Carbon captured and stored since 1996 is significant but overestimated by up to 30%

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Although a significant amount of carbon has been caught and stored so far, governments should curb overestimation.

This is according to a new report from Imperial College London published today in *Environmental Science & Technology Letters*. The researchers compared estimations of stored carbon with official reports, and found that the reports lead to overestimates of actual carbon stored by 19 to 30 percent.

They calculated 197 million metric tons of carbon were captured and stored between 1996 and 2020, which represents a significant achievement in climate change mitigation. However, the researchers say the lack of consistent reporting frameworks mean current reported rates of carbon capture are overestimated, giving an inaccurate picture of the technology's contribution to fighting climate change. This, the researchers say, disempowers us in meeting climate mitigation strategies like the Paris Agreement and risks hiding issues that could otherwise be easily solved, such as inefficiencies in facility technology and transport.

Lead author Yuting Zhang, Ph.D. candidate at the Department of Earth Science and Engineering, says that "carbon capture and storage (CCS) is rightly a cornerstone of climate change mitigation, but without a centralized reporting framework we approach climate change on the back foot when we need to be more proactively tackling the issue with robust and accurate reporting."

"Policymakers should embrace a centralized reporting database that includes rates of carbon capture, transport, and storage, including quality assurance measures like independent auditing."

CCS is a worldwide initiative to reduce the amount of carbon dioxide (CO_2) in the atmosphere by capturing the greenhouse gas at its source and storing it underground. The Intergovernmental Panel on Climate Change (IPCC) has said that CCS is key to reaching the goal of net-zero emissions by mid-century to mitigate climate change.

At present, the most centralized and up-to-date information on capture rates comes from the annual reports and databases of thinktanks—but these report CCS activity as facility capacity rather than actual carbon stored. As of 2021, the global capture capacity was estimated at 40 million metric tons per year across 26 operational CCS facilities.

No centralized framework exists globally to compel the reporting of precise amounts of carbon captured, so actual rates of capture, transport, and storage are not centrally reported. However, this information is needed if we are to track the climate change mitigation impact of existing operations. Variations in the performance of industry-scale CCS plants may also help us to understand and mitigate any issues affecting the performance of individual CCS facilities.

Senior author Dr. Samuel Krevor from Imperial's Department of Earth Science and Engineering says that "carbon capture has the potential to significantly alter the planet's fate, but unclear guidance means there's no international consensus on how much has been stored so far, save for academic calculations. We urgently need clearly defined parameters so we know exactly where we stand."

"The nearly 200 million metric tons of climate-warming carbon removed from the atmosphere is significant, but reaching this figure should not have relied on academic research."

To carry out the study, the researchers looked at the capture and storage rates of 20 of the 26 CCS plants worldwide from a variety of publicly available sources recorded between 1996 and 2020. They organized the sources into three categories corresponding to the associated degree of assurance: 1) legal assurance, 2) quality assurance through auditing, 3) no assurance. They calculated the carbon capture rate to be 29 million metric tons of CO_2 in 2019 and the total storage over the study period (1996 –2020) to be 197 million metric tons. At these rates, underground

storage provided CO_2 mitigation of around half of the emissions avoided by solar panels in the U.S. in 2019.

They then compared these figures with those currently reported by thinktanks—currently the most authoritative source of information on CCS achievements, which report carbon capture capacity.

The researchers found that reporting only capacity means storage rates are overestimated by between 19 and 30 percent. They argue that requiring facilities to report actual capture rates would tell us more precisely how well CCS is working and put us in a much better position to address the climate crisis.

While the gap between capacity and actual storage were sometimes due to project performance issues, this was not always the case. The discrepancies also arose from changes over time in the source of CO_2 and variations in the definition of capture capacity used by projects.

Co-author Visiting Professor Chris Jackson from Imperial's Department of Earth Science and Engineering says that "CCS is a relatively new climate technology that is already contributing significantly to the fight against climate change. However, we show that capture capacity is not the best way to measure storage rates, and that governments should ideally enforce the use of the bottom-line metric of carbon captured."

"By and large, CCS plants are operating well and are contributing significantly to climate mitigation—but measuring their success more accurately can only help this effort."

Consistent reporting on CCS storage performance can better facilitate the modeling of large-scale deployment of CCS to monitor short-term emission reductions and long-term resource requirement of the technology. The researchers say reporting frameworks should include

key details like intended capture rate capacity, maximum capture rate capacity, annual capture of CO_2, annual transport of CO_2, annual storage of CO_2, quality assurance measures such as third-party auditing, and reasons for any offline periods where the CCS facility could not operate as intended.

More information: Yuting Zhang et al, An estimate of the amount of geological CO_2 storage over the period 1996-2020, *Environmental Science & Technology Letters* (2021). DOI: 10.31223/X5HD06

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