Demystifying Carbon Dioxide Removal

August roundup

Dear all,

After an extended summer break, we're excited to return with a wealth of new research on carbon dioxide removal (CDR). Academics have developed a carbon removal budget to determine how much CDR is needed to meet global temperature goals and to spark discussions on how this should be allocated. We also explore the renewed interest in adding alkaline substances to the ocean for CDR, the newly discovered climate benefits of trees, and survey findings on expert perspectives regarding CDR.

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.

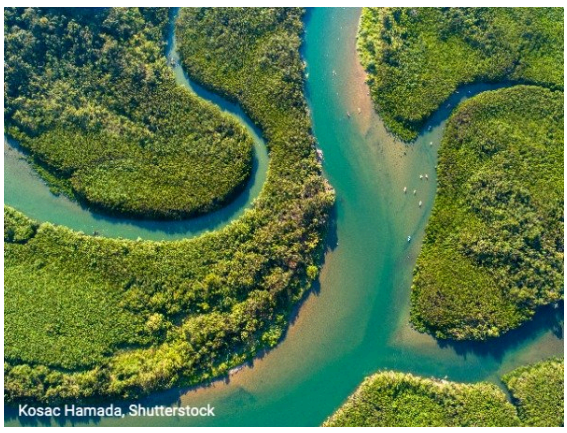
Till next time,
Victoria
victoria.kalyvas@gsccnetwork.org

New to the newsletter? Subscribe here!

Stat of the month:

49 billion tonnes

The amount of CDR needed to keep warming below 1.5°C by 2100, according to a new carbon removal budget.



Carbon removal budget

Academics at the University of Oxford have created a carbon removal budget to calculate how much CDR is available to meet global temperature goals and how this aligns with the remaining global carbon budget. "Carbon removal is the 'net' in 'net zero' and it is mission critical for tackling climate change. However, carbon removal is not in infinite supply and is certainly not free to produce," said lead author, Dr Ben Caldecott.

As both a "finite and essential resource" the authors write that demand for CDR will "likely exceed supply" and allocating use could benefit from a budgeting approach. Like the global carbon budget, the CDR budget "allows us to value remaining carbon emissions and figure out how we distribute that globally between different countries, sectors, and companies." This has implications for who has the right to access CDR that is available to use today and who should be responsible for developing additional CDR for future use.

The authors illustrate that the need for CDR outstrips forecasted deployment in the near term. They estimate "that between 2025 and 2100 the world will face a carbon removal shortfall of 49 gigatons of CO2 in a scenario where warming is kept to about 1.5C". This means that models for future carbon use and reduction assume that more CDR is being deployed in theory than is true in practice and that a higher quantity will be available in future than what is deemed feasible.

Reductions must come first to avoid tipping points

Other studies are helping to build a clearer picture of how CDR will help meet global carbon targets. One recent study employed a new dataset of land-based CDR to assess total CDR use in different IPCC scenarios, which had lacked sufficient data to accurately estimate the total deployment of CDR. The study shows that taking up CO2 via planting trees accounts for "around 10% (median) of the net greenhouse gas emission reductions between 2020 and 2030 in scenarios that limit warming to 1.5°C with limited overshoot".

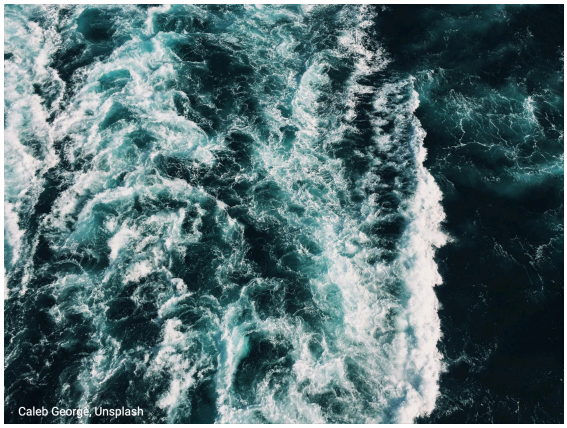
The authors acknowledge that there will be a need for novel CDR methods, like direct air capture (DAC), to remove carbon at the billion-tonne scale, but this will be to cancel out remaining emissions and draw down extra carbon in the atmosphere after reaching net zero. Over 80% of emissions reductions will occur through cutting emissions from fossil fuels and deforestation.

Another paper published in Nature Communications reiterates how critical it is to reduce emissions to avoid crossing climate tipping points, such as those that potentially hit at around 40% forest loss and would have detrimental effects on climate and water. Every fraction of a degree we overshoot 1.5°C of warming increases the risks, which "underlines the need for urgent emission cuts now that do not assume substantial carbon dioxide removal later", according to climate impacts researcher Dr David McKay.

