sold for less than $10/tonne.[8] Multiple exposés have reported on the various ways in which the VCM and offsetting credits are flawed, by cutting corners in their design and in their implementation.[9] The issues range from unrealistic estimation of emissions reduction quantities and 'business-as-usual' scenarios to poor monitoring and verification to selling the same credit multiple times. Critically, in the context of carbon removal, many of the activities from which credits are derived are susceptible to reversals, such as reforested areas being burned down, and this risk is not yet well handled in these schemes. A noteworthy example is the almost total failure of the buffer pool, additional credits kept aside in case of reversals, for carbon credits generated by forestry projects in California.

6 Bellona sits on the advisory board of Puro.earth, https://puro.earth/governance/
7 Private sector commitments add up to approximately $1.3 billion, while the EU ETS is valued at €683 billion
8 https://openknowledge.worldbank.org/bitstream/handle/10986/33809/9781464815867.pdf?sequence=4&isAllowed=y
9 https://carbonmarketwatch.org/our-work/carbon-pricing/carbon-credit-tracker/

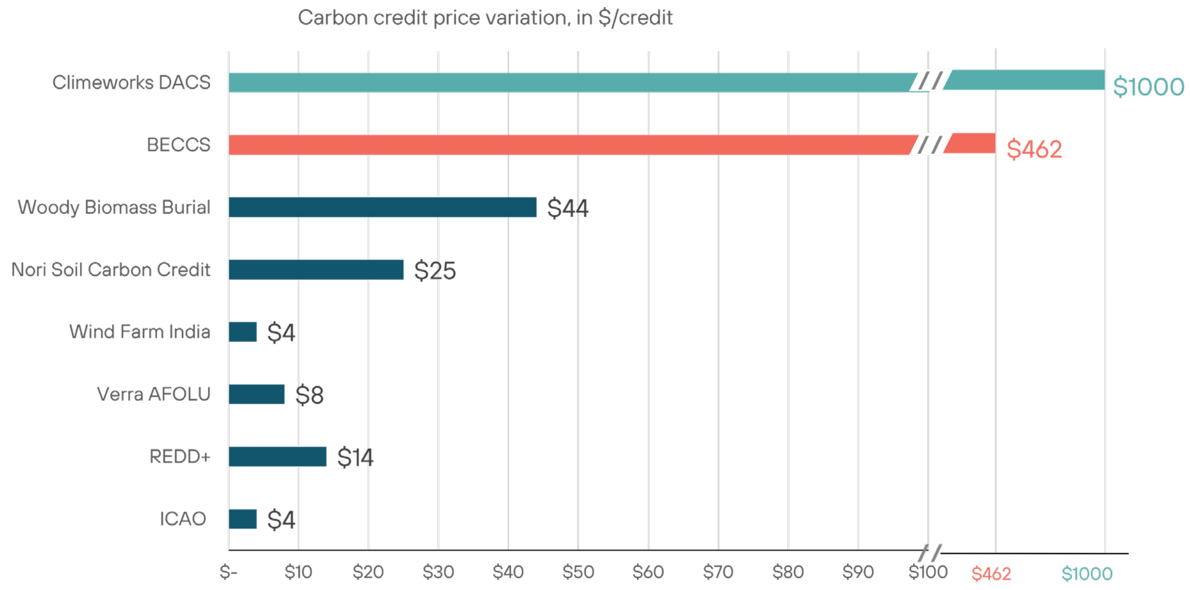


Figure 3. Carbon credits vary significantly in terms of their price tag—and the quality and permanence of the mitigation activity they represent—but are considered interchangeable.[10]

For example, the US-based marketplace Nori, sells 1 ton of CDR credits for $20 that rely on storing carbon in soils. However, the small print states that the CO_2 is intended to be stored for a 'minimum of 10 years'. Yet carbon must be **permanently** removed to have a viable climate impact. If the CO_2 is re-emitted, the climate effect of having removed it in the first place is effectively nullified. That means that 1 tonne of CDR credits purchased to balance out 1 tonne of emissions could result in 2 tonnes of CO_2 ending up in the atmosphere in reality, but no emissions occurring on paper.

That said, some CDR credits exist today which more accurately reflect the real cost of physically and permanently removing CO_2 from the atmosphere. For example, the Swiss Direct Air Capture (DAC) company Climeworks sells carbon credits priced at $1000/tonne, more than 100 times the current median price of a VCM credit. This price clearly signals that true permanent removals are both challenging and scarce. Yet, there is still demand for such credits, generally purchased through bilateral agreements for future removals, from stakeholders who recognise the severe limitations of the current VCM system. However, given these high prices and the dearth in CDR supply, there is little to suggest that such practices will become the norm without regulatory intervention.

Ultimately, the existing VCM produces mixed results and comes at the expense of sectoral emission reductions. The desire to match a donation of funds with a specific climate outcome that can be used to claim carbon neutrality requires a quantification tool and monitoring, reporting and verification system which does not yet exist, and which may prove too complex to reliably implement. Combining the pre-existing issues of the VCM with the additional complications of carbon removal highlights that CDR, and climate mitigation in general, is unlikely to be handled appropriately in voluntary markets without effective regulatory intervention.

10 Data sourced from carboncredits.com, climatetrade.com, cdr.fyi, nori.com and climeworks.com

POLICY RECOMMENDATIONS: REGULATE CDR BEFORE MARKETS RUN AMOK

The recent emergence of CDR as a necessary component of climate mitigation has sparked debates on if and how to include it into compliance carbon markets, such as the EU ETS. While this may be a useful way to handle CDR in the long-term, there are significant challenges which must be addressed first to avoid the issues currently prevalent in the voluntary carbon market. In particular, the critical issues are the inherent difference between an emission reduction and a carbon removal; the limited quantity of CDR projects currently available; the credibility of those projects to permanently remove CO_2 from the atmosphere; and the risk that some stakeholders are likely to be priced out of CDR by stakeholders who arguably do not need CDR to meet climate commitments.

