These New Materials Could Help Solve Drought in the Western US

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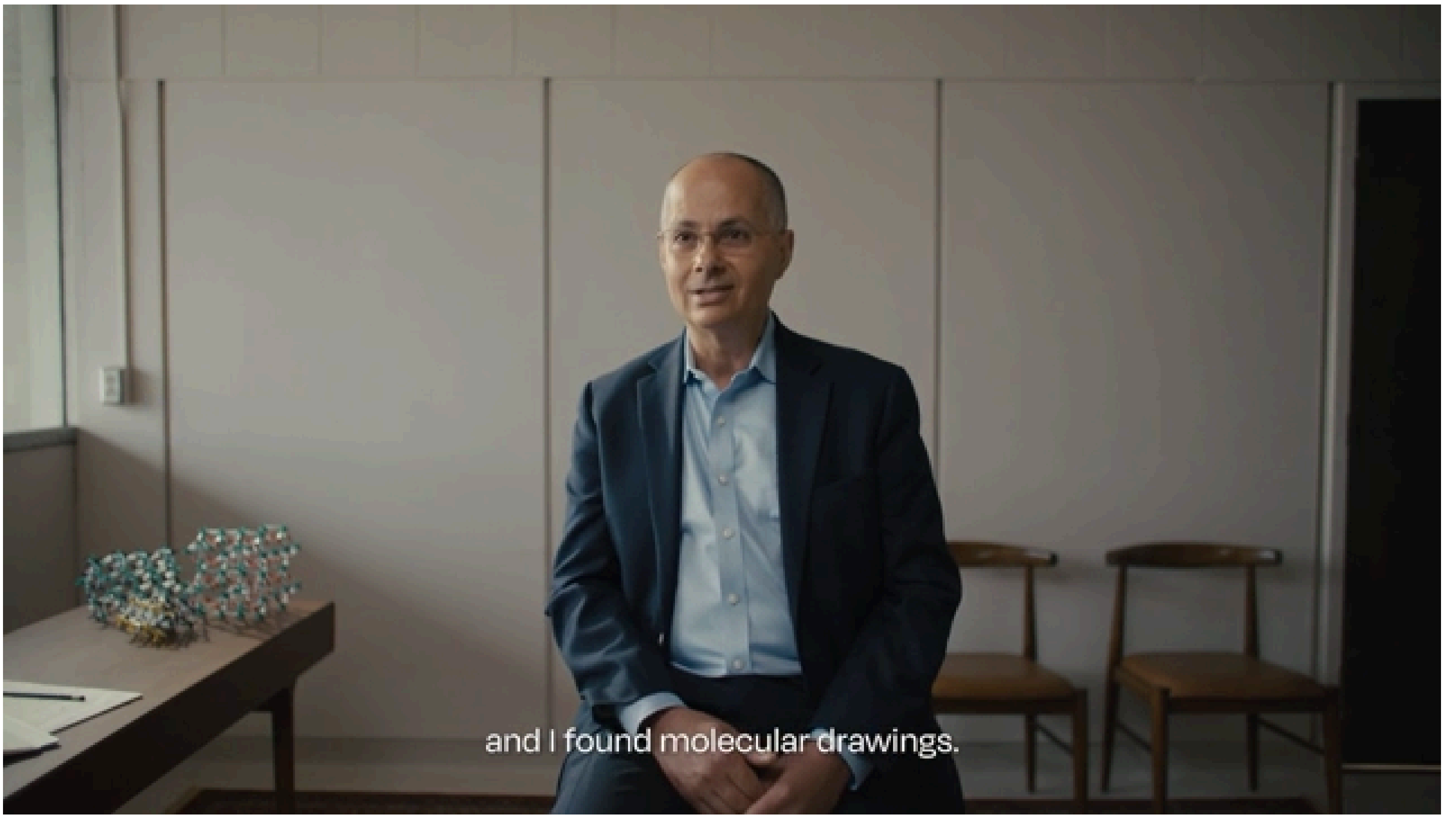


