

# New hydrogen producing method is simpler and safer, researchers say

March 6 2024

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A new way to produce hydrogen gas, simply and safely, was published today in *Science Advances*. Co-author Esteban Toledo, Ph.D. student at KTH Royal Institute of Technology, works with the decoupled water splitting prototype in Stockholm, Sweden. Credit: David Callahan

Researchers in Sweden unveiled a new concept for producing hydrogen energy more efficiently, splitting water into oxygen and hydrogen without the dangerous risk of mixing the two gases.

Developed at KTH Royal Institute of Technology in Stockholm, the new method decouples the standard electrolysis process for producing [hydrogen gas](#), which splits [water molecules](#) by applying an electric current. In contrast with prevailing systems, it produces the resulting [oxygen](#) and hydrogen gases separately rather than simultaneously in the same cell, where they need to be separated by membrane barriers

That separation eliminates the possibility of the gases mixing with the risk of explosions, says researcher Esteban Toledo, a Ph.D. student at KTH who co-authored the paper [published](#) today in *Science Advances* along with Joydeep Dutta, professor of applied physics at KTH. It also eliminates the need for rare Earth metals.

The two researchers patented the system, and a company, Caplyzer AB, was formed through KTH Innovation to scale the technology.

Dutta says the hydrogen gas Faradaic efficiency was shown to be 99 percent. The researchers also report that lab tests showed no apparent electrode degradation as a result of long-term tests, which is important for commercial applications.

Producing hydrogen from water always generates oxygen. A typical alkaline electrolyzer has a positive and [negative electrode](#) paired up inside a chamber of alkaline water, separated by an ion-permeable barrier. When an [electric current](#) is applied, water reacts at the cathode by forming hydrogen and negatively charged [hydroxide ions](#), which diffuse through the barrier to the anode to produce oxygen.



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But the barrier causes resistance, and if the electric charge fluctuates, the risk of an explosive mix between oxygen and hydrogen is heightened.

Toledo says re-conceptualizing water electrolysis sets the stage for a more reliable form of green energy production, incorporating intermittent sources such as solar or wind.

"Since we don't risk mixing the gases, we can operate over a wider range of input power," he says. "It's much easier then to couple with renewable energies that generally provide variable power."

The simultaneous production of gases is circumvented by replacing one of the electrodes with a supercapacitive electrode made from carbon. These electrodes alternately store and release ions, effectively separating hydrogen and oxygen production.

When the electrode is negatively charged and produces hydrogen, the supercapacitor stores energy-rich hydroxide (OH) ions. When the direction of the current is swapped, the supercapacitor releases the absorbed OH, and oxygen is produced at the now-positive electrode.

"One electrode does the evolution of both oxygen and hydrogen," Dutta says. "It's a lot like a [rechargeable battery](#) producing hydrogen—alternately charging and discharging. It's all about completing the circuit."

**More information:** Esteban Toledo-Carillo et al, Decoupled Supercapacitive Electrolyzer for Membrane-Free Water Splitting, *Science Advances* (2024). [DOI: 10.1126/sciadv.adi3180](https://doi.org/10.1126/sciadv.adi3180).  
[www.science.org/doi/10.1126/sciadv.adi3180](https://www.science.org/doi/10.1126/sciadv.adi3180)

Provided by KTH Royal Institute of Technology

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