The recommendations presented here are to inform the ongoing initiatives in the European Union, including the legislative proposal for substantiating green claims made by companies; Sustainable Products Initiative, including the proposal for the Ecodesign for Sustainable Products Regulation; proposal for empowering consumers in the green transition; and the Carbon Removal Certification Mechanism). In turn, the private sector should look towards different models, whereby their voluntary financial contributions to environmentally friendly activities can be used in an effective manner without misleading consumers about the environmental impact of their own activities.

✗ Don't allow fossil geological emissions to be balanced out by biological removals.

✓ Do treat removals stored in temporary biological sinks and permanent geological sinks separately.

Not all CDR is equal. How and where the removed CO_2 is stored is the primary factor which determines the quality of a removal, namely, its permanence. Removals that store carbon in geological sinks (e.g., underground storage, mineralization) can be expected to remain stored for thousands of years. Removals that store carbon in terrestrial or biological sinks (e.g., afforestation, soil carbon sequestration) have a high risk of reversal within years or decades. As CO_2 remains in the atmosphere for 300-1000 years, if a removal does not last for at least similar length of time, it does not fully compensate for the emitted CO_2. For this reason, biological CDR should not be allowed to balance out fossil-based geological emissions—the biological sink is both much smaller and operates on a much shorter timescale than geological sinks.

✗ Don’t treat removals interchangeably with reductions

✓ Do make aggressive and rapid emission reduction targets, with a separate removal target on top.

Even if the quality of removal certificates is well managed, there is the risk of both misleading the public on carbon neutrality claims and of mismanaging what is ultimately a limited resource. Removals are more resource-intensive and riskier than reductions and the scale of available removals will be limited both by available resources (e.g., sustainable biomass, low-carbon electricity, access to CO_2 storage). If CDR is allowed to be fully interchangeable with reductions, such as being used as an offset, it risks conflating the two, allowing misleading carbon neutrality claims based on emission reduction offsets and wasting the limited quantity of removals to compensate for emissions that could have been more effectively reduced.

✗ Don’t let available removals be “used up” by first-come first-serve companies.

✓ Do implement robust sectoral emission reduction requirements where feasible reductions cannot be offset by removals.

Not all CO_2 emissions will be preventable, nor will all emissions be able to be balanced with removals. Emissions from diffuse sources, e.g., fuels, fertiliser, livestock, pharmaceuticals will be difficult, if not prohibitively expensive, to abate with the technology available today. No less, some stakeholders which could otherwise abate their emissions may tap into the CDR market, pricing out stakeholders who are not able to abate their emissions. One stakeholder may purchase removals and be able to make a climate neutrality claim at the expense of another stakeholder who will not be able to balance their emissions. In such a scenario, the stakeholders would collectively fall short of reaching net-zero.

✗ Don’t let emitters hide their emissions behind offsets.

✓ Do regulate advertising and marketing claims to ensure that stakeholders (and their products) must always present disaggregated data and cannot claim climate neutrality on the basis of offsets.

In current offsetting practices, the benefit of having reduced or removed CO_2 elsewhere is cancelled out by the emission for which the credit is purchased. Although offsetting is an insufficiently ambitious climate measure, it is currently used to make opaque and misleading claims of “climate neutrality”, that obscure the emission intensity of the activity.

While greenhouse gas emitters may have to report direct emissions to national accounts, emission reporting to consumers is often vaguer. In particular, “net” numbers can obscure the magnitude of emissions versus the magnitude of removals or offsets. Clearer reporting standards are necessary to provide consumers with transparent information, including:

- Reporting of absolute emissions
- Reporting of absolute removals, including the type of sink and permanence
- Reporting of reduction and avoidance offsets, including the type of offset and other relevant characteristics such as timeframe of the activity and baseline assumptions.

Carbon accounting is an intermediary between physical carbon flows and our motivation to change those flows. The accounting of emissions, of non-emissions (reductions and avoidance), and of removals does not, by itself, affect the atmosphere. Instead, **carbon accounting affects people—by assigning emissions**

to individual, corporate, governmental, and other actors, carbon accounting quantifies the responsibility to act to reduce those emissions. Carbon accounting also allows us to quantify the fulfilment of that responsibility and to trade ownership responsibility and actions between actors. Thus, carbon accounting does not necessarily represent a one-to-one relationship with physical carbon, as the responsibility to act may lie with several actors, or gaps in responsibility may exist. Furthermore, the trading of reductions, via offsetting, may result—on paper—in a responsibility being fulfilled, it does change that physical carbon is still being emitted to the atmosphere. And **as long as atmospheric greenhouse gases are still increasing, we have a collective responsibility to act.**

Reducing emissions and removing carbon from the atmosphere are two sides of the climate change mitigation coin. Both will help us achieve climate neutrality, but both are distinct methods of doing so. **Reductions must form the overwhelming proportion of climate action but only carbon removal results in a physical flow of carbon from the atmosphere to a sink.** As such, climate neutrality can only be achieved if emissions are reduced to a sufficient extent that carbon removals can balance out the rest.

Carbon Dioxide Removal must be given the space to develop without undermining broader climate mitigation efforts. Unfortunately, the voluntary markets alone will not be able to do this reliably, so governments must step in to provide much-needed clarity.

— **Mark Preston Aragonès**
Policy Manager
Carbon Accounting
Bellona Europa

ANNEX: WHY (AND HOW TO) COUNT CARBON (AND OTHER GHGS)?

Global warming, and the catastrophic climatic change it brings, is affected by the total, physical quantity of greenhouse gases (GHGs) emitted to and removed from the atmosphere, regardless of where, how, or why those emissions and removals occur. Accurately measuring physical stocks and flows of greenhouse gases for both natural and human-led processes is necessary to understand how these activities result in changes in atmospheric greenhouse gas concentrations and thereby understand the work needs to be done to stop them from increasing further.