Storage issues

Even if we can take up billions of tonnes of CO2 from the atmosphere, it's not enough to simply remove it, we must also be able to store it durably somewhere – for thousands to millions of years. Another paper assessed just how feasible projections of the amount of carbon we can store under the ground are.

The researchers suggest that a conservatively feasible projection, consistent with technologies available to be deployed by governments globally, would be around 5 to 6 billion tonnes per year. The maximum rate they believe would be technically feasible would be around 16 billion tonnes of CO2 storage per year by 2050, with 60% of this coming from the US. These findings fall in the low range of the latest IPCC projections that there would be 1 to 30 billion tonnes of global CO2 storage available (for both carbon capture and storage and removals) per year by 2050.



"Over 80% of emissions reductions will occur through cutting emissions from fossil fuels and deforestation."

Caustic concerns

Due to its slight alkalinity, the ocean naturally takes up around 10 billion tonnes of CO2 from the atmosphere every year, an amount roughly equal to 25% of global annual CO2 emissions from burning fossil fuels. That has led researchers to explore different ways to boost this process by adding more alkaline chemicals or rocks into the ocean, which take up CO2 as they dissolve — a process known as ocean alkalinity enhancement (OAE).

The Woods Hole Oceanographic Institution in the US has recently made headlines for a new USD 10 million project (creatively named LOC-NESS or "Locking Ocean Carbon in the Northeast Shelf and Slope"), to test this in the open ocean. As a first stage, the project would release 20 tonnes of sodium hydroxide – commonly known as lye and used as an ingredient in soaps – into the water and test how this spreads in the ocean and affects marine biochemistry and biodiversity, such as phytoplankton and microbes.

The project is currently waiting to hear if they will receive permits for the experiments from the US Environmental Protection Agency. As with other similar recent experiments, there have been mixed perspectives about if the project should go ahead. Academics

have endorsed the project, citing the need for research from independent scientific organisations such as WHOI as companies start to market OAE as a climate solution. Fishermen in Cape Cod, where the trial will take place, have strongly voiced their opinions. "The ocean's not a lab rat," fisherman Chris Brown, who serves as board president of the Seafood Harvesters of America, told the National Fisherman. "Once it gets out of the lab and becomes a feature of capitalism, we're screwed," Brown added.

Others expressed similar concerns in an opinion piece in Common Dreams that "after a technology is developed, the scientists involved lose control over what happens next". Another opinion piece in Gulf Times warns that the scale of OAE needed to "make a dent" in CO2 levels would require a significant expansion of the mining industry – surpassing the total production of global coal mining – and the use of nearly all the active large ships in the world to produce and transport the necessary minerals. These concerns are echoed in a blog post by Friends of the Earth, which writes that OAE "would likely emit more CO2 than it would capture due to the required mining, transportation, and shipping of alkaline materials".

Studies on public perceptions have also highlighted that OAE, compared to other methods like DAC, often elicits more negative emotions from the public, "particularly worr[ied] about impacts on ocean ecosystems". Ultimately, treading carefully in these uncharted waters is essential to ensure marine CDR is well regulated and negative impacts are limited.

New kid on the CDR block

The Carbon Removal Standards Initiative (CRSI) is trying to piece together the mess of the CDR standards system, which already features dozens of different and competing methodologies. CRSI aims to build accountability and justice in CDR by providing "technical assistance to NGOs and policymakers to develop and implement CDR policies, with a unique focus on quantification standards". The initiative aims to be independent and unbiased, and is not reliant on funding from the sale of credits. Founder Anu Khan, who previously worked as the deputy director of science and innovation at CDR think tank Carbon180, believes government intervention will be needed to scale up CDR to the billion-tonne levels needed. As a result, CRSI will work closely with policymakers to ensure they have the expertise needed to develop CDR standards. "The private sector has a lot of power right now in setting standards because the public sector doesn't have the capacity", Shuchi Talati, the former chief of staff in the office of fossil energy and carbon management at the US Department of Energy, told Heatmap News.

Climate benefits of trees

As plants use CO2 to grow, increased CO2 levels are known to help plants grow faster and bigger, but the benefits of higher CO2 levels in mature forests had not previously

been demonstrated in practice. Scientists from the University of Birmingham highlighted these benefits for the first time, by slowly pumping CO2 into the air via eight-storey-high pipes upwind of a 180-year-old forest of English oak trees, reaching CO2 levels anticipated in 2050. After seven years of monitoring, they found that the trees' wood production increased by 10% as they took in more of the CO2 in the atmosphere. This is good news for carbon uptake, but the scientists also warned that woodier trees are no "silver bullet". "While carbon is certainly better off in trees than in the atmosphere, where it causes global warming, it's not a long-term solution", the lead authors explained in The Conversation. Over longer time scales, the carbon stored in wood is released back into the atmosphere, meaning it is "not remotely equivalent to it being locked away in coal seams and oil reservoirs deep underground."

