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# Demystifying Carbon Dioxide Removal

## November post-COP roundup

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Dear all,

Big news: negotiators agreed on rules for carbon markets at COP29, including a standard for removals, after almost 10 years of negotiations. Despite progress, some key issues will still have to be worked out, including defining 'durable' carbon storage. We look into progress, and what's still needed, below.

Elsewhere, new analysis has highlighted issues in how we calculate emissions from land use, which have caused us to overestimate how much carbon is being removed by land – with huge implications for meeting climate targets. Scientists have called on countries to provide more clarity on the types of carbon removal they aim to use, and at what scale.

Researchers have provided a reality check on the “seductive concept” of direct air capture (DAC), while other scientists are checking out new ideas for taking up carbon, from constructing fake whale poo to exploring new bacteria.

As always, please feel free to share this newsletter with anyone who may be interested. You can [sign up here](#), or [click here](#) to see previous editions. Don't hesitate to get in touch if you have any questions, suggestions or feedback.

**Till next time,**

**Victoria**

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Stat of the month:

1000 years

The [minimum amount of time](#) carbon removed from the atmosphere would need to be stored to maintain net-zero.



## UN carbon trading agreement

Carbon markets received attention unexpectedly early at COP29. Carbon trading rules – known as [Article 6](#) – were [rushed through for adoption on day one](#) following years of [stalled discussions](#). Decisions included a standard on requirements for [the types of removals should be included](#) in the international carbon market, although these standards [still leave a lot to be desired](#).

This year, the UN body overseeing the negotiations took a new approach: Standards were recommended to decisionmakers for their approval, rather than being negotiated line-by-line. Although COP29 President Mukhtar Babayev lauded the “[positive momentum](#),” some stakeholders were unimpressed by the process, saying that it bypassed negotiations in what Isa Mulder of Carbon Market Watch described as a “[backdoor deal](#).”

Additional rules were discussed throughout the two weeks of COP, with [final decisions adopted over the final weekend](#). However, these were also [met with criticism](#): rules to govern bilateral trading of carbon credits between countries, called Article 6.2, do not require transparency from countries and provide [no real repercussions for countries](#) if they do not abide by the rules.



## Defining durability

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One area that COP failed to cover in depth is the durability of carbon storage after it has been removed. The carbon market rules agreed at the conference [“fail to stipulate the time periods or minimum standards for ‘durable’ carbon storage,”](#) said Kate Dooley, Senior Research Fellow at the University of Melbourne, in the Conversation, [“Temporary carbon removal into land and forests should not be used to offset fossil fuel emissions.”](#)

The COP29 final text did say that rules for Article 6.4, including on durability, must be continuously updated and guided by the [“best available science”](#), but should ensure regulatory stability. Some advocates remain concerned about the vagueness of the language on this point. The governing body of Article 6.4, which is developing a UN-backed international carbon market, will be responsible for continuing this work and [clarifying rules around the non-permanence risk of carbon credits](#), or what happens when removed carbon is re-released.

The question of durability is central, as not all sinks store carbon for the same amount of time or with the same level of reliability. Carbon stored as fossil fuels or in rocks underground can be locked away for thousands of years, meaning it is not exactly equivalent to carbon stored in land and forests as, at some stage, plants die, break down and release some of this carbon back into the atmosphere. Carbon stored in land and forests can also be re-released into the atmosphere due to forest fires and human activities, such as deforestation and conversion of land to agricultural land.

Concerningly, millions of tonnes of carbon used in carbon offset programmes have already been [re-released into the atmosphere due to wildfires](#). At the same time “governments are already [over-relying on such methods](#) to achieve their Paris commitments. [The weak new rules only exacerbate this problem](#),” says Dooley. Plus, changing land use in order to remove carbon at large scales is not as simple as it appears due to the [“complex web of social, cultural, environmental and political factors unique to each region.”](#)



Scientists suggest that the term ‘net zero’ should be upgraded to “geological net zero,” which means “any future carbon emissions must be counteracted by permanent removal of the pollution from fossil fuels – not from pre-existing natural ecosystems.”

