Breakthrough in electricity storage: New large and powerful redox flow battery

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Scientists at Fraunhofer UMSICHT have succeeded in increasing the size and power of the battery stack by rethinking its design. Credit: Fraunhofer UMSICHT

More and more electricity is being generated from intermittent sources of power, such as solar and wind energy. Powerful electric energy storage devices are necessary to level out corresponding irregularities in the power supply. Fraunhofer scientists have recently made an important breakthrough with their development of a redox flow battery that

reaches stack power up to 25 kW, with a cell size of 0.5 square meters. This is eight times larger than the previous A4-sized systems. They will be presenting the new battery for the first time at the Hannover Messe trade show (from April 8–12).

Sun and wind are important sources of energy. Almost a quarter of the electricity we use today is derived from renewable sources. The German Federal Government has set itself the objective of generating total electricity the country needs from sun, wind, biomass, by 2050. For the "Energiewende" to be a success, however, increasing amounts of solar and wind energy have to be stored for use during the night, or for times when there is less wind. Electric batteries are an option. Redox flow batteries offer an effective way to balance out fluctuations in the supply of renewable energy and thus guarantee its constant availability. The batteries store electrical energy in chemical compounds, the liquid electrolytes. The electrolytes are charged and discharged in small reaction chambers. Several of these cells are lined up in stacks. However, the batteries that are currently available on the market, which are roughly the size of A4 paper (1/16 square meters), can only generate 2.3 kilowatts (kW) of power..

First presentation at Hannover Messe

Scientists at the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen, Germany, have succeeded in significantly increasing the size of the stack and, with it, its capacity. A new design has allowed them to produce stacks up to 0.5 square meters in size. This is eight times larger than the cells in previous systems, and results in power up to 25 kW. Scientists will showcase this battery at the Energy Alliance's Fraunhofer booth at Hannover Messe (Hall 13, booth C10). The prototype has an efficiency of up to 80 percent, and can take a load of up to 500 amps of current.

So how have the experts managed to increase the size and capacity so remarkably? Scientists began by testing new membrane materials and researching battery management and battery design. Flow simulations helped them to optimize the cell structure. A complete redesign of the battery followed which enabled the Fraunhofer team to make their breakthrough.. "The biggest challenge we faced for producing batteries with this level of performance was the development of a completely new stack structure andthe scale-up," explains Dr. Jens Burfeind, Group Manager for Electrochemical Storage Systems at Fraunhofer UMSICHT.

Large test laboratory for redox flow batteries

UMSICHT experts are working together with colleagues from the Fraunhofer Institutes for Chemical Technology ICT and for Solar Energy Systems ISE to conduct intensive research into redox flow batteries as part of a project funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The research work is carried out at the institute in Oberhausen, home to one of Europe's largest test laboratories for redox flow batteries. "Successfully redesigning the battery stacks was an important step in developing redox flow batteries that could, for example, supply 2000 households with electricity," says Dr. Christian Dötsch Division Director Energy at Fraunhofer UMSICHT. This would require a capacity of around two megawatts, so the next fixed objective is to develop a stack that is two square meters in size and has a capacity of 100 kW.

How a redox flow battery works

The redox flow cell (red for reduction = electron uptake, ox for oxidation = electron release) is an accumulator. It stores energy in electrolyte solutions contained in tanks. The electrolyte circulate from these tanks through a cell, which generates electricity from the fluid in a

chemical process. The most common kind of this type of battery is the vanadium redox flow battery. The vanadium is charged and discharged in small reaction chambers. Several of these cells are lined up in stacks, which increases the battery's power. Redox flow batteries offer several advantages; they are cost-effective, robust, durable, and can be individually customized.

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