It's also important to note that not all forests can make use of the extra CO2. The only comparable study, done on an Australian eucalyptus forest, found no link between increased CO2 and tree growth. The authors of the study on English oak trees suggest their findings are likely relevant only to "'temperate deciduous broadleaf' forests – those which are neither exceptionally hot or cold and which drop their leaves each year."

We normally stick to discussing CO2 in this newsletter, but new research highlights for the first time that trees also play a significant role in taking up methane – a shorter-lived, but much more potent warming gas. The researchers were surprised to find that bark on tree trunks takes up methane. As a result, they suggest trees take up between about 25 million and 50 million tonnes of atmospheric methane each year – equivalent to around 0.5% of all global methane emissions – with most taken up by tropical forests. The finding means that trees could be 7-12% better for the climate than they get credit for.


Olga Danylenko, Shutterstock

"The finding means that trees could be 7-12% better for the climate than they get credit for."

What do experts think about CDR?

The Institute for Policy Integrity has conducted what it believes to be the largest-ever survey of expert views on negative emissions, asking a group of 699 researchers who had published at least one article on CDR their thoughts on key issues surrounding CDR, such as on barriers to implementation and policy enablers. The majority of researchers surveyed are based in Europe and North America (67%), with 21% based in Asia and the rest in other geographies.

Experts surveyed were asked to rank the issues that they believe will pose challenges to scaling CDR, with the key ones being market costs, insufficient market demand or government incentives, incomplete regulatory regimes and technological constraints, each of which was seen as significant by more than 65% of respondents. As for the policies that could best help to make large-scale CDR viable and efficient, carbon pricing was suggested by 89% of respondents. The median predicted scale of CDR from human intervention in 2050 was 2.3 billion tonnes, however, many participants suggested much more bullish figures. Models used in the latest IPCC assessment suggest that by 2050 around 5.75 billion tonnes of CDR per year – from afforestation and land use changes, bioenergy with carbon capture and storage (BECCS) and DAC – will be needed to keep warming to 2C or below.

Respondents anticipate that by 2075, BECCS will contribute the largest share of CDR, accounting for just over 20% of total removal. This is followed by forest-based CDR and DAC. Respondents often estimate higher CDR shares in their own areas of expertise, which could be due to either access to better information or potential bias. Additionally, nearly half of the respondents believe that if widespread CDR does not become viable by 2075, mitigation efforts would be "significantly greater" and that society has a capacity to expand decarbonisation efforts. This suggests that the expectation of future CDR solutions may present a moral hazard.


Fabien Barral, Unsplash

Pick of the news

World's first carbon removal bond to fund Amazon reforestation (Bloomberg)
The World Bank has developed a new kind of bond that ties investors' financial returns to the amount of carbon removed from the atmosphere via reforestation in the Amazon.

Can dirt clean the climate? (The New York Times)
Australian company Loam Bio is using fungi to take up carbon via soil.

Can pulling carbon from thin air slow climate change? (Scientific American)
Growth in the DAC industry can help scale CDR, but risks being captured by the fossil fuel industry.

Can this startup make ocean CDR pencil out, even absent the voluntary market? (Latitude Media)

Ocean CDR company Equatic believes that due to the market for hydrogen, it has a viable business model even if the voluntary carbon market were to disappear.

California wants to pipe carbon dioxide across the state. But what happens if it leaks? (Fast Company)
The need to build thousands of kilometres of new pipelines to transport and store CO2 in California has raised security concerns.

Useful resources:

- Market update: A readout of 2024's second quarter by cdr.fyi saw the highest volume of durable CDR transactions ever recorded, with BECCS accounting for over 90% of these.
- Technical perspective: The World Resources Institute has outlined how having separate climate targets for the reduction and removal of CO2 can prevent overreliance on CDR.
- Open letter: CDR NGO Carbon Removal Canada, alongside 12 other organisations, has submitted an open letter asking ministers to hold a public consultation on establishing a target for permanent carbon removal.
- Commentary: Researchers from the Grantham Institute explore how CDR should best be aligned with an emissions cap, as the UK Government embarks on consultations on the issue.
- Study: New research suggests that China could remove up to 921 million tonnes of CO2 per year via biochar. This means that alongside the carbon sequestration potential of forests, China could achieve carbon neutrality without having to rely on less developed CDR technologies such as BECCS or DAC.

New to the newsletter? Subscribe here!

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!

Contact me at victoria.kalyvas@gsccnetwork.org