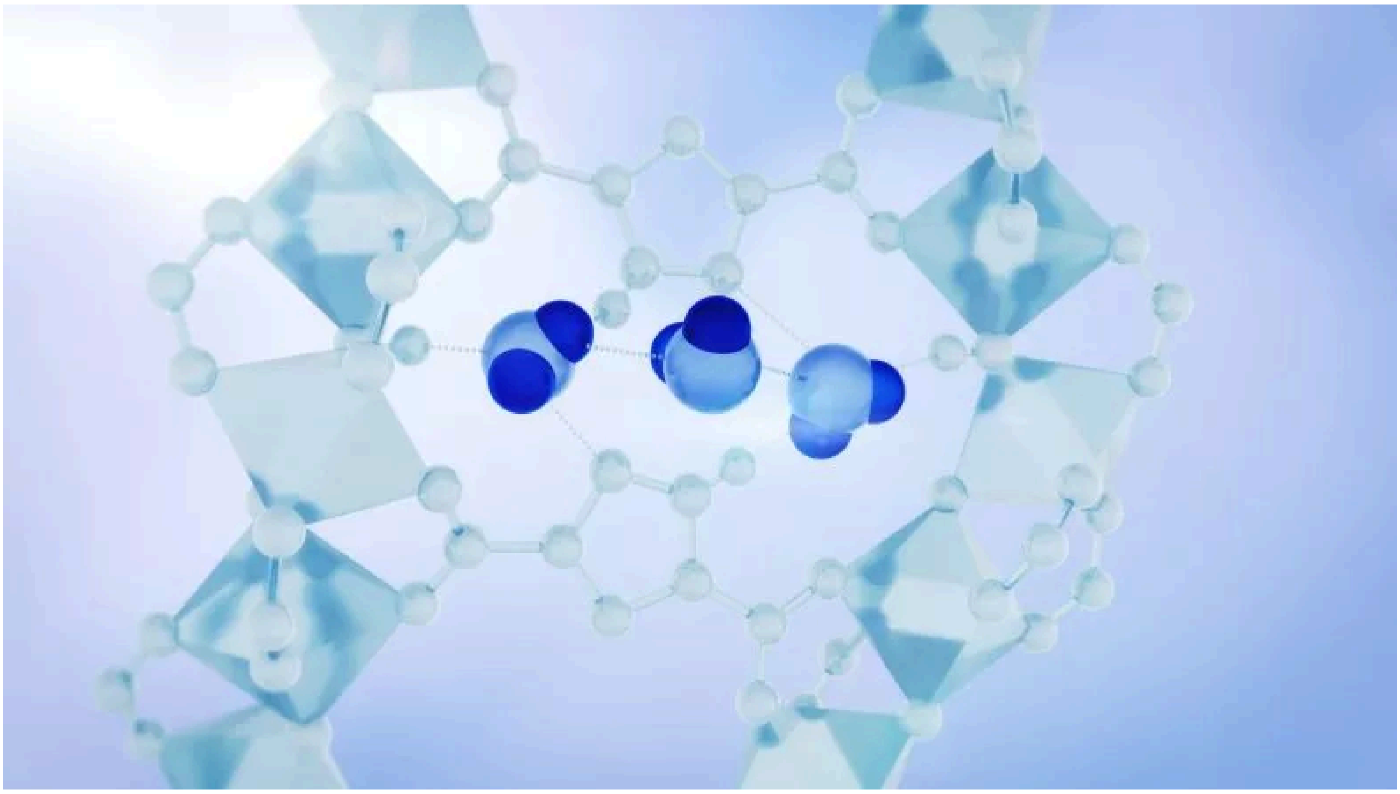
By Tom Howarth
Science Reporter (Nature)

Material science researchers have developed highly porous crystalline materials, known as metal-organic frameworks (MOFs) and covalent organic frameworks (COFs), capable of efficiently capturing water vapor from the atmosphere—even in extremely dry conditions.

These novel materials could transform the way water is sourced, offering an alternative to reliance on dwindling natural reservoirs.

The development comes at a critical time, as water shortages intensify across the western U.S. and globally.

The country's two largest reservoirs, Lake Mead and Lake Powell—both critical components of the Colorado River system that serves approximately 40 million people—are currently only 35 and 34 percent full, respectively. Experts warn that they may never reach full capacity again.