A new paper highlighted the need for durable carbon storage and acknowledged that what constitutes ‘durable’ has so far been poorly defined – ranging from “[decades to millennia](#)”. The authors found that storage of CO<sub>2</sub> for “[less than 1000 years is insufficient for neutralizing remaining fossil CO<sub>2</sub> emissions under net zero emissions.](#)” If emissions are stored for just 100 years, this would result in an additional warming of 0.8°C in the long term (by 2500), compared to permanent storage. This is all assuming we reach net-zero, leaving around 6 billion tonnes of unavoidable emissions per year.

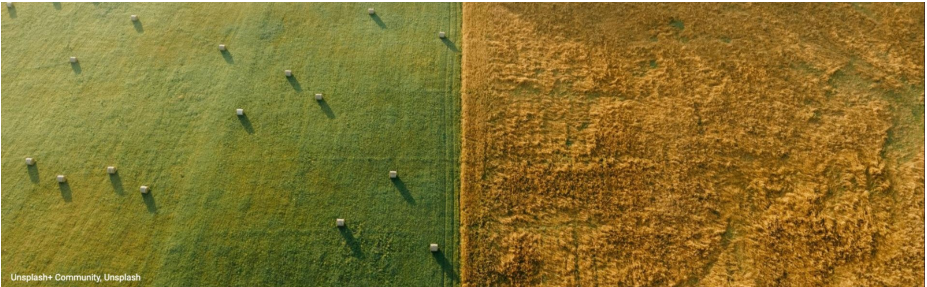
The authors advised that developing removal options that store carbon durably should be incentivised, meaning [stricter regulations on the use of temporary removals to offset emissions from fossil fuels](#). The authors still recognise the [value of shorter-term CDR](#) using nature-based approaches, as these can still help to buy time, take up other types of greenhouse gases like methane, and could [offset CO<sub>2</sub> in the long term if there is a commitment to continually maintain the removals over very long time frames.](#)

Another recent paper reiterated the concept that [emissions and removals should be ‘like-for-like’](#). Basically, the emissions you create from [driving your car should not be cancelled out by planting a tree](#), but by an approach that stores carbon underground in geological storage for long or permanent timescales. Current accounting enables some “passive” forms of CO<sub>2</sub> uptake, like forests and oceans, to be [included as anthropogenic removals](#), even when they are not caused by humans. This means that we are overestimating the amount of carbon we are taking up. The scientists suggest that the term ‘net zero’ should be upgraded to “geological net zero,” which means “any future carbon emissions must be counteracted [by permanent removal of the pollution from fossil fuels – not from pre-existing natural ecosystems.](#)”

### What else happened this month?

- Trump got elected, with implications for future CDR development in the US. E&E news reports that it might be in the best interest of [DAC companies to “cozy up” with the oil and gas industry to try to get continued funding.](#) Others believe that state governments could be the [better avenue for progressing CDR policy.](#)

- The US National Science and Technology Council recently released a [research strategy on marine CDR](#), which might be [short-lived](#) following the election result.
- The EU Council gave the green light on a [certification framework](#) for permanent carbon removals, carbon farming and carbon storage in products.
- Other countries also passed CDR-related legislation during COP29. Kazakhstan rolled out a [nationwide soil carbon programme](#), and a [carbon market regulation framework got senate approval](#) in Brazil.



## Accounting errors

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Analysis has found that we need to [reach net zero emissions five to seven years earlier than estimated](#), due to country climate targets overestimating the potential contribution of land carbon sequestration to their emissions reduction targets by 15-18%.

A [new briefing](#) from my colleagues at Zero Carbon Analytics provided context: countries use various approaches to account for their land-based carbon removal in their Nationally Determined Contributions (NDCs) and, due to the complexity of measuring these sorts of emissions, the UN provides countries [flexibility in how they report and measure emissions from land](#) instead of mandating a consistent approach. The approaches used by individual countries are also different from the methodologies used by the IPCC.

The main reason for this discrepancy is that countries are not required to report emissions from ‘unmanaged land’, such as emissions from [wildfires in areas with limited human activity](#) – as these are considered natural rather than human-caused emissions. The emissions are still released even if they are not reported, leaving an [incomplete picture of the carbon cycle](#). This means that [“Impressive-sounding national climate plans don’t always give a true reflection of progress.”](#) Dr. Joanne Bentley, who led the Zero Carbon Analytics analysis, told The Guardian.

