

## NEGEM Briefing on the role of CDR in IPCC AR6 WGIII

On April 4<sup>th</sup>, the International Panel on Climate Change (IPCC) published Working Group III's contribution to the Sixth Assessment Report on the mitigation of climate change. The NEGEM consortium congratulates the hundreds of scientists, technical experts and reviewers involved in the drafting of this important document.

This briefing outlines the NEGEM consortium's reflections on the way CDR is handled in the IPCC report and provides recommendations for ongoing CDR research and policy developments.

The headline message of the report is clear: our current and expected pathways of emissions are not in line with the Paris Agreement and we must move quickly to reduce emissions this decade.

The consortium echoes the statement made by Jim Skea, co-Chair of the IPCC WGIII, at the presentation of the report:

“It's now or never, if we want to limit global warming to 1.5°C; without immediate and deep emissions reductions across all sectors, it will be impossible.”

**One of the key messages which has emerged is the fact that deploying Carbon Dioxide Removal (CDR) will be essential to globally reach net-zero.** For many in the climate community, this is not new information: it has been clear for some time that some emission sources are likely to continue emitting greenhouse gases well beyond 2050 and that these will need to be balanced out with reliable CDR.

However, the extent to which CDR is essential to meet our climate goals has shifted and expanded significantly. The increasing reliance on CDR in IPCC models indicates that emissions are not declining quickly enough to meet globally agreed temperature targets.

The IPCC report provides clarity on the fact that some CDR deployment will be needed to counterbalance residual emissions from hard to abate sectors and suggests ranges for CDR deployment. However, the report makes several assumptions that raise the question of whether the amount of CDR shown in the models is realistic or desirable. Since CDR underpins the logic of net-zero and is an essential component of long-term climate plans, it is vital that we lay the groundwork for future deployment and develop a more detailed understanding of how much CDR can realistically be deployed within global limits. CDR will be a vital but limited resource and climate mitigation efforts must take this into consideration. This is the primary objective of the NEGEM project, which aims to identify a realistic deployment potential for CDR in a socially, environmentally and economically conscious manner along with an appropriate governance framework for it to effectively contribute to achieving the aims of the Paris Agreement.

### *Understanding of CDR is improving*

The 6th Assessment Report makes significant progress in its assessment of CDR by providing a clear definition, examining a broader set of methods, capping the contribution of biomass use for climate mitigation and outlining the sequential roles of CDR in broader climate policy.

The report provides a clear definition of CDR and clarifies some common misconceptions: CDR involves the removal of atmospheric CO<sub>2</sub> and long-term storage in various reservoirs. The report also raises the issue of permanence, flagging concerns that CDR deployment could fail to deliver on its intended purpose of

reducing atmospheric CO<sub>2</sub> concentrations if there aren't reliable tools to measure, report and verify that carbon is actually removed from the atmosphere and permanently stored.

Where previous reports had relied almost exclusively on forestry and BECCS, this report explores newer approaches such as Direct Air Capture and Storage (DACs) and Enhanced Weathering (EW), among others. While the body of scientific literature assessed for the AR6 is constantly growing in regard to these additional technologies, they are still poorly represented in the Integrated Assessment Models (so-called IAM's) used to develop mitigation pathways, with some technology options not represented at all.

The report states that bioenergy-based mitigation faces an 'absolute limit' and suggests upper ranges of approximately 300EJ when food security and environmental considerations are included. Previous reports had failed to recognise such a ceiling, however this is still significantly higher than in other reports, such as the International Energy Agency's 100EJ or the Energy Transition Commission's 65EJ. Despite suggesting an 'absolute limit' to biomass availability, some of the models in the report go beyond, up to 450 EJ. As such, the limit to biomass suggested in the IPCC's report is still questionable.

Importantly, the IPCC outlines three complementary roles for CDR:

1. First, to supplement emission reductions and accelerate climate mitigation;
2. Second, to achieve net-zero by balancing out residual CO<sub>2</sub> and non-CO<sub>2</sub> greenhouse gas emissions;
3. Third, for CDR to exceed annual GHG emissions and achieve 'net-negative' emissions globally to draw down global temperatures if temperature goals are exceeded.

The framing outlined by the IPCC provides much-needed clarity on how CDR should be deployed within broader climate policy. In the short- to medium-term, this requires separate targets and governance frameworks for emission reductions and carbon removal to ensure net-emissions are more quickly reduced. In EU climate policy, such a separation is included in the European Climate Law, where the contribution of the land-sink towards the net emission reduction target of 55% by 2030 is capped to 225MtCO<sub>2</sub>e.

At the same time, the IPCC calls on policymakers to responsibly incentivise research, development and demonstration, to better understand the risks and benefits of deploying CDR more broadly.

Bioenergy and Carbon Capture and Storage, or BECCS, plays a less predominant role in this IPCC report than in the previous one, where the large scales of deployment were a source of criticism. Nevertheless, the role of BECCS is still substantial and appears to focus on its potential for power generation, rather than its potential deployment for industrial or district heating or other biogenic point sources such as the pulp and paper or wastewater treatment sectors.