An artist's impression showing the internal structure of a Metal Organic Framework (MOF). **ATOCO**

Meanwhile, according to the U.S. Drought Monitor, 72 percent of the western U.S. is abnormally dry or experiencing some form of drought. This is particularly concerning given that January and February are traditionally among the wettest months of the year.

A Revolutionary Water Solution

Reticular chemistry, a growing field of research in material science and chemistry, is unlocking new possibilities for addressing water scarcity. This discipline focuses on designing MOFs and COFs—fine-tuned materials with immense internal surface areas.

To put it into perspective, one teaspoon of MOF powder can have an internal surface area as large as a football field.

"You can think of the inside of the material as being much larger than the outside because when you drill these little holes into the particles on the molecular level, you're creating extra surfaces," Omar Yaghi, a pioneer in reticular chemistry who kick-started research in the field more than 30 years ago, told *Newsweek*.

By combining this large capacity for storage with clever chemical tricks that attract specific molecules, like "honey for bees," MOFs and COFs are able to absorb water and other gases directly from the air with little energy input required.

Yaghi's company, Atoco, is at the forefront of exploring this technology's applications for Atmospheric Water Harvesting (AWH).

By utilizing MOFs and COFs, Atoco's approach efficiently extracts water vapor from the atmosphere, even in arid conditions where humidity levels drop below 20 percent—a challenge for traditional water harvesting methods.

Professor Omar Yaghi bends down to inspect a prototype water harvesting system in Death Valley, California. **ATOCO**

"The atmosphere holds a lot of water. If you calculate the amount of water in the atmosphere globally, it is seven times all of the surface water in the world," Samer Taha, Atoco's CEO, told *Newsweek*. "And this is a sustainable source that is automatically replenished by itself."

By harnessing the unique properties of reticular materials, AWH technology could provide an alternative to reliance on dwindling natural water sources and is able to function completely off grid without a direct power supply.

Real-World Impact: A Nevada Case Study

Atoco recently showcased its groundbreaking water harvesting technology at the WaterSmart Innovations conference in Las Vegas, unveiling an off-grid water generation unit powered solely by ambient energy.

The company also released a whitepaper detailing how this approach could be used to alleviate water scarcity in Nevada, one of the driest states in the U.S.

Nevada relies heavily on the Colorado River for its water supply, but with declining reservoir levels and increasing demand due to population growth, the state has been forced to implement extreme conservation measures—such as banning the use of Colorado River water for nonfunctional turf irrigation by 2027.

Atoco's research showed that a medium-sized AWH station (5 m x 5 m), utilizing heat exchangers that exploit temperature differences between the ambient air and underground soil, could generate approximately 3,000 liters of water per day in Nevada's climate.

This fully decentralized, self-sustaining system requires no external power beyond a small solar panel to operate pumps and fans.

"The biggest dream is to decentralize access to clean water," Taha said.

"The idea here is: since there is a serious issue of water scarcity and its becoming worse and worse because of global warming, we can utilize these novel materials to create an efficient technology that can capture water out of air and generate it in a liquid form anywhere. And that is what we have achieved."

A Global Solution

The implications of Atoco's technology extend far beyond Nevada and the western U.S.

With nearly two-thirds of the global population experiencing severe water scarcity for at least one month each year and 700 million people potentially facing displacement due to water shortages by 2030, scalable solutions like Atoco's could play a pivotal role in global water security.

Moreover, MOFs and COFs have applications beyond water harvesting. With slight modifications to their chemical structure, these materials can be used for efficient, low-cost carbon capture from the atmosphere—another pressing global challenge.

The versatility of these materials has led Yaghi to propose that we are entering a new material epoch in human history.

"Materials are so important that we named certain periods of human history after them: the Iron Age, the Bronze Age, the Silicon Age," he said. "I do think that the 21st century is the MOF century, and I don't think that there's anybody out there that will dispute that fact."

Do you have a tip on a science story that Newsweek should be covering? Do you have a question about reticular chemistry? Let us know via science@newsweek.com.