For example, around [34% of forests in Canada are classified as unmanaged](#), meaning that [emissions from natural disturbances, such as wildfires, are not accounted for](#). In 2023 alone, record-breaking wildfires, as well as other natural changes, released [640 million metric tonnes of carbon](#) from Canadian forests – [more than](#) Canada’s CO2 emissions from [fossil fuels](#) in 2022.

Another paper published last week has called on countries to [provide more details on the role of CDR in national climate targets](#). Currently, countries do not have to provide information on the contribution of CDR to their national climate pledges, and most do not distinguish between emissions removals and emissions reductions. This results in low transparency and makes it difficult to determine the ambition and feasibility of climate plans, as well as assess current and future gaps in scaling CDR.

The authors suggested that countries [distinguish emissions reductions from removals in their NDCs](#), better categorise the type of removal by where the carbon is stored – for example, in managed land, wood products or underground in geological storage – and carefully integrate CDR into other areas of the Paris Agreement, such as Article 6.

### **DAC: Reality check on "a seductive concept"**

Issues with relying on nature-based approaches for long-term carbon removal mean more people will look to DAC as a measurable way to reduce carbon. However, researchers in the MIT Energy Initiative have provided a "reality check" on countries' DAC strategies, finding that ["the strategies rely on overly optimistic — indeed, unrealistic — assumptions about how much CO2 could be removed by DAC."](#) They highlight four challenges:

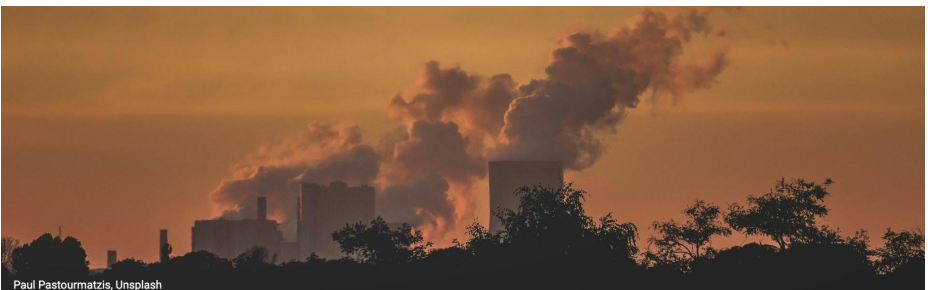
- 1. Scale:** the low concentration of CO<sub>2</sub> in the air means that ["1.8 million cubic meters of air, which is roughly equivalent to the volume of 720 Olympic-sized swimming pools,"](#) needs to be processed to remove a single tonne of CO<sub>2</sub>. The largest DAC plant in operation is capable of only removing around 4,000 tonnes per year. Building plants with larger capacity means they will need to be a lot bigger - for example, ["one recently proposed design for capturing 1 million tonnes of CO<sub>2</sub> per year would require an "air contactor" equivalent in size to a structure about three stories high and three miles long."](#)
- 2. Energy use:** DAC needs to use renewable energy to run, otherwise, its purpose is defeated. However, estimates of deploying DAC with electric power at a large [scale of 10 billion tonnes of CO<sub>2</sub> each year would require over 40% of global electricity generation today](#). The researchers also suggest that studies assuming DAC can [run off "waste heat" are likely wishful thinking](#).
- 3. Plant sites:** The complexity of building new infrastructure is ["commonly underestimated in the real world and neglected in models."](#)
- 4. Cost:** The three previous challenges all point to high costs, which studies often underestimate. The authors suggest that ["assuming such low prices will distort assessments of strategies, leading them to underperform going forward."](#)



## New ideas

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- Scientists have created a yellow powder that captures CO<sub>2</sub> at a rate “[at least 10 times faster](#)” than other materials used for DAC, according to the leader of the study. It is also more durable than other materials, with researchers suggesting it could be re-used potentially thousands of times. Having fewer whales in the ocean means less whale poo, which, believe it or not, means the ocean sequesters less carbon. Marine scientists have come up with an unorthodox solution: [making fake whale poo and sprinkling it in the ocean to help phytoplankton growth and carbon uptake](#). However, the technology may have unknown risks for ocean chemistry and biodiversity and will need to be shown to have “[no deleterious effect](#)” before experiments can expand. An alternative, of course, would be to [restore whale populations](#).
- Microbiologists have discovered a new cyanobacteria, nicknamed “Chonkus”, in volcanic waters which [breaks down carbon dioxide to convert into energy](#) and exploring how [these sorts of discoveries could help contribute to climate solutions](#).
- Carbon removal developers are planning to build the [first DAC facility that will run entirely on wind power](#), aiming to remove 50,000 tonnes of CO<sub>2</sub> per year before 2030.





