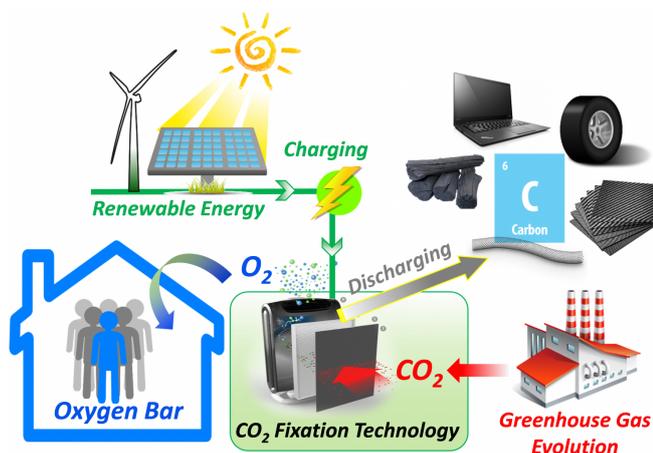


# A battery-inspired strategy for carbon fixation

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A flowchart of energy storage and carbon fixation using Li-CO<sub>2</sub> technology. Credit: Qiao et al.

Scientists working toward the elusive lithium-air battery discovered an unexpected approach to capturing and storing carbon dioxide away from the atmosphere. Using a design intended for a lithium-CO<sub>2</sub> battery, researchers in Japan and China have developed a way to isolate solid carbon dust from gaseous carbon dioxide, with the potential to also separate out oxygen gas through the same method. Their work appears August 9 in *Joule*, a new interdisciplinary energy journal from Cell Press.

Converting [carbon dioxide emissions](#) into other carbon-containing compounds is desirable due to carbon dioxide's contribution to the greenhouse effect and global warming. Examples range from natural processes, such as plants turning CO<sub>2</sub> into oxygen and sugars, to man-made ones, such as injecting carbon dioxide into rock formations to be trapped as carbonate minerals.

"The problem with most physical and chemical pathways for CO<sub>2</sub> fixation is that their products are

gases and liquids that need to be further liquefied or compressed, and that inevitably leads to additional energy consumption and even more CO<sub>2</sub> emissions," says senior author Haoshen Zhou of Japan's National Institute of Advanced Industrial Science and Technology and China's Nanjing University. "Instead, we are demonstrating an electrochemical strategy for CO<sub>2</sub> fixation that yields [solid carbon](#) products, as well as a lithium-CO<sub>2</sub> [battery](#) that can provide the energy necessary for that process."

The researchers encountered the carbon fixation strategy when they tried to recharge a lithium-CO<sub>2</sub> battery prototype. Instead of fully regenerating lithium ions and CO<sub>2</sub> from the lithium carbonate and carbon produced during battery discharge, as would have taken place with a reversible Li-CO<sub>2</sub> battery, the lithium carbonate decomposed, yielding additional carbon, as well as oxygen gas that was not isolated due to rapid reaction with the battery electrolyte. Typically, this kind of buildup causes physical degradation and reduced functional lifespan for a battery, but instead, the deposition of solid carbon boasts a separate advantage, pointing to a promising approach to fix carbon in a stable and easy-to-dispose-of form.

"What is impressive about this work is the possibility to convert one-third of the CO<sub>2</sub> species to carbon with a high theoretical energy efficiency above 70%," says *Joule* scientific editor Rahul Malik. "Battery architecture is an unforeseen but intriguing way to look at carbon fixation."

Since generating carbon solids both realizes carbon fixation decreases battery performance, the researchers were not able to simultaneously satisfy both goals within a single device. However, by incorporating a tiny amount of ruthenium metal into their design as a catalyst, they were able to avoid extensive carbon deposition and induce better reversibility, converting their carbon-fixing apparatus into a functioning Li-CO<sub>2</sub> battery.

A remaining challenge for both [carbon fixation](#) and battery performance is to move from pure CO<sub>2</sub> to ambient air, a jump that would potentially allow for treating atmospheric CO<sub>2</sub> in the first case and would advance towards the theoretically powerful but not-yet-stable lithium-air battery technology in the second case. The fixation technique might also be adapted to scrub other harmful or polluting gases such as carbon monoxide, sulfur dioxide, nitric oxide, and nitrogen dioxide from the atmosphere, Zhou says.

Looking ahead, the researchers are also excited by their system's potential to perhaps lead to a pathway for converting carbon dioxide into pure carbon and oxygen gas. "Attaining the release of oxygen gas upon charging, coupled with the accumulation of solid [carbon](#), would realize an electrochemical [carbon dioxide fixation](#) strategy analogous to photosynthesis," says Zhou.

**More information:** *Joule*, Qiao et al.: "Li-CO<sub>2</sub> Electrochemistry: A New Strategy for CO<sub>2</sub> Fixation and Energy Storage" [http://www.cell.com/joule/fulltext/S2542-4351\(17\)30008-9](http://www.cell.com/joule/fulltext/S2542-4351(17)30008-9) , [DOI: 10.1016/j.joule.2017.07.001](#)

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