Such measurement of physical GHG stocks and flows is a fundamental component of carbon accounting. However, the primary purpose of carbon (or GHG) accounting not to quantify physical greenhouse gases, but to quantify responsibility for emissions and the actions taken to reduce them. Such ownership of GHG emitting and reducing activities is used to incentivise activities that decrease emissions and increase removals and penalise activities that increase emissions or decrease removals. **The purpose of carbon accounting is accountability.**

ACCOUNTING FOR CLIMATE RESPONSIBILITY

Accurate measuring greenhouse gas emissions can be technically difficult but has a right and wrong answer since it deals with physical, observable flows. However, **greenhouse gas accounting is focused on deciding who is responsible for flows of GHGs.** Thus, GHG accounting is dependent on how responsibility is legally defined, which varies broadly across geographies and political structures.

Answering the question of “which emissions am I responsible for?” first requires establishing the scope of the accounting system, including:

- **Geographic boundaries:** What is the geographic area where emissions—or entities responsible for emissions—are included? (e.g., a country, a continent, the world)
- **Temporal boundaries:** For what time period(s) are the emissions accounted? (e.g., a month, a year, a decade)
- **Entity types:** Who are the responsible actors to whom emissions are assigned? (e.g., governments, households, corporations, vehicle owners).

Different scopes are useful for different purposes. While the amount of greenhouse gases emitted in a given region and timeframe is a physical fact, the perceived responsibility to act to reduce those emissions changes depending on the scope of the carbon accounting system.

The following section provides examples of three types of emission accounting system: direct emissions, consumption-based emissions and comprehensive emissions.

Direct emission accounting assigns ownership of emissions to the emitter[11]. The emitter typically the has the most direct ability to reduce those emissions: governments can incentivise reductions and penalise emissions within their borders, corporations can alter their production methods and people can turn down their heat or drive less.

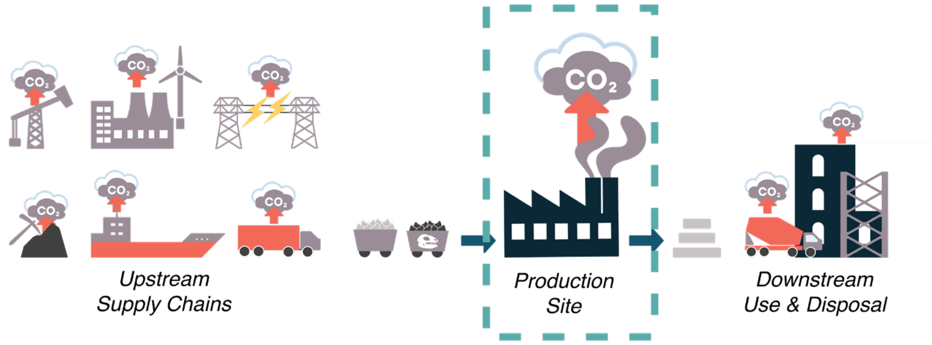


Figure 4. A simplified example: direct emissions of a cement manufacturer

With direct emission accounting, the emissions of a cement manufacturer would only be those emitted at the cement plant itself (and by any company vehicles). The cement plant could decrease its direct emissions by, e.g., installing CO_2 capture or an electric kiln. However, whether such actions decrease overall emissions depends on elements beyond the scope of the cement plant, such the fate of the capture CO_2 or the origin of the electricity.

While direct emission accounting assigns the carbon, and the responsibility to deal with it, to the emitter, **consumption-inclusive emission accounting**[12] instead assigns it to the consumer. This means that an entity is responsible not merely for the emissions it produces[13], but for those occurring in upstream supply chains of what they consume.

These supply chain emissions can be difficult to account for accurately as supply chains are often highly international, and emissions reporting standards can vary widely across regions. However, since environmental impact is frequently not included in the price of products and services, consumption-based emission accounting allows an entity to understand—and take responsibility for—the greenhouse gas emissions resulting from their decision to consume a particular product or service.

10 the Greenhouse Gas Protocol, a global standard for corporate carbon emissions, direct emissions are known as “Scope 1” emissions. In Life Cycle Assessment (LCA), which is used for evaluating the environmental footprint of products and services, they are known as “gate-to-gate” emissions.

12 In the Greenhouse Gas Protocol, this would encompass Scope 1, Scope 2 and upstream Scope 3 activities. In LCA, this would be considered a “cradle-to-gate” system.

13 Another type of consumption-based accounting, used in input-output analysis, is based on “final demand”, where all emissions are attributed only to the end user of a product or service, and not to intermediate users (who produce products for further consumption).

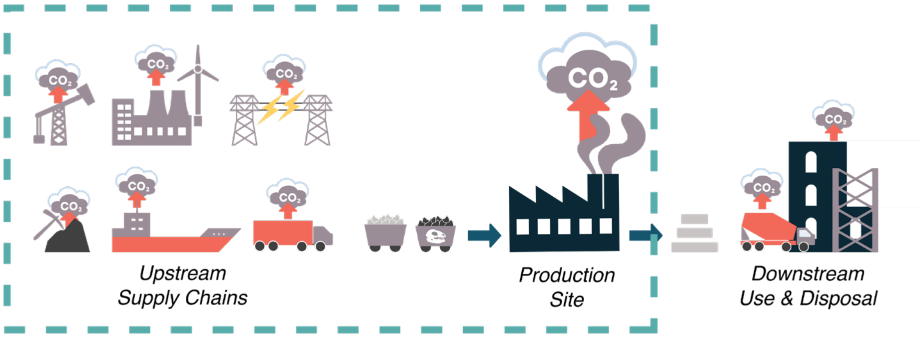


Figure 5. A simplified example: consumption-inclusive emissions of a cement manufacturer

With consumption-inclusive emission accounting, the emissions attributed to a cement plant would also include those in the upstream supply chains of its material and energy inputs (e.g., electricity production, transport, mining, packaging). The cement plant can influence these emissions by switching suppliers, changing transport methods, or alternating production methods and recipes to use lower-emission inputs.

