Researchers are charting a sustainable course in oceanic carbon capture

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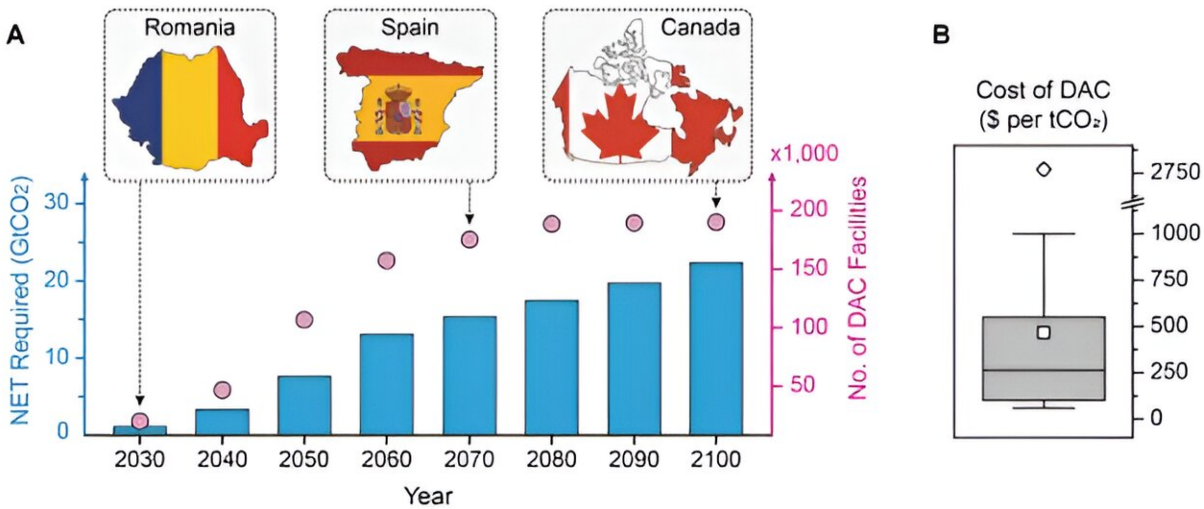

A Cost Analysis of Negative Emissions Technologies. (A) In order to stay on track with the 2°C warming scenario by 2100, negative emissions are necessary. Models estimate that the cumulative quantity that must be captured by 2030, 2070, and 2100 to limit warming by 2°C at a 66% likelihood are 0.7, 13.8, and 20 $GtCO2^{y-1}$, respectively. At an average cost of $467 per tCO2 using DAC in 2030, the cost to capture would be equivalent to the GDP of Romania in 2022. In 2070 and 2100, assuming the ideal $100 per tCO2, the cumulative cost would be comparable to the GDP of Spain and Canada in 2022. Assuming a 10% improvement in annual capture capacity each decade, over 100,000 facilities would have to be built by 2050 to keep us on track with the 2°C scenario plan based on UN estimates. (B) Based on values for the cost of capture using DAC per ton of CO_2 reported in the literature, the mean DAC cost is approximately $467 per ton of CO_2, represented by the square. Most of the values reported fall below $500 per tCO2, with the median at about $250 per tCO2 (represented by the horizontal line). An outlier exists at $2,770 per tCO2, which represents an experimental technology that utilizes nanoparticles. Credit: *Energy & Environmental Science* (2023). DOI: 10.1039/D3EE01471A

As researchers around the world race against time to develop new strategies and technologies to fight climate change, a team of scientists at the University of Houston is exploring one possible way to directly reduce the amount of carbon dioxide in the environment: Negative emissions technologies (NETs).

Mim Rahimi, assistant professor of environmental engineering at UH's Cullen College of Engineering is leading the development of an emerging NET called electrochemical direct ocean capture (eDOC), which helps the ocean cleanse itself of harmful carbon dioxide. The concept is detailed in a paper published in the journal *Energy & Environmental Science*.

"Electrochemical direct ocean capture amplifies the ocean's ability to absorb carbon, sidestepping the expensive sorption process typical in many current strategies," Rahimi said. "The promise of eDOC is undeniable, but scaling it, optimizing costs and achieving peak efficiency remain challenges we're actively addressing."

Earth's carbon dioxide is stored in the atmosphere and the terrestrial biosphere, but the vast majority is found in our oceans. According to World Ocean Review, the planet's five oceans contain 38,000 gigatons of CO_2. Furthermore, United Nations climate experts say oceans absorb 25% of all carbon dioxide emissions and capture 90% of the excess heat generated by those emissions, making them a vital buffer against climate change.

Rahimi and his team are working to create electrochemical tubes to remove dissolved inorganic carbon from synthetic seawater.

Current efforts to remove carbon dioxide from the ocean mainly involve complex processes like electrolysis, which attempt to either turn dissolved inorganic carbon into gas or convert it into magnesium or calcium carbonates. However, these techniques are energy-intensive and costly due to the use of rare and expensive materials, such as platinum and specialized membranes that easily clog, degrading their performance.

The researchers' alternative strategy eliminates the need for those costly membranes. Instead, it relies on a process that adjusts the acidity of seawater using affordable and environmentally friendly electrode materials. The system not only promises to be more cost-effective, but also significantly reduces the environmental impact of traditional carbon removal efforts.

"While membrane-based systems showed promise, they come with challenges," said Prince Aleta, a doctoral student in Rahimi's lab. "We're using electricity instead of thermal-based methods, and our current trajectory emphasizes systems without membranes for heightened efficiency."

One of the key advantages of this innovation is its versatility and scalability. The system can easily be integrated into existing on-shore infrastructure, such as desalination plants, as well as off-shore locations like oil rigs.

"While eDOC won't single-handedly turn the tide on climate change, it enriches our mitigation tool kit," added Rahimi. "In this global challenge, every innovative approach becomes invaluable."

More information: Prince Aleta et al, Direct Ocean Capture: The Emergence of Electrochemical Processes for Oceanic Carbon Removal, *Energy & Environmental Science* (2023). DOI: 10.1039/D3EE01471A

Provided by University of Houston

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