Will engineered carbon removal help solve the climate crisis?

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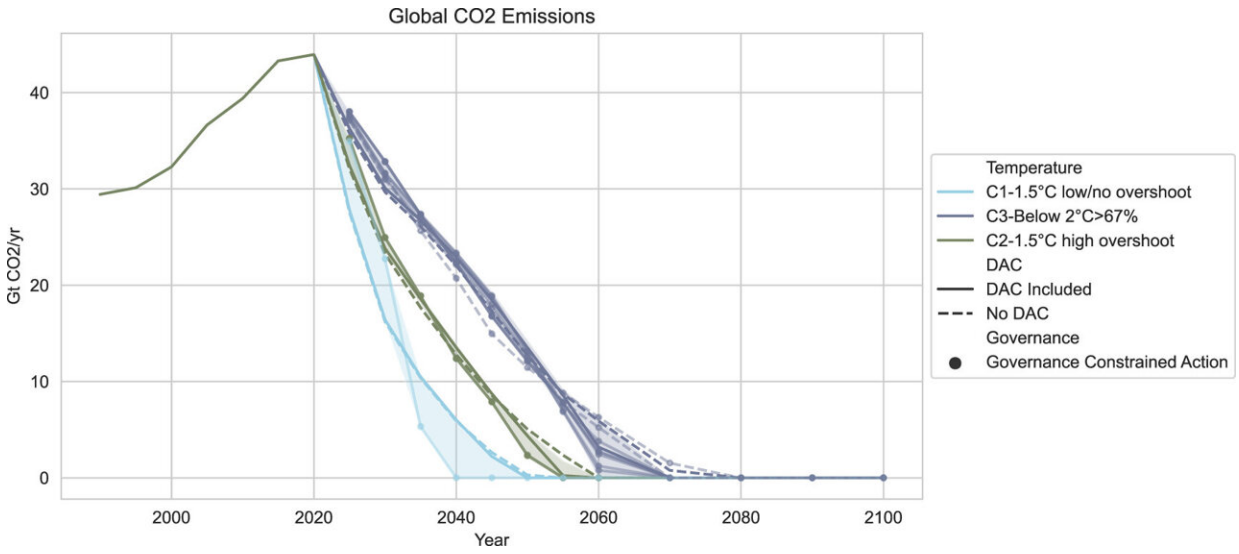

Global CO_2 emissions pathways across scenarios analyzed in this study. In light blue are as-likely-as-not 1.5 °C scenarios (IPCC C1 equivalent), in green are 1.5 °C high-overshoot scenarios (IPCC C2), and in purple are likely 2 °C scenarios (IPCC C3). Scenarios without DACCS are shown with dashed lines, scenarios with institutional governance constraints are shown with dots, and the full range across all considered technoeconomic sensitivities is shown as a shaded area. Credit: *Environmental Research Letters* (2023). DOI: 10.1088/1748-9326/acd8d5

Meeting the 1.5°C goal of the Paris Agreement will require ambitious climate action this decade. Difficult questions remain as to how warming can be limited within technical realities while respecting the common

but differentiated responsibilities and respective capabilities of nations on the way to a sustainable future. Meeting this challenge requires substantial emissions reductions to reach net-zero emissions globally.

Among the new options being studied in scientific literature, engineered Carbon Dioxide Removal (CDR) like Direct Air Capture of CO_2 with Carbon Capture and Storage (DACCS), is a potentially promising technology to help bridge this gap. DACCS captures carbon by passing ambient air over chemical solvents, which can be considered a form of CDR if the captured carbon is stored permanently underground. But whether these novel technologies can help make ambitious goals more attainable, or whether they can help reach them more equitably remains an open question.

In their study published in *Environmental Research Letters*, an interdisciplinary research group led by IIASA scientists developed new scenarios exploring fairness and feasibility in deep mitigation pathways, including novel CDR technologies. For the first time, the team implemented DACCS in a well-established integrated assessment model called MESSAGEix-GLOBIOM, and studied how this technology could impact global mitigation pathways under different scenarios of environmental policy effectiveness based on country-level governance indicators.

"In current policy debates, concerns about the political feasibility and fairness of the current generation of climate mitigation scenarios are raised, and DACCS is often proposed as a possible solution. In our study we quantified under what conditions and how DACCS might address those concerns," explains Elina Brutschin, a study co-author and researcher in the Transformative Institutional and Social Solutions Research Group of the IIASA Energy, Climate, and Environment Program.

The researchers emphasize that the goal of limiting warming to 1.5°C does not change when considering novel forms of CDR. For a broader perspective on pathways to limit warming, the research team investigated how novel CDR interacts under different assumptions of technoeconomic progress and the evolution of regional institutional capacity. The researchers highlight the risks of dependency on unproven carbon removal while also discussing the role novel CDR and similar technologies could play in the future for developing countries.

The results indicate that novel CDR can keep pre-Paris climate targets within reach when accounting for such risks, but that increasing institutional capacity beyond historical trends is necessary for limiting warming to the Paris Agreement's 1.5°C goal, even with novel CDR processes. The study also suggests that substantially improving institutional capacity to implement environmental policies, regulations, and legislation is critical to keep warming below 2°C if new forms of CDR fail to emerge in the near future.

The authors further point out that, when accounting for the possible future evolution of novel CDR technologies combined with inherent risks, the "fairness" of overall outcomes did not meaningfully improve. DACCS did not impact near-term required global mitigation ambition, and additional carbon removal in developed economies accounted for only a small component of the mitigation necessary to achieve stringent climate targets. This is because the removal of carbon dioxide in these areas does not compensate sufficiently for their historical emissions by mid-century.

The inability of DACCS to enhance the fairness of outcomes, like cumulative carbon emissions, in 1.5°C scenarios, emphasizes the notion that meeting global climate targets is a global effort requiring an 'all-of-the-above' mitigation strategy. There is no room for flexibility when it comes to reaching climate goals.

The results, however, show that engineered removals can play a role in making the post-peak temperature stabilization (or decline) phase more equitable. This means that the full timeframe under which accounting takes place is critical for exploring fair outcomes that are agreeable by most Parties to the United Nations Framework Convention on Climate Change (UNFCCC).

"Our results show that new technologies for removing carbon from the atmosphere can play a role in ambitious climate policy, but they won't be a silver bullet for solving the climate crisis. Developed countries especially need to cut emissions by more than half this decade, primarily by reducing existing sources of emissions while scaling up CDR technologies to be in line with the Paris Agreement," says study lead author Matthew Gidden, a researcher in the IIASA Energy, Climate, and Environment Program.

The researchers emphasize that there is a clear need for the modeling community to assess the role of novel CDR in a structured way to better understand robust outcomes and insights versus observations related to a given model framework or approach. Looking forward, these issues can be explicitly included in scenario design to arrive at more equitable outcomes while incorporating political realities of the capabilities of governments and institutions to enact strong climate policy.

More information: Matthew J Gidden et al, Fairness and feasibility in deep mitigation pathways with novel carbon dioxide removal considering institutional capacity to mitigate, *Environmental Research Letters* (2023). DOI: 10.1088/1748-9326/acd8d5

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