A third type of carbon accounting, **comprehensive emission accounting**[14], assigns to an entity its direct emissions, all upstream emissions associated with its consumption, as well as all downstream emissions associated with the use and disposal of any products or waste it produces. This form of emission accounting can be particularly insightful for corporations whose products result in substantial emissions during their use, such as fuel or fertiliser producers. It is also useful in decisions about potential future activities or technologies, as estimating the emissions of the complete system ensures that emissions are not merely moved out of scope.

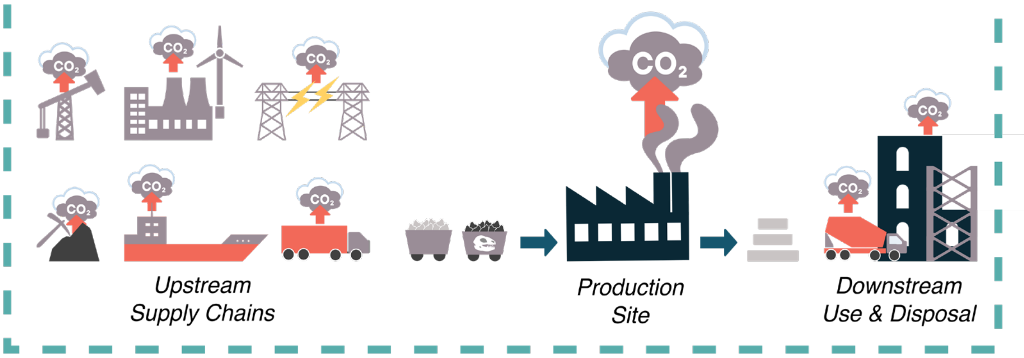


Figure 6. A simplified example: with comprehensive emissions emissions of a cement manufacturer

With consumption emission accounting, the emissions attributed to a cement plant would also include those in the upstream supply chains of its material and energy inputs and the downstream supply chains of cement transport, use, and disposal, and disposal of production wastes. The cement plant can influence these emissions by increasing energy and material efficiency; capturing and storing CO_2, switching suppliers, changing transport methods, alternating production methods and recipes to use lower-emission inputs; providing consumers with information to use their cement most efficiently; and promoting recyclability.

14 Encompassing the full Scope 1, 2, and 3 of the Greenhouse Gas Protocol. In LCA, this would be considered a “cradle-to-grave” system.

Table 2. Examples of emissions by entity types and actions available to reduce emissions (note: intended to be illustrate not exhaustive)

Comprehensive Emission Accounting

Consumption-Inclusive Emission Accounting

Direct Emission Accounting

Entity Type	Upstream Emissions	Direct Emissions	Downstream Emissions	Possible Actions to Reduce Emissions
Governments	Imports	Domestic Production, Consumption, Land Use	Exports	Emission caps, taxation, subsidies, restriction/incentivization of production methods, negotiation for international standards
Corporations	Supply chains of inputs	Factories, machinery, land use, transport fleets	Product transport, use of products and services, wastes	Increased material and energy efficiency, change of product/service design, reduced production, change transport methods, change suppliers, CO_2 capture and storage
Individuals	Supply chain of purchases	Heating, Cooking, Vehicle Use	Wastes	Change behaviour and consumption patterns

What scope of accounting system will be most useful depends on the goals of the accountant. Direct emission accounting can be good use to governments, who have the authority to regulate emissions within their borders. Consumption-based accounting can inform the purchasing decisions of individual and institutional shoppers. And comprehensive accounting remains the gold standard for corporations that have the capacity to influence not only their direct emissions, but the upstream emissions of their purchasing decisions, and the downstream emissions of the products they design. Comprehensive accounting is also critical for all activities that purport to reduce, avoid, or remove emission; otherwise, there is a risk that the emissions are merely displaced elsewhere.

The use of accounting methods that overlap or assign the same emissions to multiple actors, or the use of multiple accounting methods, are not necessarily inaccurate or "double-counting". Though emission accounting uses the unit of "tonnes of CO_2" or "tonnes of CO_2 equivalent (CO_2eq)[15]", it is not counting physical GHGs—it's counting responsibility for those emissions. Unlike physical emissions, responsibility and capacity to reduce emissions may overlap or be interdependent between entities. Thus, assigning emissions only to the producer or the consumer creates a false dichotomy—both are necessary stakeholders in both the production and reduction of emissions and both share the accounted responsibility. Furthermore, any case where there are measured emissions that are not accounted for implies a gap of responsibility. For an accounting system to be complete, any such "orphan emissions" need to be assigned to a responsible entity.

15 "CO_2 equivalent" (CO_2eq) is a unit of measurement that translates the physical amount of non-CO_2 greenhouse gases into an amount that is equal to the global warming potential of CO_2 over a given timeframe to make different GHGs easier to compare. Most commonly a 100-year global warming potential is used, but since different gases behave in different ways over time, this amount is dependent on the assumed timeframe. For example, 1 kg of methane (CH_4) warms the atmosphere as much as 25 kg of CO_2 in 100 year timespan, but in the first 20 years after being emitted, it warms the atmosphere as much as if 86 kg of CO_2 was emitted.

ACCOUNTING FOR CLIMATE ACTION

There are two sides to the carbon accounting ledger. The first side, the emission accounting discussed above, measures responsibility. The second side measures the fulfilment of that responsibility via tracking actions taken to reduce emissions.

Successful emission mitigation requires that there is fewer GHGs in the atmosphere than there would have been otherwise. Knowing how much carbon that we did not emit requires establishing a baseline. This baseline selecting a point of reference that is used to compare emissions before and after an action is taken.

The three main mitigation activities can be defined by their point of reference:

1. **Emission Reduction** uses a **historical baseline**: an amount of GHGs physically emitted by the entity at some point in the past, e.g., "GHGs emitted in the EU in 1990" or "CO_2 emitted in Microsoft's supply chains in 2005".

