Microbe-linked solar panels are better than plants at converting sunlight to energy

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Plants are exceptional sunlight sponges. But they store only about 1% of the energy they soak up, locking it into the sugars and other organic molecules they use to build their cells. Scientists have boosted that number by a few percentage points with light-absorbing microbes and genetic engineering. But now, researchers have taken a more sizable jump with solar panels, creating a hybrid device that uses a combination of catalysts and microbes to convert 10% of the captured solar energy into liquid fuels and other commodity chemicals.

I'm a big fan of the work," says Chris Chang, a chemical biologist and solar fuels expert at the University of California, Berkeley, who was not involved in the study. "It provides a really nice demonstration that you can get high efficiency [in solar chemical conversion], which is a key step."

The new fuels could also solve another crucial problem: renewable energy storage. As solar and wind power grow in use, researchers have begun looking for ways to store the excess energy such systems produce. Batteries are too expensive for storing more than nominal amounts. But energy-rich chemicals, which can be piped around and kept in chemical tanks, could store much more at a manageable price.

The new work got its start in 2011, when researchers led by Dan Nocera, a chemist at Harvard University, created an artificial leaf that used energy from sunlight to split water into oxygen and hydrogen gas (H_2). H_2 can then be run through a device called a fuel cell to produce electricity. But because its energy density is so low—thanks to its vapor state—any fuel produced requires massive storage tanks or high pressures to compress it into smaller, more manageable volumes.

Several research teams followed up by combining the H_2 with the carbon in carbon dioxide (CO_2) to produce energy-dense liquid hydrocarbons. Last year, for example, Nocera's group reported that it developed a hybrid system that used bacteria and electricity to "stitch" together H_2—generated from splitting water—and the carbon from CO_2 into a liquid alcohol called isopropanol. But the setup had a problem. The catalyst used to split water was made from a nickel alloy that generated a form of highly reactive oxygen that killed the bacteria. The only solution was to use an unusually high voltage of electricity, which produced fewer reactive oxygen molecules. It also sharply reduced the efficiency of converting the energy in the electricity to chemical bonds in the fuel. In the end, the system converted only 3.2% of the input energy into chemical fuel.

Now, Nocera and his colleagues have replaced the nickel catalyst with a new cobalt-phosphorous alloy version, which does not make reactive oxygen species. That allowed the team to lower the voltage, leading to a "dramatic increase in efficiency," Nocera says. Their new hybrid setup can convert 10% of the energy in sunlight to a variety of chemicals and fuels, far above the efficiency of plants, they report today in *Science*.

As tantalizing as it seems to produce fuel merely from the starting ingredients of sunlight, water, and CO_2 in the air, Nocera cautions that the solar fuel approach still has a long way to go before dethroning oil as the king of fuels. "It's very hard to make this competitive with digging [oil] out of the ground," Nocera says. Even so, he adds, solar fuel setups may one day help provide fuels and chemicals to the billions of people in developing countries who lack access because of poor infrastructure. His team is already taking a shot in India, where he is negotiating with researchers to pass along the intellectual property for the new method.