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'Major discovery' from MIT primed to unleash solar revolution

Scientists mimic essence of plants' energy storage system

Anne Trafton, News Office
July 31, 2008

In a revolutionary leap that could transform solar power from a marginal, boutique alternative into a mainstream energy source, MIT researchers have overcome a major barrier to large-scale solar power: storing energy for use when the sun doesn't shine.



Daniel Nocera describes new process for storing solar energy
[View video post on MIT TechTV](#)

Until now, solar power has been a daytime-only energy source, because storing extra solar energy for later use is prohibitively expensive and grossly inefficient. With today's announcement, MIT researchers have hit upon a simple, inexpensive, highly efficient process for storing solar energy.

Requiring nothing but abundant, non-toxic natural materials, this discovery could unlock the most potent, carbon-free energy source of all: the sun. "This is the nirvana of what we've been talking about for years," said MIT's **Daniel Nocera**, the Henry Dreyfus Professor of Energy at MIT and senior author of a paper describing the work in the July 31 issue of *Science*. "Solar power has always been a limited, far-off solution. Now we can seriously think about solar power as unlimited and soon."

Inspired by the photosynthesis performed by plants, Nocera and Matthew Kanan, a postdoctoral fellow in **Nocera's lab**, have developed an unprecedented process that will allow the sun's energy to be used to split water into hydrogen and oxygen gases. Later, the oxygen and hydrogen may be recombined inside a fuel cell, creating carbon-free electricity to power your house or your electric car, day or night.

IMAGES



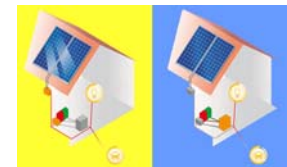
Photo / Donna Coveney

Daniel G. Nocera, the Henry Dreyfus Professor of Energy at MIT, has developed a simple method to split water molecules and produce oxygen gas, a discovery that paves the way for large-scale use of solar power. [Enlarge image](#)



Photo / Tom White, MIT

MIT researchers have developed a new catalyst, consisting of cobalt metal, phosphate and an electrode. When the catalyst is placed in water and electricity runs through the electrode, oxygen gas is produced. When another catalyst is used to produce hydrogen gas, the oxygen and hydrogen can be combined inside a fuel cell, creating carbon-free electricity to power a house or an electric car, day or night. [Enlarge image](#)



Graphic / Patrick Gillooly, MIT

With Daniel Nocera's and Matthew Kanan's new catalyst, homeowners could use their solar panels during the day to power their home, while also using the energy to split water into hydrogen and oxygen for storage. At night, the stored hydrogen and oxygen could be recombined using a fuel cell to generate power while the solar panels are inactive. [Enlarge](#)

The key component in Nocera and Kanan's new process is a new catalyst that produces oxygen gas from water; another catalyst produces valuable hydrogen gas. The new catalyst consists of cobalt metal, phosphate and an electrode, placed in water. When electricity -- whether from a photovoltaic cell, a wind turbine or any other source -- runs through the electrode, the cobalt and phosphate form a thin film on the electrode, and oxygen gas is produced.

Combined with another catalyst, such as platinum, that can produce hydrogen gas from water, the system can duplicate the water splitting reaction that occurs during photosynthesis.

The new catalyst works at room temperature, in neutral pH water, and it's easy to set up, Nocera said. "That's why I know this is going to work. It's so easy to implement," he said.

'Giant leap' for clean energy

Sunlight has the greatest potential of any power source to solve the world's energy problems, said Nocera. In one hour, enough sunlight strikes the Earth to provide the entire planet's energy needs for one year.

James Barber, a leader in the study of photosynthesis who was not involved in this research, called the discovery by Nocera and Kanan a "giant leap" toward generating clean, carbon-free energy on a massive scale.

"This is a major discovery with enormous implications for the future prosperity of humankind," said Barber, the Ernst Chain Professor of Biochemistry at Imperial College London. "The importance of their discovery cannot be overstated since it opens up the door for developing new technologies for energy production thus reducing our dependence for fossil fuels and addressing the global climate change problem."

'Just the beginning'

Currently available electrolyzers, which split water with electricity and are often used industrially, are not suited for artificial photosynthesis because they are very expensive and require a highly basic (non-benign) environment that has little to do with the conditions under which photosynthesis operates.

More engineering work needs to be done to integrate the new scientific discovery into existing photovoltaic systems, but Nocera said he is confident that such systems will become a reality.

"This is just the beginning," said Nocera, principal investigator for the Solar Revolution Project funded by the Chesonis Family Foundation and co-Director of the Eni-MIT Solar Frontiers Center. "The scientific community is really going to run with this."

Nocera hopes that within 10 years, homeowners will be able to power their homes in daylight through photovoltaic cells, while using excess solar energy to produce hydrogen and oxygen to power their own household fuel cell. Electricity-by-wire from a central source could be a thing of the past.

The project is part of the [MIT Energy Initiative](#), a program designed to help transform the global energy system to meet the needs of the future and to help build a bridge to that future by improving today's energy systems. MITEI Director Ernest Moniz, Cecil and Ida Green Professor of Physics and Engineering Systems, noted that "this discovery in the Nocera lab demonstrates that moving up the transformation of our energy supply system to one based on renewables will depend heavily on frontier basic science."

The success of the Nocera lab shows the impact of a mixture of funding sources - governments, philanthropy, and industry. This project was funded by the National Science Foundation and by the [Chesonis Family](#)

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Foundation, which gave MIT \$10 million this spring to launch the Solar Revolution Project, with a goal to make the large scale deployment of solar energy within 10 years.

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