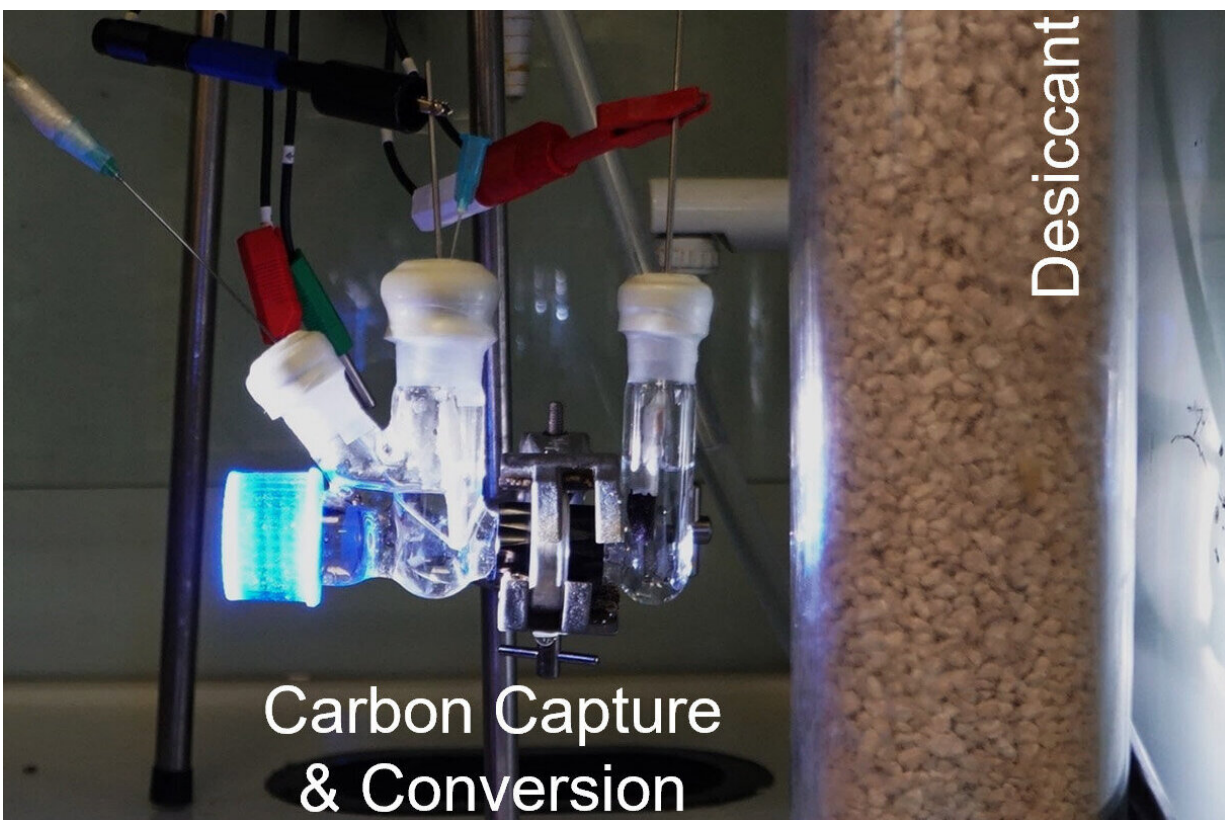


Clean, sustainable fuels made 'from thin air' and plastic waste

June 19 2023



Photograph showing carbon capture from air and its photoelectrochemical conversion into fuel with simultaneous waste plastic conversion into chemicals. Credit: Ariffin Mohamad Anuar

Researchers have demonstrated how carbon dioxide can be captured from industrial processes—or even directly from the air—and

transformed into clean, sustainable fuels using just the energy from the sun.

The researchers, from the University of Cambridge, developed a solar-powered reactor that converts captured CO₂ and plastic waste into [sustainable fuels](#) and other valuable chemical products. In tests, CO₂ was converted into syngas, a key building block for sustainable liquid fuels, and [plastic bottles](#) were converted into glycolic acid, which is widely used in the cosmetics industry.