# Our pick of the news

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[Why the world needs a carbon removal budget, not just a carbon budget](#) (World Economic Forum)

Developing a carbon removal budget could help policymakers and industry make more informed investment decisions on CDR and more effectively allocate the finite amount of CDR we have.

[COP29 agreement on carbon markets divides African stakeholders](#) (Down To Earth)

Despite the agreement on Article 6 of the Paris Agreement, carbon markets cannot solve the underlying issue of emissions from developed countries. A lack of proper safeguards on markets means that there is a risk of predatory practices and land-grabbing, particularly in African countries.

[Atmospheric methane removal: A promising but challenging climate solution](#) (Mongabay)

Researchers are pushing for novel methane removal technologies to be investigated, but the most urgent step is to make significant and rapid cuts to human-caused methane emissions.

[Broadening the carbon removal debate beyond the ETS](#) (Euractiv)

Integrating CDR into the European Emissions Trading System (ETS) could be logical but requires additional thought, said Felix Schenuit and Mark Preston Aragoes.

[Calls for caution as enhanced rock weathering shows carbon capture promise](#) (Mongabay)

Enhanced rock weathering might have big potential to take up carbon, but there are many uncertainties on measuring how much carbon is stored and for how long.

[How can we remove carbon from the air? Here are a few ideas](#) (The Wall Street Journal)

Article weighs up the pros and cons of top CDR approaches.



## Useful resources

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[Framework](#): As the likelihood of overshooting global temperature targets has increased, the American Geophysical Union released an ethical framework for climate intervention research that



“intends to support a transformation toward globally participative governance and practice of research.” ‘Climate intervention’ refers to CDR and other methods to “counteract global warming”, such as solar radiation modification which aims to block out the sun.

[Conference](#): The Institute for Responsible Carbon Removal recently held its Fourth Annual CDR Law & Policy Conference on the emerging regulatory terrain for CDR. Recordings are available [here](#).

[Guide](#): The Carbon Business Council has published a Carbon Removal Policy Guide with FAQs and resources for policymakers.

[Review](#): The Sabin Centre reviewed NDCs and found that 40 countries identified blue carbon ecosystems as a way to contribute to their mitigation, adaptation, or both, strategies.

[Database](#): European NGO Carbon Gap has put together an ever-evolving database of CDR research gaps.

[Primer](#): The US Office of Fossil Energy and Carbon Management released a primer on CDR credits for those “looking to make a meaningful CDR purchase on behalf of their organization.”

[Analysis](#): Nature-focused European NGO Fern has claimed that Stockholm Exergi’s proposed biomass with carbon capture and storage project “will probably not achieve negative emissions.” They add that “there are considerably cheaper and more effective alternatives to BECCS: [an 0.8% reduction of Sweden’s annual wood harvest](#) would sequester as much carbon dioxide as Stockholm Exergi promises.”

[State of the voluntary market](#): A 2024 report on the voluntary carbon market (VCM) released by Carbon Direct found that CDR currently represents only 4% of the USD 1 billion VCM. Projected demand in 2030 based on current project financing falls short, meeting less than 5% of new CDR needed in 2030 to meet IPCC’s 1.5°C-consistent scenarios.

[Paper](#): Researchers suggested a metric called “additional carbon accountability” as a new way to calculate fair shares of the global carbon budget. Some countries should take on extra mitigation or removal responsibilities, on top of their climate targets, based on their past and estimated future emissions. They found that the US and China had the highest carbon accountability overall and the highest per capita for the United Arab Emirates and Russia.

[Interview](#): Microbial ecologist Jake M. Robinson explained why creating a whole forest is not as simple as planting a few trees.

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Each month the demystifying carbon dioxide removal newsletter digs into the world of CDR to bring you the latest stories on everything from carbon credits and net-zero plans to nature-based solutions (NbS) and new technologies. Feel free to forward this email to your colleagues!

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