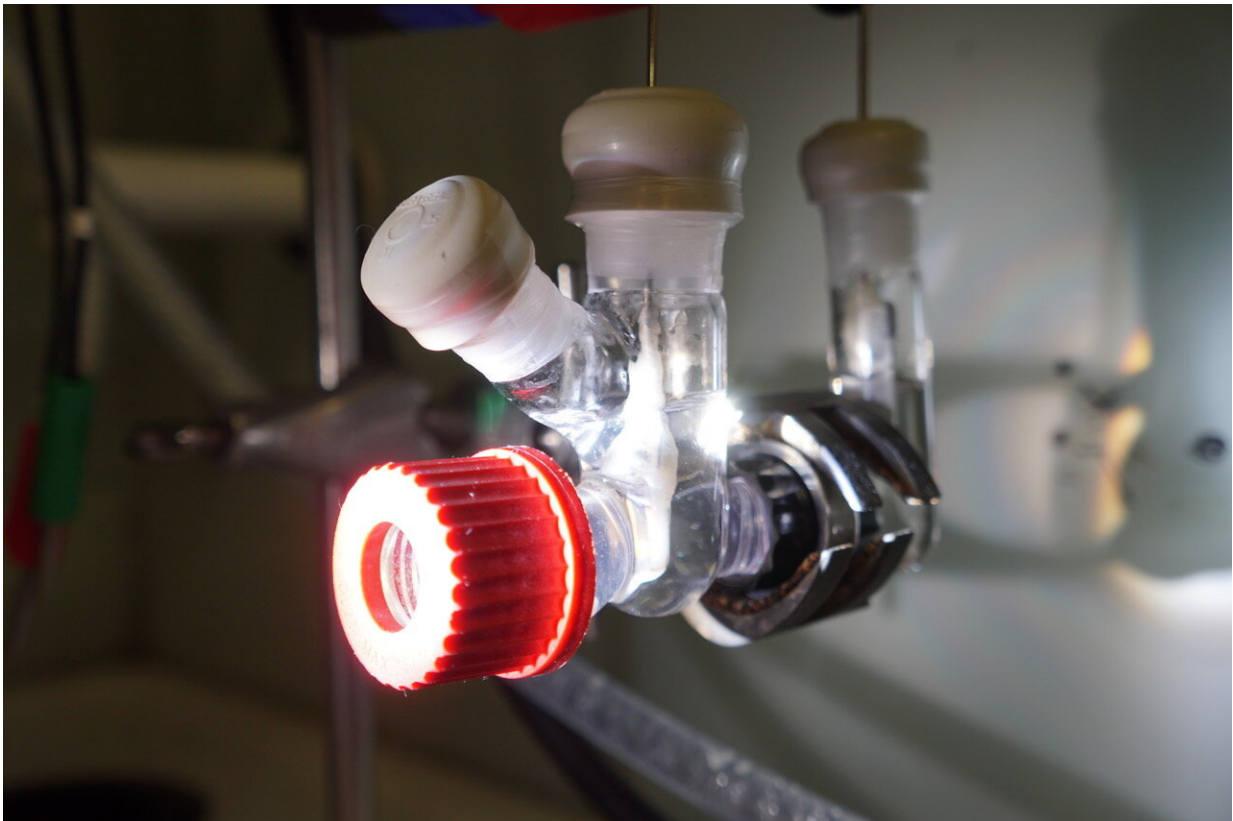


Solar-powered system converts plastic and greenhouse gases into sustainable fuels

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and greenhouse gases into sustainable fuels and other valuable products—using just the energy from the sun.

The researchers, from the University of Cambridge, developed the system, which can convert two waste streams into two chemical products at the same time—the first time this has been achieved in a solar-powered [reactor](#).

The reactor converts the [carbon dioxide](#) (CO₂) and plastics into different products that are useful in a range of industries. 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. The system can easily be tuned to produce different products by changing the type of catalyst used in the reactor.

Converting plastics and [greenhouse gases](#)—two of the biggest threats facing the natural world—into useful and valuable products using solar energy is an important step in the transition to a more sustainable, circular economy. The results are reported in the journal *Nature Synthesis*.