Unlike earlier tests of their solar fuels technology however, the team took CO₂ from real-world sources—such as industrial exhaust or the air itself. The researchers were able to capture and concentrate the CO₂ and convert it into sustainable [fuel](#).

Although improvements are needed before this technology can be used at an industrial scale, the results, reported in the journal *Joule*, represent another important step toward the production of clean fuels to power the economy, without the need for environmentally destructive oil and gas extraction.

For several years, Professor Erwin Reisner's research group, based in the Yusuf Hamied Department of Chemistry, has been developing sustainable, net-zero carbon fuels inspired by photosynthesis—the process by which plants convert sunlight into food—using artificial leaves. These artificial leaves convert CO₂ and water into fuels using just the power of the sun.

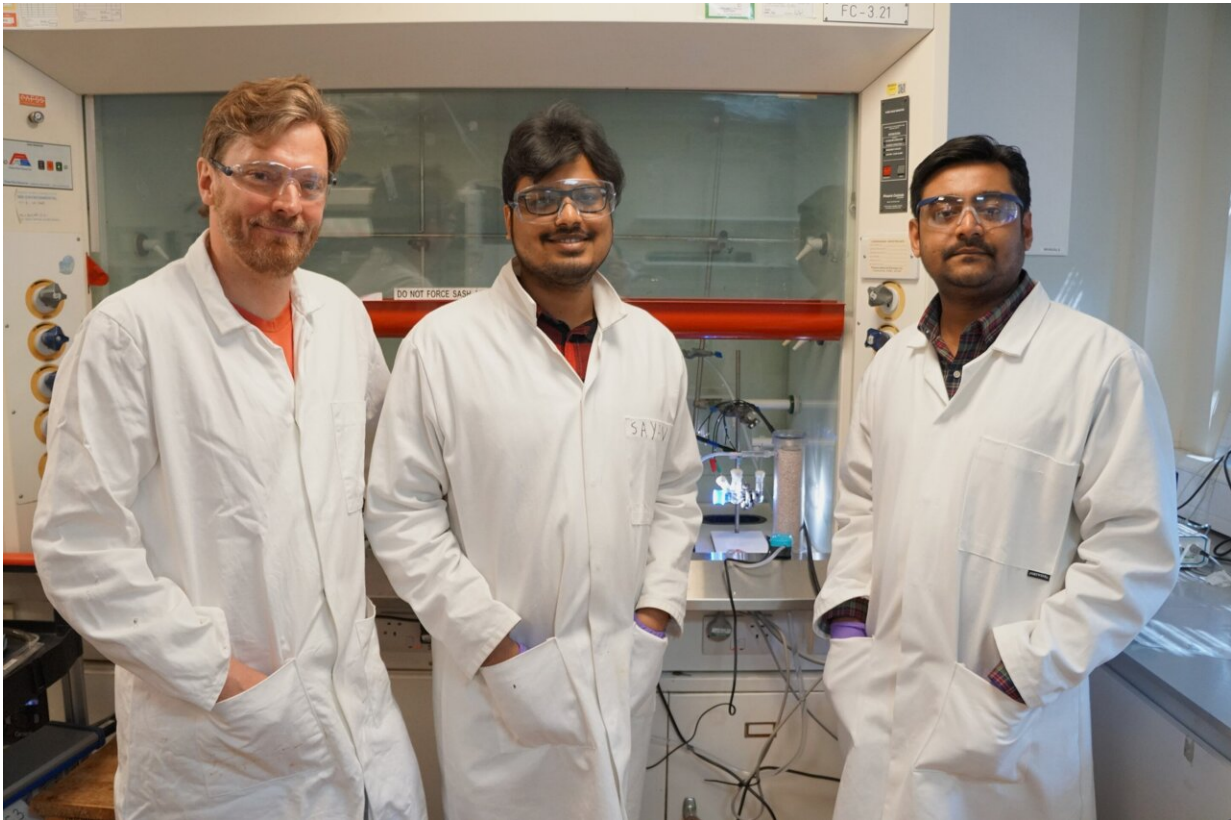
To date, their solar-driven experiments have used pure, concentrated CO₂ from a cylinder, but for the technology to be of practical use, it needs to be able to actively capture CO₂ from [industrial processes](#), or directly from the air. However, since CO₂ is just one of many types of molecules in the air we breathe, making this technology selective enough