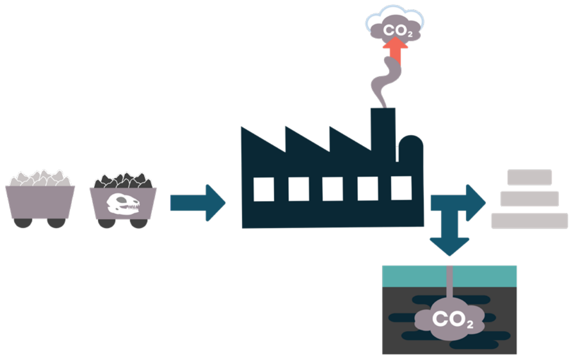
2. **Emission Avoidance** uses a **counterfactual baseline**: an amount of GHGs that is assumed would be emitted if an activity didn't take place, e.g., "CO_2 emitted by clear-cutting 1000 acres of forest" or "GHGs emitted by generating 1000 kWh of electricity from coal."

3. **CO_2 removal** uses a **physical baseline**: how much CO_2 is currently in the atmosphere, e.g., "415 parts per million" or "3210 gigatonnes".

1. EMISSION REDUCTION

"Emission reduction" is used to refer two distinct concepts.

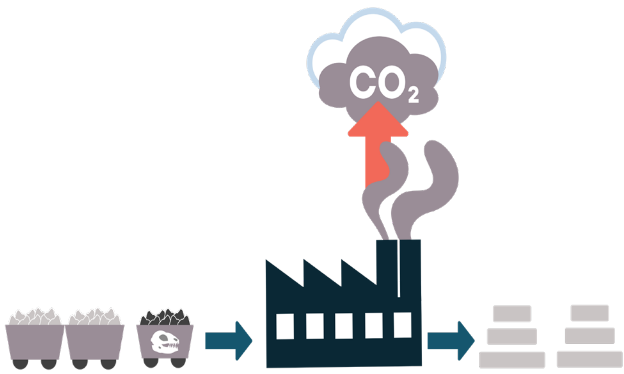
The first, **absolute emission reduction** is when the total amount of greenhouse gases emitted decreases compared to a historical baseline. With absolute reductions, fewer GHGs are physically entering the atmosphere. Massive and rapid absolute reduction of emissions is the foundation of any effective climate policy. Only by preventing further emissions of greenhouse gases can we hope to limit further catastrophic climate change.



A cement plant reduces its emissions in absolute terms by installing CO_2 capture, with the captured CO_2 going to permanent geologic storage. The plant has emitted less CO_2 than it did the previous year.

Figure 7. A simplified example: A cement manufacturer reduces absolute emissions using CO_2 capture and storage

The second type of reduction is **relative emission reduction**. A relative reduction is when the amount of GHGs emitted per unit decreases (e.g., per GJ of energy generated, per tonne of product, per capita, per euro of GDP), such as via increased energy or material efficiency.



A cement plant halves its relative emissions by increasing its fuel efficiency, but also doubles its production capacity. Less CO_2 is emitted per tonne of cement but since more cement is produced the total emissions of the plant stay the same.

Figure 8. A simplified example: A cement manufacturer reduces relative emissions (but not absolute emissions) by increasing fuel efficiency

Absolute reductions can occur without relative reductions, such as via demand reduction. And relative emissions reductions can result in absolute reductions, such as producing the same amount of product in a more efficient way. However, relative reductions do not necessarily result in absolute reductions: a relative reduction in emissions can occur along with an increase in the emitting activity, such as by buying a more fuel-efficient car but then driving more often—this is known as the **rebound effect.** A large enough rebound effect can result in an absolute increase in emissions despite a relative reduction in emissions

2. EMISSION AVOIDANCE

Emission avoidance is the assumption that, in an alternate reality, more GHGs would have been emitted than is being emitted now. Avoidance can be attributed to active interventions, such as employing a local population to actively protect a forest from loggers, fires, and pests, or passive interventions, such as not exercising clear-cutting rights and leaving a forest standing. Such avoidance activities, e.g., preventing deforestation, increasing renewable energy generation are critical for preventing additional increases in greenhouse gas emissions.

However, since the amount of greenhouse gases avoided is dependent on the selection of a counterfactual scenario—what would have happened otherwise—the exact amount of emission avoidance is inherently unverifiable and easily manipulated. In the avoided deforestation scenario, it may be assumed that total deforestation would have occurred otherwise, rather than assuming some or all of the trees would have been left standing—regardless of the original intentions or plans of the forest owner. Furthermore, avoidance activities can have knock-on effects, such as the protection of one forest shifting deforestation to another (so-called 'indirect land use change'), that are equally difficult to attribute and quantify. **Therefore, while avoidance activities themselves may be of critical importance, the usefulness of quantifying emission avoidance activities by the amount of "CO_2(eq) avoided" is limited.**

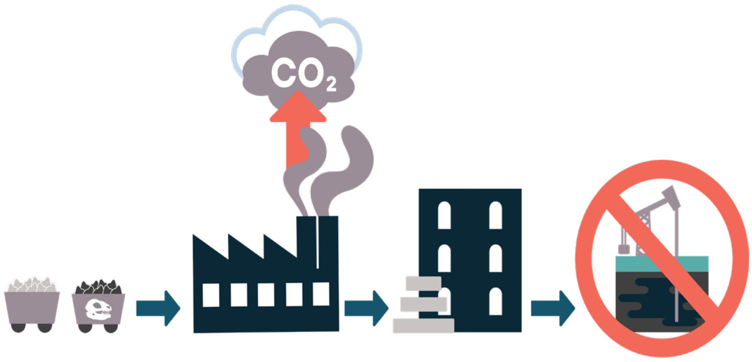


Figure 9. A simplified example: A cement manufacturer claims emission avoidance due to the use of the cement in energy efficient buildings.

