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RESEARCH NEWS

Cost-effective, long-life redox flow batteries

An affordable way to store clean energy

Renewable energy sources can fluctuate in the amount of power they are able to provide – which is why batteries are used to temporarily store the energy. The problem with lithium ion batteries is their short service life, while redox flow batteries have, to date, been cost-prohibitive. Now, however, innovative new redox flow systems are available at the same price point as lithium ion batteries, and last twice as long. Volterion is a spin-off of the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, and has succeeded in dramatically reducing the manufacturing costs involved.

Our power supply depends to an increasing extent on renewable sources of energy. However, their power generation output fluctuates widely – calling for a medium to store that electrical energy until it is required. Powerful battery systems are also an integral part of other modern technology such as electromobility solutions. The grid is not equipped, for instance, to accommodate fast charging stations operating at 350 kilowatts. Nor does the power grid cover all the locations where it would be sensible to install such stations. Lithium ion batteries are of limited use in such scenarios, not least due to their insufficiencies in relation to cycle durability. Two to three years of charging and draining such batteries two or three times a day would render them useless. Not so redox flow batteries, which offer superior cycle durability. They are also non-flammable, recyclable and easily modified for both capacity and performance. This makes them particularly suitable for applications in which batteries are placed under high levels of stress. But until now, despite these advantages, they have simply been cost-prohibitive.

The first affordable redox flow batteries

Researchers at Fraunhofer UMSICHT in Oberhausen have been able to drastically cut the costs involved in the manufacture of redox flow batteries. The innovative new batteries are manufactured and marketed by Fraunhofer spin-off Volterion. To understand how the researchers have optimized the redox flow battery, we need to take a brief look at how these batteries are made. Redox flow batteries consist of stacks, which in turn consist of electrochemical cells to convert the electrical energy into chemical energy, and electrolyte fluid tanks to store that chemical energy. This stack structure is the main reason why redox flow batteries are so expensive. However, as Dr. Thorsten Seipp, former research scientist at Fraunhofer UMSICHT and now managing director at Volterion, explains: "We've been able to reduce the cell weight to ten percent of the stack, which significantly reduces the cost. Whereas, in conventional stacks, the thick-

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ness of each cell was often as high as eight to ten millimeters, we've succeeded in cutting that down to two to three millimeters." Thanks to the material saving, the new redox flow batteries cost around the same as a lithium ion battery, but last twice as long. For the first time, they are affordable for use in a wide range of applications.

The key is in the material

The success is due first and foremost to the improvements made in the material. Stacks are generally made out of a graphite-polymer composite. During processing, however, such materials lose their polymer properties. The long polymer chains are undone, and the material loses both its flexibility and part of its stability. Inter-cell connections cannot be welded; instead cells must be joined using threaded sealing rings. "What we did at Fraunhofer UMSICHT was to modify the material and the manufacturing process in such a way that the material retains its polymer properties. As a result, the material remains stable and flexible and can be made significantly thinner, allowing the stacks to be welded together, and doing away completely with fast-wearing sealing rings," explains Seipp. This makes the production of the stacks much more cost-effective, and the stacks themselves more robust, too.

Applications from sewage treatment plants to MRI examinations

One of the first applications of the new redox flow batteries is in a sewage treatment plant. The plant currently uses methane to generate power, and there are plans to make use of photovoltaic facilities as well. A 100-kilowatt battery would match the fluctuations in both energy generation and energy demand, and this will allow the sewage treatment plan to meet its entire energy requirements self-sufficiently. Redox flow batteries could also be extremely useful in hospitals as a power source for MRI scanners. "Each MRI scanner has an output of 200 kilowatts, so if you have three or four running at the same time, the circuit is soon overloaded. Putting in a new power line is an expensive solution, costing 80,000 euros a kilometer, making a redox flow battery a good alternative," says Seipp. MRI scanners run for a few minutes at a time, during which period they consume huge amounts of power, before lying dormant until the next examination. That means that any battery powering the device is exposed to multiple charge cycles daily. "Our optimized batteries are as if made for this application – and indeed any application calling for short bursts of power in quantities that the grid cannot reliably provide," finishes Seipp.

Currently, the researchers at Fraunhofer UMSICHT are working alongside colleagues from Volterion to make further cost savings in the production of the batteries. They are also looking to scale up the size of the applications. At the moment, the batteries are designed to deliver between 100 and 300 kilowatts, but in the future this could be multiple megawatts.

Compact new redox flow batteries for storage of renewable energy.

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