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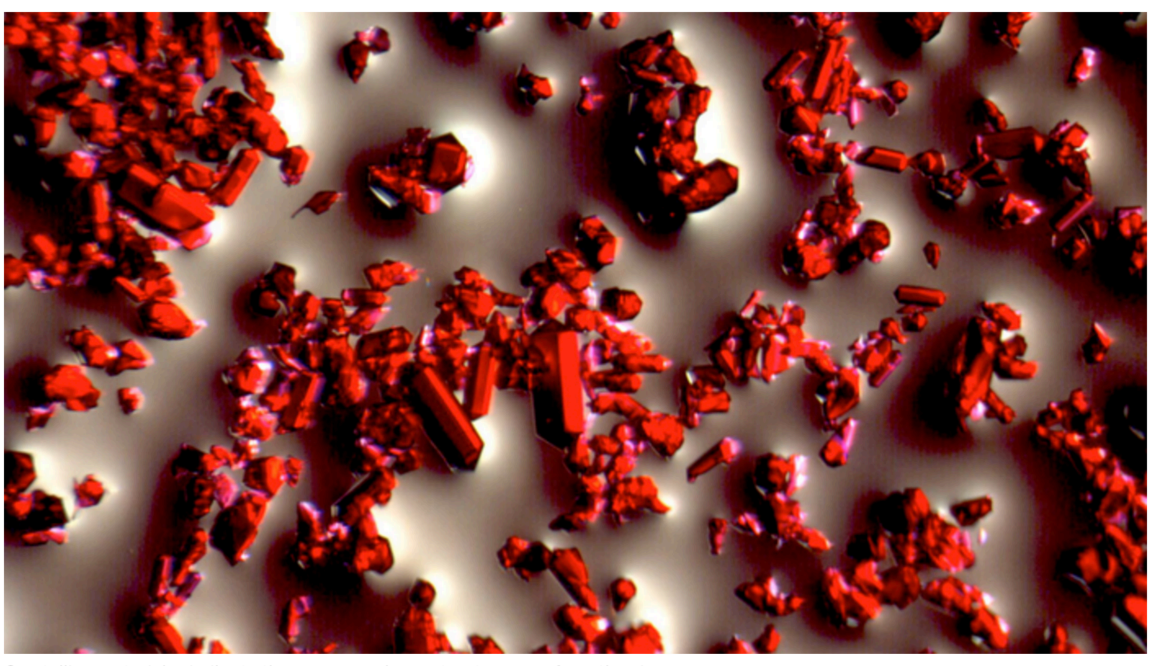
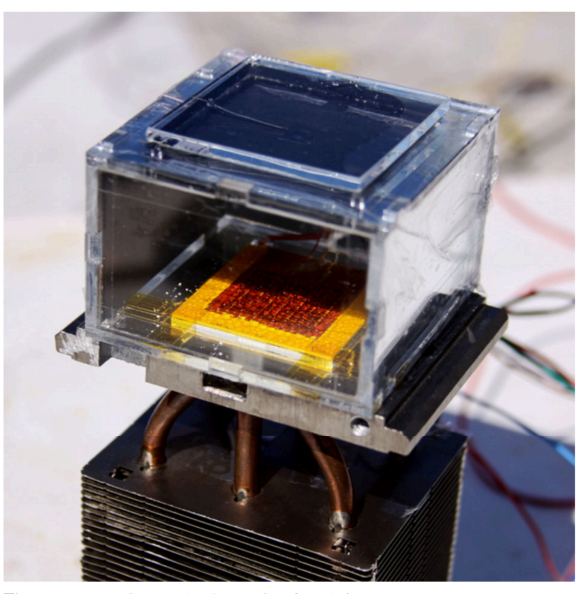


Crystalline materials similar to these can now harvest water vapor from the air. — Yaghi Laboratory at UC Berkeley

This new solar-powered device can pull water straight from the desert air

By **Robert Service** | Apr. 13, 2017 , 2:00 PM

You can't squeeze blood from a stone, but wringing water from the desert sky is now possible, thanks to a new spongelike device that uses sunlight to suck water vapor from air, even in low humidity. The device can produce nearly 3 liters of water per day for every kilogram of spongelike absorber it contains, and researchers say future versions will be even better. That means homes in the driest parts of the world could soon have a solar-powered appliance capable of delivering all the water they need, offering relief to billions of people.