A cement plant produces cement that is used to build an energy efficient building. The cement producer then claims that, if their cement wasn't used, a less efficient building would have been constructed, resulting in higher energy demand and higher fossil fuel use. The cement plant then claims as an avoidance the estimated CO_2 not emitted from the possible non-use of fossil fuels in the energy efficient building. No changes to the emissions of cement production itself occur.

3. CO_2 REMOVAL

The **removal** of greenhouse gases from the atmosphere, typically CO_2, is different than emission avoidance or reduction in that it is a process that physically extracts CO_2 from the atmosphere, rather than preventing the increase of CO_2. CO_2 can be removed by enhancing natural processes[16], such as photosynthesis of biomass or weathering of rocks or by engineered chemical reactions.[17]

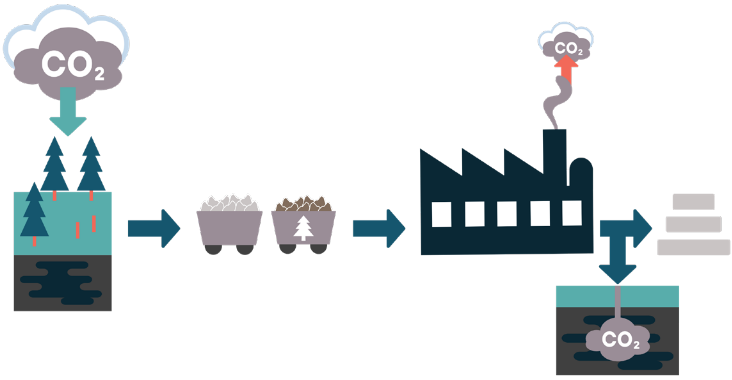


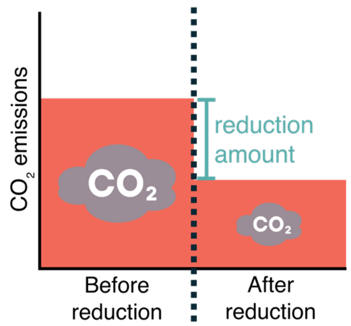
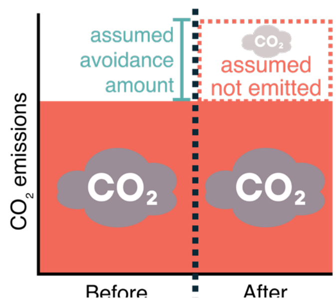
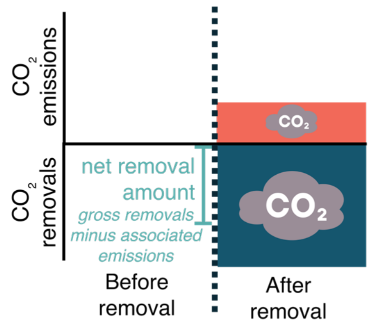
Figure 10. A simplified example: A cement manufacturer removes CO_2 from the atmosphere via the combination of biofuel and carbon capture and storage

A cement plant switches to a biobased fuel source and installs CO_2 capture. The captured CO_2 is sent to geological storage. If the emissions associated with the biofuel production and the CO_2 capture and storage and their supply chains are less than the amount of biogenic CO_2 captured and stored, the cement plant results in net carbon dioxide removals.

The goal of carbon dioxide removal is to reduce the amount of greenhouse gases in the atmosphere. However, extracting CO_2 from the atmosphere is by itself insufficient to result in a decrease of atmospheric greenhouse gases. The CO_2 must then be permanently kept out of the atmosphere. Furthermore, the amount of CO_2 and other GHGs emitted in the process of removing and storing the CO_2—and the associated supply chains[18]—must be less than the amount of CO_2 removed and stored. It is this **net removal amount**, rather than the amount that was extracted from the atmosphere that is the amount by which the CO_2 in the atmosphere decreases and thereby the number by which removals should be quantified.

16 CO_2 already naturally removed by ecosystems does not qualify as Carbon Dioxide Removal.
17 https://cdrprimer.org/read/chapter-2
18 As in the “comprehensive emission accounting”, above.

Table 3. Emission reductions, avoidance, and removals are each distinct but vital parts of mitigating climate change.

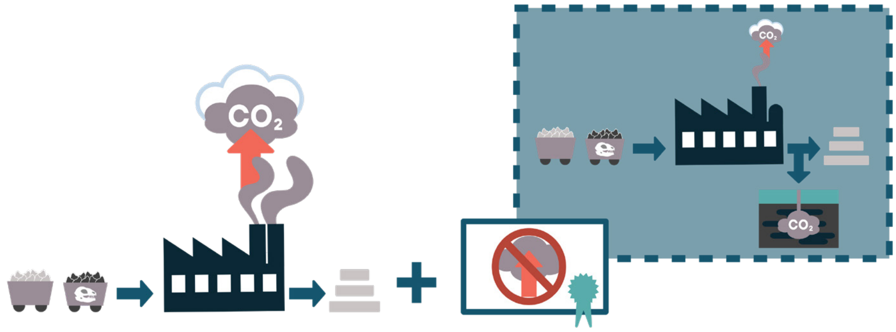
Reduction	Avoidance	Removal
occurs when: a change in a greenhouse-gas-emitting-activity results in that activity emitting fewer GHGs than it did before or less of that activity occurring.	**occurs when:** an activity is assumed to result in fewer GHG emissions than in a counterfactual scenario.	**occurs when:** greenhouse gases, such as CO_2 are physically and permanently[19] removed from the atmosphere.
is measured in: kg CO_2(eq) not emitted compared to a measured historical baseline	**is measured in:** kg CO_2(eq) that are assumed would have been emitted otherwise.	**are measured in:** *net* kg CO_2(eq) removed from the atmosphere (kg removed minus kg emitted in the removal and storage process and supply chains)
has the net effect that: the amount of GHGs in the atmosphere increases (as GHGs are still emitted), but less quickly than it did before[20].	**has the net effect that:** the amount of GHGs in the atmosphere is assumed to increase slower than it would have if the avoidance had not occurred. The net effect of emission avoidance is inherently unverifiable	**has the net effect of:** the amount of physical CO_2 in the atmosphere decreases
		

Finally, **offsetting** is not an activity that reduces, avoids, or removes emissions. Offsetting is the exchange of ownership of the emission reduction, avoidance, or removal activity to a second entity who then claims that those reductions/avoidance/removals balance out their own continued emissions. Effectively, offset is the trading of responsibility.

