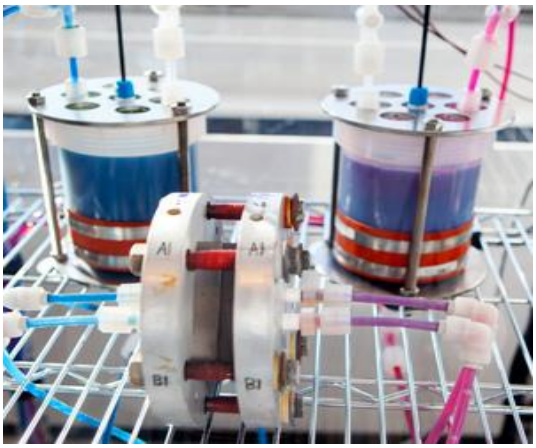
New Battery Material Could Help Wind and Solar Power Go Big

Low-cost materials could make storing hours of power from a wind farm economically feasible. By Kevin Bullis on January 8, 2014

Why It Matters

The intermittency of renewable power limits its use.



Liquid energy: Novel energy storage materials flow from the white containers shown here into a fuel-cell like device in the foreground, where they generate electricity.

Utilities would love to be able to store the power that wind farms generate at nightð when no one wants itð and use it when demand is high during the day. But conventional battery technology is so expensive that it only makes economic sense to store a few minutes of electricity, enough to smooth out a few fluctuations from gusts of wind.

Harvard University researchers say theyôve developed a new type of battery that could make it economical to store a couple of days of electricity from wind farms and other sources of power. The new battery, which is described in the journal *Nature*, is based on an organic moleculeð called a quinoneð thatôs found in plants such as rhubarb and can be cheaply synthesized from crude oil. The molecules could reduce, by two-thirds, the cost of energy storage materials in a type of battery called a flow battery, which is particularly well suited to storing large amounts of energy.

If it solves the problem of the intermittency of power sources like wind and solar, the technology will make it possible to rely far more heavily on renewable energy. Such batteries could also reduce the number of power plants needed on the grid by allowing them to operate more efficiently, much the way a battery in a hybrid vehicle improves fuel economy.

In a flow battery, energy is stored in liquid form in large tanks. Such batteries have been around for decades, and are used in places like Japan to help manage the power grid, but theyôre expensiveð about $700 per kilowatt-hour of storage capacity, according to one

estimate. To make storing hours of energy from wind farms economical, batteries need to cost just $100 per kilowatt-hour, according to the U.S. Department of Energy.

The energy storage materials account for only a fraction of a flow batteryôs total cost. Vanadium, the material typically used now, costs about $80 per kilowatt-hour. But thatôs high enough to make hitting the $100 target for the whole system impossible. Michael Aziz, a professor of materials and energy technologies at Harvard University who led the work, says the quinones will cut the energy storage material costs down to just $27 per kilowatt-hour. Together with other recent advances in bringing down the cost of the rest of the system, he says, this could put the DOE target in reach.

The Harvard work is the first time that researchers have demonstrated high-performance flow batteries that use organic molecules instead of the metal ions usually used. The quinones can be easily modified, which might make it possible to improve their performance and reduce costs more. ñThe options for metal ions were pretty well worked through,ò Aziz says. ñWeôve now introduced a vast new set of materials.ò

After identifying quinones as potential energy storage molecules, the Harvard researchers used high-throughput screening techniques to sort through 10,000 variants, searching for ones that had all the right properties for a battery, such as the right voltage levels, the ability to withstand charging and discharging, and the ability to be dissolved in water so they could be stored in liquid tanks.

So far the researchers are using quinones only for the negative side of the battery. The positive side uses bromine, a corrosive and toxic material. The researchers are developing new versions of the quinones that could replace the bromine.

The Harvard researchers are working with the startup Sustainable Innovations to develop a horse-trailer sized battery that can be used to store power from solar panels on commercial buildings.

The Harvard researchers still need to demonstrate that the new materials are durable enough to last the 10 to 20 years that electric utilities would like batteries to last, says Robert Savinell, a professor of engineering and chemical engineering at Case Western Reserve University. Savinell wasnôt involved with the Harvard work. He says initial durability results for the quinones are promising, and says the new materials ñwithout a doubtò can be cheap enough for batteries that store days of electricity from wind farms. And he says the materials ñcan probably be commercialized in a relatively short timeòð within a few years.

The researchers face competition from other startups developing cheaper flow batteries, such as EnerVault and Sun Catalytix (see ñStartup EnerVault Rethinks Flow Battery Chemistryò and ñSun Catalytix Seeks Second Act with Flow Batteryò). Sun Catalytix is developing inorganic molecules to improve performance and lower cost, although it isnôt saying much about them. EnerVault uses iron and chromium as storage materials and is developing ways to reduce the cost of the overall system.

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