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MITnews

Liquid battery big enough for the electri

Professor Donald Sadoway’s research in energy storage speed the development of renewable energy.

David L. Chandler, MIT News Office

today's news

The real thing?

Renee Richardson Gosline, an assistant professor at the MIT Sloan School of Management
Photo - Photo: Patrick Gillooly

MIT business professor Renee Richardson Gosline shows that people are often unsure about telling authentic luxury goods from fakes — until they see who's using them.

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Professor Donald Sadoway and graduate Bradwell observe one of their small test b lab. The battery itself is inside the heavil cylinder at center, which heats it to 700 d while the wires at top charge up the batte its performance.
Photo: Patrick Gillooly

There's one major drawback to most proposed renewable-energy sources: their variability. The sun doesn't shine at night, the wind doesn't always blow, and tides, waves and currents fluctuate. That's why many researchers have been pursuing ways of storing the power generated by these sources so that it can be used when it's needed.

So far, those solutions have tended to be too expensive, limited to only certain areas, or difficult to scale up sufficiently to meet the demands. Many researchers are struggling to overcome these limitations, but MIT professor Donald Sadoway has come up with an innovative approach that has garnered significant interest — and some m

The idea is to build an entirely new kind of battery, whose key componen at high temperature so that they would stay entirely in liquid form. The ex devices currently being tested in Sadoway's lab work in a way that's neve attempted in batteries before.

This month, the newly established federal agency ARPA-E (Advanced R Agency, Energy) announced its first 37 energy-research grants out of a p applications, and Sadoway's project to develop utility-scale batteries rece largest sums — almost $7 million over five years. And within a few days announcement, the French oil company Total — the world's fifth-largest $4 million, five-year joint venture with MIT to develop a smaller-scale vers technology, suitable for use in individual homes or other buildings.

Because the technology is being patented and could lead to very large-s commercialization, Sadoway will not discuss the details of the materials b both Sadoway and ARPA-E say the battery is based on low-cost, domes liquid metals that have the potential to shatter the cost barrier to large-sc storage as part of the nation's energy grid. In announcing its funding of S ARPA-E said the battery technology “could revolutionize the way electric produced on the grid, enabling round-the-clock power from America's wir power resources, increasing the stability of the grid, and making blackout past.”

Andrew Chung, a principal at Lightspeed Venture Partners in Menlo Park has no equity stake in Sadoway’s project at this point, says that “grid-sca area that’s set to explode in the next decade or so,” and is one that his co following closely. The liquid battery concept Sadoway is developing “is an approach to solving the problem,” he says.

Big is beautiful

Most battery research, Sadoway says, has been aimed at improving stor or mobile systems such as cellphones, computers and cars. The requirer systems, including very low weight and high safety, are very different fro grid-scale, fixed-location battery system. “What I did was completely igno conventional technology used for portable power,” he says. The different requirements for stationary systems “opens up a whole new range of pos

A large, utility-owned system “doesn’t have to be crash-worthy; it doesn’t t proof’ because it won’t be in the hands of the consumer.” And while cons to pay high prices, pound-for-pound, for the small batteries used in high-v devices, the biggest constraint on utility-sized systems is cost. In order to present fossil-fuel power systems, he says, “it has got to be cheap to buil maintain, last a long time with minimal maintenance, and store enormous energy.”

And so the new liquid batteries that Sadoway and his team, including gra David Bradwell, are designing use low-cost, abundant materials. The bas place three layers of liquid inside a container: Two different metal alloys, a salt. The three materials are chosen so that they have different densitie to separate naturally into three distinct layers, with the salt in the middle s two metal layers —like novelty drinks with different layers.

The energy is stored in the liquid metals that want to react with one anoth only by transferring ions — electrically charged atoms of one of the meta electrolyte, which results in the flow of electric current out of the battery. \ is being charged, some ions migrate through the insulating salt layer to c the terminals. Then, when the power is being drained from the battery, th back through the salt and collect at the opposite terminal.

The whole device is kept at a high temperature, around 700 degrees Cel layers remain molten. In the small devices being tested in the lab, mainta temperature requires an outside heater, but Sadoway says that in the full the electrical current being pumped into, or out of, the battery will be suffi that temperature without any outside heat source.

