Scientists create a vanadium flow battery model

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A group of scientists from the Skolkovo Institute of Science and Technology (Skoltech), Lomonosov Moscow State University (MSU) and the Moscow Institute of Physics and Technology (MIPT), led by Skoltech Professor Aldo Bischi, has developed a mathematical model of the electrochemical cell of the vanadium flow battery. The model describes the battery's dynamic behavior, including the flow of vanadium ions through the cell membrane. The results of the study were published in the journal *Applied Energy*.

The vanadium flow battery is seen as one of the most advanced energy storage devices from the perspective of its integration with renewable energy sources. The battery's operating principle consists of converting electrical energy into the energy of chemical reactions between vanadium salts. The flow battery differs from classical batteries in that it uses both the electrochemical cell and the liquid electrolyte stored in separate tanks and flowing through the cell when the battery is in operation. Thus, the battery's capacity and power can be scaled independently, which gives the designers more flexibility in creating real power installations and enables them to design new high-power and high-capacity storage devices. Another advantage of vanadium flow batteries is that they have a much longer life compared to their conventional counterparts. Currently, vanadium flow batteries are used in combination with solar panels and wind power generators. The new model will help detect and monitor failures and expand the scope of application of the battery.

The new mathematical model effectively describes the cross-over – a major problem in the vanadium flow battery's operation, leading to capacity reduction.

The approach proposed by Professor Aldo Bischi and his team helps attain high accuracy in modeling the battery's charge and discharge characteristics (voltage, capacity, and charge level) and the capacity reduction due to cross-over using reasonable computational effort.

"Our model can be used to develop condition monitoring techniques for vanadium flow batteries as a way to prevent degradation of their performances due to long operation," explains the study's first author and Skoltech Ph.D. student Mikhail Pugach.

More information: M. Pugach et al. Zero dimensional dynamic model of vanadium redox flow battery cell incorporating all modes of vanadium ions crossover, *Applied Energy* (2018). DOI: 10.1016/j.apenergy.2018.05.124

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