Offsetting is based on the—often false—assumption that reductions, avoidance, and/or removal activities are both equivalent and fungible. Paired with the assumption that markets are efficient, entities with difficult-to-reduce emissions thus pay entities who can more easily reduce their emissions to do so, resulting in the same total reduction at a lower price. However, this requires ensuring that the boundaries and baseline used by all entities are the same so that each offset exchanged is a measurable tonne of CO_2(eq).

In a cap-and-trade market such as the EU ETS, a set total amount of emissions allowed and the market participants allocate the emissions based on their willingness to pay. The reduction activities and baselines they use are regulated. The market regulator can ratchet down the amount of allowed emissions, thus resulting in absolute reductions among the market actors.

19 If the extracted atmospheric CO_2 is at any point re-released into the atmosphere, it is not a removal, but rather a delayed emission.
20 A total reduction results in no increase of atmospheric GHGs, reductions by themselves cannot result in a decrease of atmospheric GHGs



A cement manufacturer in a cap-and-trade market does not reduce his emissions and emits more than his allowed share of CO_2. They purchase an offset credit from another producer on the market; the credit embodies the reduced emissions of the other producer who is subject to the same baselines and boundaries as the purchasing manufacturer. The total amount of CO_2 emitted by the market as a whole stays within the cap set by the regulator.

Figure 11. A simplified example: Offsets in a cap-and-trade market can result in real reductions across the market as a whole

In uncapped markets, such as the voluntary carbon market, there is no consistent accounting scope or emission baseline, and so it is impossible to verify the actual effect of traded activities, which may consist of absolute or relative reductions; avoidance; or removals; or a mix thereof. Furthermore, offsets can obscure the carbon footprint of the purchaser, especially if the offsets are "subtracted" from the accounted emissions.

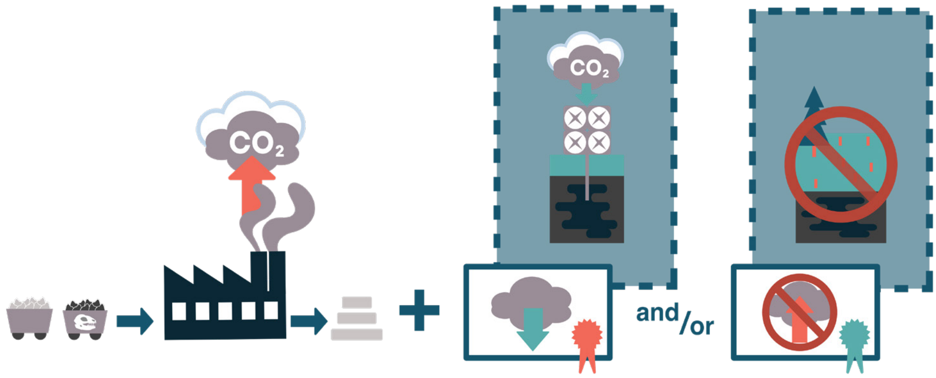


Figure 12. A simplified example: Offsets in a voluntary carbon market are impossible to verify that they result in real reductions

A cement manufacturer does not reduce their emissions but wants to claim "carbon neutrality". They buy carbon offset credits from the voluntary carbon market. These credits may embody CO_2 removed from the atmosphere, or CO_2 that has been or may be reduced or avoided in the future, based on the baselines and assumptions of each individual seller. The cement manufacturer claims that the purchased offsets balance out their own emissions. It is not possible to verify if the total system emissions are lower or higher than before.

CONCLUDING REMARKS

Greenhouse gas accounting is an intermediary between physical carbon flows and our motivation to change those flows. The accounting of emissions, of non-emissions (reductions and avoidance), and of removals does not, by itself, affect the atmosphere. Instead, carbon accounting affects people—by assigning emissions to individual, corporate, governmental, and other actors, carbon accounting quantifies the responsibility to act to reduce those emissions. Greenhouse gas accounting also allows us to quantify the fulfilment of that responsibility and to trade ownership responsibility and actions between actors. Thus, carbon accounting does not necessarily represent a one-to-one relationship with physical carbon, as the responsibility to act may lie with several actors, or gaps in responsibility may exist. Furthermore, the trading of reductions, via offsetting, may result—on paper—in a responsibility being fulfilled, it does change that physical carbon is still being emitted to the atmosphere. And as long as atmospheric greenhouse gases are still increasing, we have a collective responsibility to act.

BIBLIOGRAPHY

Badgley, G., Chay, F., Chegwidden, O.S., Hamman, J.J., Freeman, J. and Cullenward, D. (2022). California's forest carbon offsets buffer pool is severely undercapitalized. *Frontiers in Forests and Global Change*, 5(930426). doi:10.3389/ffgc.2022.930426.

Bellona Europa (2022). *Addressing differences in permanence of Carbon Dioxide Removal*. [online] Available at: https://network.bellona.org/content/uploads/sites/3/2022/04/Addressing-differences-in-permanence-of-Carbon-Dioxide-Removal.pdf.

Carbon Cycle Institute (2021). *What is Carbon Farming? | Carbon Cycle Institute*. [online] Carbon Cycle Institute. Available at: https://www.carboncycle.org/what-is-carbon-farming/.

CarbonPlan (2021). *Systematic over-crediting of forest offsets – CarbonPlan*. [online] carbonplan.org. Available at: https://carbonplan.org/research/forest-offsets-explainer.

cdr.fyi (2022). *cdr.fyi*. [online] www.cdr.fyi. Available at: https://www.cdr.fyi/ [Accessed 26 Aug. 2022].