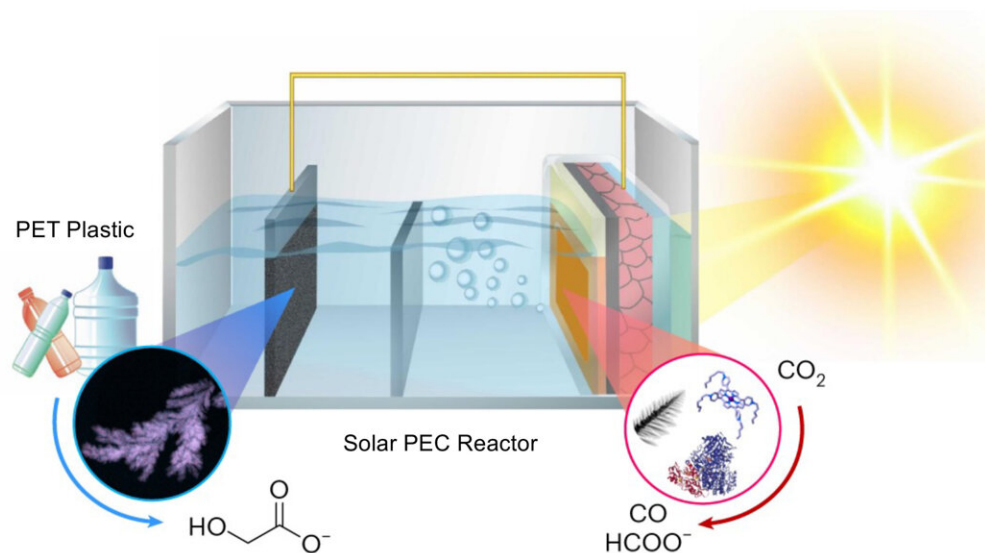
"Converting waste into something useful using [solar energy](#) is a major goal of our research," said Professor Erwin Reisner from the Yusuf Hamied Department of Chemistry, the paper's senior author. "Plastic pollution is a huge problem worldwide, and often, many of the plastics we throw into recycling bins are incinerated or end up in landfill."

Reisner also leads the Cambridge Circular Plastics Center (CirPlas), which aims to eliminate [plastic waste](#) by combining blue-sky thinking with practical measures.

Other solar-powered "recycling" technologies hold promise for

addressing [plastic pollution](#) and for reducing the amount of greenhouse gases in the atmosphere, but to date, they have not been combined in a single process.

"A solar-driven technology that could help to address plastic pollution and greenhouse gases at the same time could be a game-changer in the development of a circular economy," said Subhajit Bhattacharjee, the paper's co-first author.



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"We also need something that's tunable, so that you can easily make changes depending on the final product you want," said co-first author Dr. Motiar Rahaman.

The researchers developed an integrated reactor with two separate compartments: one for plastic, and one for greenhouse gases. The reactor uses a light absorber based on perovskite—a promising alternative to silicon for next-generation solar cells.

The team designed different catalysts, which were integrated into the light absorber. By changing the catalyst, the researchers could then change the end product. Tests of the reactor under normal temperature and pressure conditions showed that the reactor could efficiently convert PET plastic bottles and CO₂ into different carbon-based fuels such as CO, syngas or formate, in addition to glycolic acid. The Cambridge-developed reactor produced these products at a rate that is also much higher than conventional photocatalytic CO₂ reduction processes.

"Generally, CO₂ conversion requires a lot of energy, but with our system, basically you just shine a light at it, and it starts converting harmful products into something useful and sustainable," said Rahaman. "Prior to this system, we didn't have anything that could make high-value products selectively and efficiently."

"What's so special about this system is the versatility and tunability—we're making fairly simple carbon-based molecules right now, but in future, we could be able to tune the system to make far more complex products, just by changing the catalyst," said Bhattacharjee.

Over the next five years, the researchers hope to further develop the reactor to produce more complex molecules. The researchers say that similar techniques could someday be used to develop an entirely solar-powered recycling plant.

"Developing a [circular economy](#), where we make useful things from waste instead of throwing it into landfill, is vital if we're going to meaningfully address the climate crisis and protect the [natural world](#)," said Reisner. "And powering these solutions using the sun means that we're doing it cleanly and sustainably."

More information: Erwin Reisner, Photoelectrochemical CO₂-to-fuel conversion with simultaneous plastic reforming, *Nature Synthesis* (2023). [DOI: 10.1038/s44160-022-00196-0](https://doi.org/10.1038/s44160-022-00196-0).
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