to convert highly diluted CO₂ is a huge technical challenge.

"We're not just interested in decarbonization, but de-fossilization—we need to completely eliminate fossil fuels in order to create a truly circular economy," said Reisner. "In the medium term, this technology could help reduce carbon emissions by capturing them from industry and turning them into something useful, but ultimately, we need to cut fossil fuels out of the equation entirely and capture CO₂ from the air."

The researchers took their inspiration from [carbon capture](#) and storage (CCS), where CO₂ is captured and then pumped and stored underground.

"CCS is a technology that's popular with the fossil fuel industry as a way to reduce carbon emissions while continuing oil and gas exploration," said Reisner. "But if instead of carbon capture and storage, we had carbon capture and utilization, we could make something useful from CO₂ instead of burying it underground, with unknown long-term consequences, and eliminate the use of [fossil fuels](#)."



L-R: Erwin Reisner, Sayan Kar, Motiar Rahaman. Credit: Ariffin Mohamad Annuar

The researchers adapted their solar-driven technology so that it works with flue gas or directly from the air, converting CO_2 and plastics into fuel and chemicals using only the power of the sun.

By bubbling air through the system containing an alkaline solution, the CO_2 selectively gets trapped, and the other gases present in air, such as nitrogen and oxygen, harmlessly bubble out. This bubbling process allows the researchers to concentrate the CO_2 from air in solution, making it easier to work with.

The integrated system contains a photocathode and an anode. The system

has two compartments: on one side is captured CO₂ solution that gets converted into syngas, a simple fuel. On the other side plastics are converted into useful chemicals using only sunlight.

"The plastic component is an important trick to this system," said co-first author Dr. Motiar Rahaman. "Capturing and using CO₂ from the air makes the chemistry more difficult. But, if we add [plastic waste](#) to the system, the plastic donates electrons to the CO₂. The plastic breaks down to glycolic acid, which is widely used in the cosmetics industry, and the CO₂ is converted into syngas, which is a simple fuel."

"This solar-powered system takes two harmful waste products—plastic and [carbon emissions](#)—and converts them into something truly useful," said co-first author Dr. Sayan Kar.

"Instead of storing CO₂ underground, like in CCS, we can capture it from the air and make clean fuel from it," said Rahaman. "This way, we can cut out the fossil fuel industry from the process of fuel production, which can hopefully help us avoid climate destruction."

"The fact that we can effectively take CO₂ from air and make something useful from it is special," said Kar. "It's satisfying to see that we can actually do it using only sunlight."

The scientists are currently working on a bench-top demonstrator device with improved efficiency and practicality to highlight the benefits of coupling direct air capture with CO₂ utilization as a path to a zero-carbon future.

More information: Erwin Reisner, Integrated Capture and Solar-driven Utilization of CO₂ from Flue Gas and Air, *Joule* (2023). [DOI: 10.1016/j.joule.2023.05.022](https://doi.org/10.1016/j.joule.2023.05.022).
[www.cell.com/joule/fulltext/S2542-4351\(23\)00219-2](https://www.cell.com/joule/fulltext/S2542-4351(23)00219-2)

Provided by University of Cambridge

Citation: Clean, sustainable fuels made 'from thin air' and plastic waste (2023, June 19) retrieved 27 April 2024 from <https://techxplore.com/news/2023-06-sustainable-fuels-thin-air-plastic.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.