Chestney, N. (2022). Global carbon markets value surged to record $851 bln last year-Refinitiv. *Reuters*. [online] 31 Jan. Available at: https://www.reuters.com/business/energy/global-carbon-markets-value-surged-record-851-bln-last-year-refinitiv-2022-01-31/.

Climeworks AG (n.d.). *Easy and direct climate action*. [online] climeworks.com. Available at: https://climeworks.com/subscriptions.

Environmental Defense Fund (2022). *State of the Science: Cropland Soil Carbon Sequestration*. [online] Available at: https://www.edf.org/sites/default/files/documents/ag-soil-C-state-of-the-science.pdf.

EUR-Lex - 32021R1119 - EN - EUR-Lex.Official Journal of the European Union. [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1119.

European Commission (n.d.). *Carbon Farming*. [online] ec.europa.eu. Available at: https://ec.europa.eu/clima/eu-action/forests-and-agriculture/sustainable-carbon-cycles/carbon-farming_en.

European Environmental Agency (2022). *Carbon stocks and sequestration in terrestrial and marine ecosystems: a lever for nature restoration?* [online] Available at: https://www.eea.europa.eu/publications/carbon-stocks-and-sequestration-rates/carbon-stocks-and-sequestration-in.

Fankhauser, S., Workman, M., Smith, S., Hickey, C., Stoefs, W., Koljonen, T., Ghaleigh, N., Mast, M. and Macinante, J. (2022). *CO_2RE-NEGEM Workshop - Consideration of Greenhouse Gas Removals (GGR) in Emissions Trading Systems: Principles and Practice*. [online] CO2RE & NEGEM. Available at: https://co2re.org/wp-content/uploads/2022/06/ETS-workshop-report-v3.pdf.

Frontier (2022). *An advance market commitment to accelerate carbon removal*. [online] frontierclimate.com. Available at: https://frontierclimate.com/.

Groom, B. and Venmans, F. (2022). The Social Value of Offsets. *Research Square*. doi:10.21203/rs.3.rs-1515075/v1.

Groom, N. (2022). Wildfires are destroying California's forest carbon credit reserves, study says. *Reuters*. [online] 8 Aug. Available at: https://www.reuters.com/world/us/wildfires-are-destroying-californias-forest-carbon-credit-reserves-study-2022-08-05/.

Hovorka, S. and Kelemen, P. (2021). The Building Blocks of CDR Systems. In: *Carbon Dioxide Removal Primer*. [online] Available at: https://cdrprimer.org/read/chapter-2 [Accessed 21 Jan. 2022].

IPCC (2021). *Climate Change 2021 Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. [online] Available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf.

IPCC (2022). *Mitigation of Climate Change Summary for Policymakers Climate Change 2022 Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. [online] Available at: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf.

Microsoft (n.d.). *Microsoft Carbon Dioxide Removal Program*. [online] Microsoft Sustainability. Available at: https://www.microsoft.com/en-us/corporate-responsibility/sustainability/carbon-removal-program#primaryR4 [Accessed 26 Aug. 2022].

Nori (n.d.). *Nori Carbon Removal Marketplace*. [online] Nori. Available at: https://nori.com/.

Puro.earth (n.d.). *The world's first market for Carbon Transformation*. [online] puro.earth. Available at: https://puro.earth/.

Schaps, K. (2022). *Existing certification schemes to inspire EU plan for carbon removals*. [online] Euractiv. Available at: https://www.euractiv.com/section/energy-environment/news/existing-certification-schemes-to-inspire-eu-plan-for-carbon-removals/.

Schwartzkopff, F. (2022). *'Crazy' Carbon Offsets Market Prompts Calls for Regulation*. [online] Bloomberg. Available at: https://www.bloomberg.com/news/articles/2022-01-06/-crazy-carbon-offsets-market-prompts-calls-for-regulation#xj4y7vzkg.

Smith, P. (2012). Soils and climate change. *Current Opinion in Environmental Sustainability*, 4(5), pp.539–544. doi:10.1016/j.cosust.2012.06.005.

South Pole (2022). *Facility for technical carbon removals being launched by major corporations*. [online] South Pole. Available at: https://www.southpole.com/news/facility-for-technical-carbon-removals-being-launched-by-major-corporations [Accessed 26 Aug. 2022].

Struck, D. (2010). *Buying carbon offsets may ease eco-guilt but not global warming*. [online] Christian Science Monitor. Available at: https://www.csmonitor.com/Environment/2010/0420/Buying-carbon-offsets-may-ease-eco-guilt-but-not-global-warming.

Tanzer, S.E. and Ramírez, A. (2019). When are negative emissions negative emissions? *Energy & Environmental Science*, 12(4), pp.1210–1218. doi:10.1039/c8ee03338b.

UNFCCC (2015). *Paris Agreement*. [online] Available at: https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf.

Wang, F. and Preston Aragonès, M. (2021). *New EU climate law delivers innovative policy framework to advance carbon removal and avoid moral hazard*. [online] ClimateWorks Foundation. Available at: https://www.climateworks.org/blog/innovative-european-union-climate-law/.

Zero Emission Platform (2020). *Europe needs a definition of Carbon Dioxide Removal*. [online] Available at: https://zeroemissionsplatform.eu/wp-content/uploads/Europe-needs-a-definition-of-Carbon-Dioxide-Removal-July-2020.pdf.

CONTACT

Mark Preston Aragonès
Carbon Accounting Policy Manager
Bellona Europa

Phone

Mobile: +32 (0) 486 738 206

Online

Email: mark@bellona.org
Website: www.bellona.org

Bellona Europa is an independent, non-profit organisation that meets environmental and climate challenges head-on. We are result-oriented and have a comprehensive and cross-sectoral approach to assess the economics, climate impacts and technical feasibility of necessary climate solutions. To do this, we work with civil society, academia, governments and polluting industries.