While some previous battery technologies have used one liquid-metal co
the first design for an all-liquid battery system, Sadoway says. “Solid com
batteries are speed bumps. When you want ultra-high current, you don’t

Inspiration from aluminum

The initial inspiration for the idea came from thinking about a very differe
Sadoway says: one of the biggest users of electrical energy, aluminum s
Sadoway realized that this was one of the few existing examples of a sys
sustain extremely high levels of electrical current over a sustained period
time. “It’s an electrochemical process that runs at high temperatures, anc
hundreds of thousands of amps,” he says. In a sense, the new concept is
aluminum plant running in reverse, producing power instead of consumin

Chung says that from the point of view of a venture capitalist, the researc
intriguing for several reasons. Not only does it offer the potential to signif
cost and increase cycle life [the number of times it can be charged and d
large-scale electricity storage, but it also suggests that the risk typically a
early stage research project may be lower because the system draws on
experience in the design and operation of aluminum production facilities.
added confidence that some of the targets around cost, scalability and sa
he says.

The team is now testing a number of different variations of the exact com
materials in the three layers, and of the design of the overall device. Sad
thanks to initial funding through the Deshpande Center and the Chesonis
Foundation, he and his team were able to develop the concept to the poi
demonstrating a proof-of-principle at the laboratory scale. That, in turn, m
get the large grants to develop the technology further.

“It’s an example of work that sprang from basic science, was developed t
and now is being scaled up to have a real transformational impact in the
Ernest Moniz, director of the MIT Energy Initiative.

The laboratory tests have provided “some measure of confidence,” Sado
many more tests will be needed to “demonstrate that the idea is scalable
size, at competitive cost.” But while he is very confident that it will all wor
of unknowns, he says, including how to design and build the necessary c
electrical control systems, and connections.

“We’re talking about batteries of a size never seen before,” he says. And
develop has to include everything, including control systems and charger
an unprecedented scale.

For Sadoway, the project is worth pursuing despite its daunting challenge
potential impact is so great. “I’m not doing this because I want another jo

Sadoway says. “It’s about making a difference … It’s an opportunity to in of the energy problem.”

Comments

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869920199@qq.com - **pardon?** 200

The material needed to create the container is not easily to be found, which achieve that goal?

krbrower - **professor** 200

No alloy is needed. Aluminum and lead are common and cheap

vinayaka 200

needed little more info with extra pictures.....

selahi2 - **Components** 200

Is one of the components salt water?

krbrower 200

Definitely not. Water is supercritical at 700 C.

linojon 200

what percent of the energy produced is required to heat the metals presumably there's a net gain?

krbrower 200

Heat loss is a minor consideration at large scale (several meters or diffusivity in earth is very low.

jiaqiangzhu - **source of energy** 200

what is the source of energy for the battery， is it from the sun or wind？

krbrower 200

Either of the above or hydro or geothermal or tidal.

vhiremath4 - **@selahi2** 200

@selahi2

In the article they state that ions are transferred and, since the energy is be an aqueous solution using an electrolyte, I'm assuming they're using some compound that readily disassociates in liquid.

selahi2 - **vhiremath4** 200

I guess salt layers have something to do with cheap salt components, points have to be below 700 degrees Celsius. Correct me if i am wrong.

krbrower 200

The electrolyte is non-aqueous, other wise enormous pressure wou maintain an aqueous medium at high density at 700 C (far above the critic water).

selahi2 - **Temperature** 200

How do they keep the temperature around 700 degrees Celsius? what is t kind of heating? will they be environment friendly plants?

dilip 200

it really sounds promising, a small flow diagram could be of help to the reader What could be the efficiency of such a battery? If it has to be maintained at 7 is in idle state, neither charging nor discharging, much of the energy could b large scale of the battery...
I wish Mr. Sadoway all the best..

krbrower - **professor** 200

My guess is that the bottom layer is molten lead, the middle layer is molten l the top layer is molten aluminum. On discharge the aluminum is oxidized to a which might be miscible with lead chloride and lead chloride is reduced to lea lead chloride and aluminum chloride is only partial the gravitational equilibr disturbed. On recharge the reactions are reversed. All components would b The larger the scale, the smaller is the ratio of surface area to mass and environment is reduced. The assembly would have some resemblance to t that gravity would keep the layers apart..