The new water harvester is made of metal organic framework crystals pressed into a thin sheet of copper metal and placed between a solar absorber (above) and a condenser plate (below). — Wang Laboratory at MIT

There are an estimated 13 trillion liters of water floating in the atmosphere at any one time, equivalent to 10% of all of the freshwater in our planet's lakes and rivers. Over the years, researchers have developed ways to grab a few trickles, such as using fine nets to wick water from fog banks, or power-hungry dehumidifiers to condense it out of the air. But both approaches require either very humid air or far too much electricity to be broadly useful.

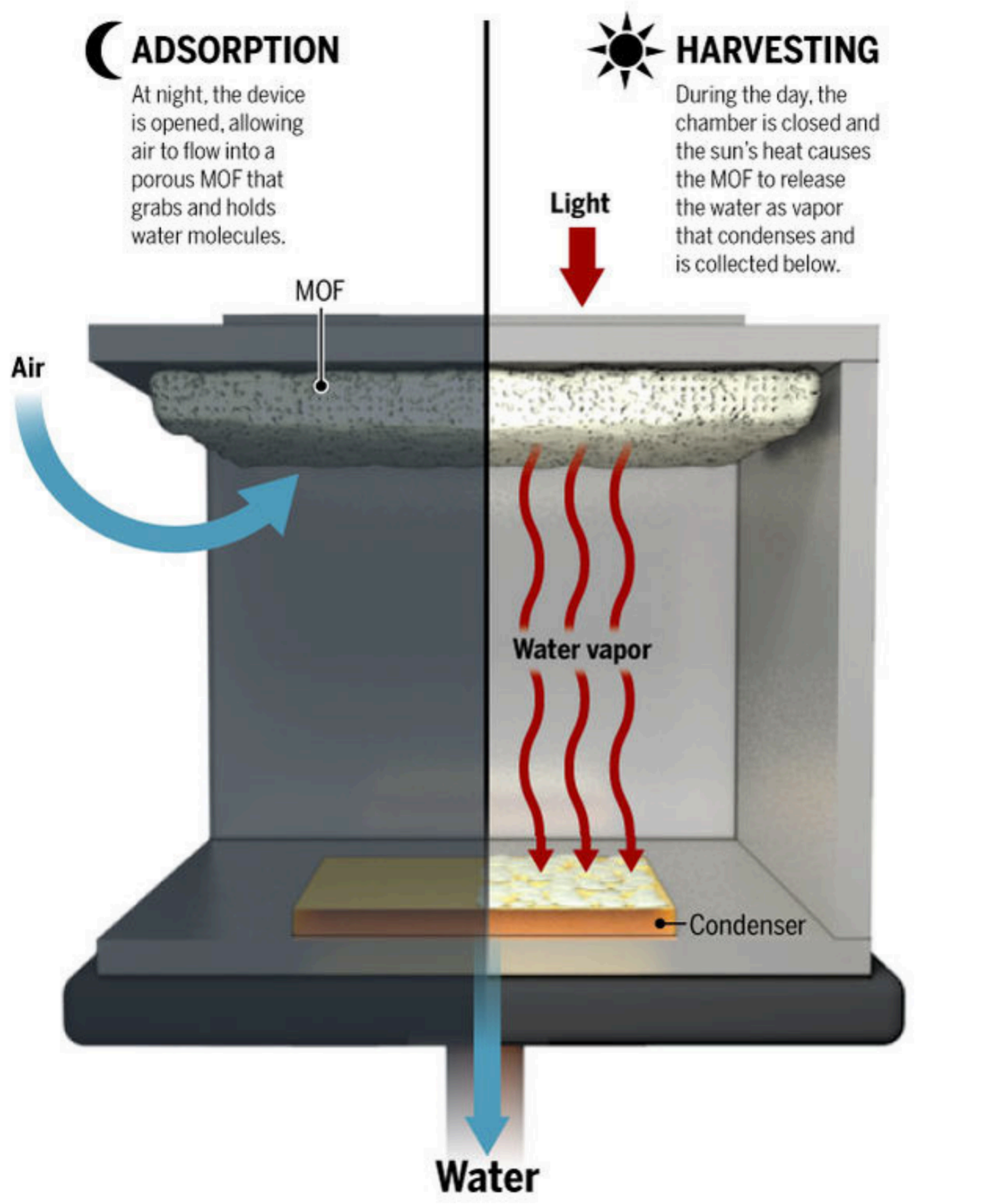
To find an all-purpose solution, researchers led by Omar Yaghi, a chemist at the University of California, Berkeley, turned to a family of crystalline powders called metal organic frameworks, or MOFs. Yaghi developed the first MOFs—porous crystals that form continuous 3D networks—more than 20 years ago. The networks assemble in a Tinkertoy-like fashion from metal atoms that act as the hubs and sticklike organic compounds that link the hubs together. By choosing different metals and organics, chemists can dial in the properties of each MOF, controlling what gases bind to them, and how strongly they hold on.