### ***The IPCC's models often gravitate towards CDR at the expense of emission reductions***

There are still many problems in the way the contribution of CDR is modelled in the IPCC report. It is important to point out that the IPCC's pathways are not prescriptive nor predictions of the future. They are complex economic models which rely on assumptions and sketch various ways the global economy might change to meet the objectives of the Paris Agreement. The models should not be interpreted at face value but can be helpful in pointing out how our current economy deviates from pathways which have a chance of staying below temperature targets.

The IPCC models are both globally and economically optimised, providing a 'top-down' view of the broad changes that are required in the global economy to stay below temperature targets in the most cost-efficient way. In this sense, the models will gravitate towards those solutions which produce the best

climate benefit for the least amount of money. In theory, CDR methods such as Bioenergy with Carbon Capture and Storage (BECCS), fill this role very well by producing a good or service while also removing CO<sub>2</sub> from the atmosphere.

However, the models make assumptions about the costs and availability of resources that may not be compatible with a realisable potential of CDR. The models also assume that almost all biomass feedstocks are carbon neutral, without considering the temporary increase in atmospheric CO<sub>2</sub> that results from the delay between an emission and a slow removal via photosynthesis. Other constraints to CDR deployment, such as environmental limits, technical, financial, social, infrastructural and governance constraints are also often excluded.

The limited inclusion of CDR constraints means that when presented with a choice between a CDR method and another mitigation option seen to be more expensive, the models will gravitate towards CDR, since it can theoretically produce the same climate outcome at a lower cost, with little regard to whether the CDR could realistically be deployed. If achievement of SDGs or demand reduction measures are not specifically prescribed, the models will often go for a CDR method instead of a more expensive but perhaps more desirable or realistic option to reduce emissions.

As a result, many of the models used in the report identify a large and unrealistic role for CDR in order to stay below both temperature targets, with wide and uncertain ranges on the amount of CO<sub>2</sub> that is removed. The median amount of CDR by BECCS projected for 2100 in the scenarios compatible with Paris targets [1] is more than the current net sink of the total global land surface [2], measured in billions of tonnes. Meanwhile, current CDR deployment is measured in the order of thousands of tonnes with the largest DACS facility removing 4000 tonnes a year.

The IPCC report relies strongly on models but these are just one way of addressing the question of global mitigation pathways and CDR deployment. The nuances of sustainability limits, commercial barriers and public attitudes do not fit into these models and it may be necessary for other methods to be brought into future IPCC reports to better characterise the global need for CDR and the limits to its deployment.

### *Deeper understanding of the limits to CDR is required*

The scale and scope of CDR deployment remain deeply uncertain and require further examination. As our understanding of the limits to CDR deployment becomes deeper, such as the limits to biomass supply, the general trend suggests that the constraints are likely to be tighter than anticipated. It is key that the uncertainties associated with CDR are reduced and that we develop a more granular understanding of how much carbon can realistically be removed from the atmosphere and how various CDR methods can contribute or hinder the achievement of other societal goals when deployed at scale.

This is the objective of the NEGEM project. The aim is to ‘filter’ the maximum theoretical deployment potential of CDR often portrayed in models (such as those of the IPCC) through a set of constraints to reduce the uncertainties associated with CDR and identify a more realistic deployment potential. These constraints include the techno-economic barriers, the commercial barriers, environmental limits, and socio-political acceptance.

At the same time, the project seeks to identify the EU-wide and national potential of CDR deployment, along with the relevant governance frameworks to accommodate it in a Paris-compatible manner. The aim is to produce a more granular knowledge base to inform ongoing policymaking processes.

## Conclusions

**The IPCC report is clear on the fact that some extent of CDR deployment will be needed, however it provides little clarity on how much can actually be supplied within global limits.** It is also clear that the need for CDR is directly correlated with the rate at which emissions are (or are not) reduced, indicating that faster and deeper emission cuts will require less CDR to meet our climate targets.

Some of the pathways, all of which are illustrative, suggest that climate goals can be met with either very little or very large amounts of CDR. Some amount of CDR is likely to be necessary in all cases, at least to address long-term residual emissions, and potentially also to complement reductions or remove historical emissions. However, the constraints to the CDR deployment are not sufficiently considered, implying that the models relying on very large amounts of removals are unlikely to be realistic.

**The priorities in the short-term should therefore be to rapidly reduce emissions while separately building the capacity to permanently remove CO<sub>2</sub> from the atmosphere.** More stringent emission reduction measures with additional efforts to enable a ramp-up of reliable CDR will be key. At the same time, further research is necessary to better understand the implications of large-scale CDR deployment and should continuously feed into the policy-making processes. The NEGEM project will continue to contribute to these endeavours.

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[1] Median annual net removals deployed by 2100 in scenarios likely limiting warming to 2°C or below (in GtCO<sub>2</sub>): BECCS 8.96; managed land 4.19; DACCS 1.02.

[2] Estimated net CO<sub>2</sub> naturally removed by the global land sink in 2021 (in GtCO<sub>2</sub>): 11.4 (land sink) - 4.0 (Land use change) = 7.4 GtCO<sub>2</sub>/yr

Global C budget 2011-2020. Global Carbon Project 2021, <https://doi.org/10.5194/essd-2021-386>

## About NEGEM



NEGEM – *Quantifying and Deploying Responsible Negative Emissions in Climate Resilient Pathways* is a Research and Innovation Action started on 1 June 2020 that will continue through 31 May 2024. The project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 869192.

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