Over the past 2 decades chemists have synthesized more than 20,000 MOFs, each with unique molecule-grabbing properties. For example, Yaghi and others recently designed MOFs that absorb—and later release—methane, **making them a type of high-capacity gas tank** for natural gas–powered vehicles.

In 2014, Yaghi and his colleagues synthesized a MOF that excelled at absorbing water, even under low-humidity conditions. That led him to reach out to Evelyn Wang, a mechanical engineer at the Massachusetts Institute of Technology (MIT) in Cambridge, with whom he had previously worked on a project to use MOFs in automobile air conditioning. After synthesizing the new zirconium-based MOF, dubbed MOF-801, Yaghi met Wang at MIT and said, "Evelyn we have to come up with a water-harvesting device." She agreed to give it a shot.

Device pulls water from the air

At night setup soaks up water vapor from air, and uses heat from the sun to release it as liquid water during the day.



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The system Wang and her students designed consists of a kilogram of dust-sized MOF crystals pressed into a thin sheet of porous copper metal. That sheet is placed between a solar absorber and a condenser plate and positioned inside a chamber. At night the chamber is opened, allowing ambient air to diffuse through the porous MOF and water molecules to stick to its interior surfaces, gathering in groups of eight to form tiny cubic droplets. In the morning, the chamber is closed, and sunlight entering through a window on top of the device then heats up the MOF, which liberates the water droplets and drives them—as vapor—toward the cooler condenser. The temperature difference, as well as the high humidity inside the chamber, causes the vapor to condense as liquid water, which drips into a collector. The setup works so well that **it pulls 2.8 liters of water out of the air per day** for every kilogram of MOF it contained, the Berkeley and MIT team reports today in *Science*.

"It has been a longstanding dream" to harvest water from desert air, says Mercouri Kanatzidis, a chemist at Northwestern University in Evanston, Illinois, who wasn't involved with the work. "This demonstration … is a significant proof of concept." It's also one that Yaghi says has plenty of room for improvement. For starters, zirconium costs $150 a kilogram, making water-harvesting devices too expensive to be broadly useful. However, Yaghi says his group has already had early success in designing water-grabbing MOFs that replace zirconium with aluminum, a metal that is 100 times cheaper. That could make future water harvesters cheap enough not only to slake the thirst of people in arid regions, but perhaps even supply water to farmers in the desert.

***Update, 14 March, 12:28 p.m.:** This item has been updated to reflect the fact that the device pulls nearly 3 liters of water out of the air for every kilogram of the water-absorbing material that is used.*

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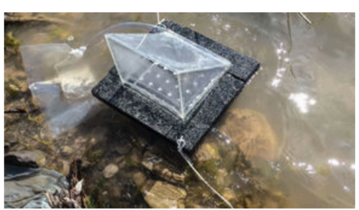
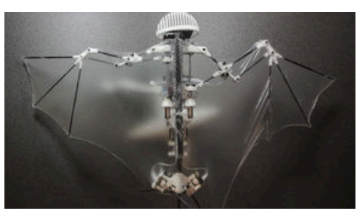
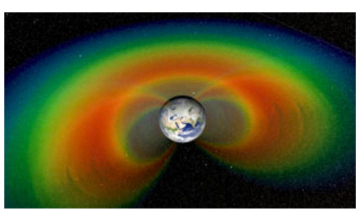

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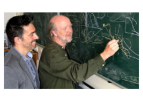
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