

PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

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Energy Research
2540 Research Park Drive
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SPONSORS

E.ON, Germany

PROJECT VALUE

\$1,144,000

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ELECTROCHEMICAL POWER SOURCES

A Facile Method for Storing and Rapid Release of Renewable Energy to an Electrical Grid

The development of utility energy storage technologies is catalyzed by a variety of reasons, including increasing fuel costs, concerns about CO₂ emissions, current strain and increased load on the aging electric grid, and political unrest in leading oil-producing countries. Power outages are estimated to cost the U.S. approximately \$79B/year with the majority of the electricity disruptions typically lasting for less than five minutes. Energy storage accounts for only 2.5% of the total electricity capacity in the U.S., and the development of bulk energy storage technologies is hindered by high costs and site location. However, the development of smaller scale utility energy storage technologies is promising, and can assist in the improvement of generating efficiency by peak shaving and filling demand valleys.

Electrochemical double-layer capacitors (EDLCs), often referred to as supercapacitors or ultracapacitors, are electrochemical energy storage devices capable of storing and delivering energy at higher rates than most batteries, making EDLCs a viable option for rapid storage and release of electrical energy to the grid. Electrochemical capacitors typically possess lower energy densities than batteries (< 5-10 Whr/kg), but have many advantages, including higher power densities (~ 10-100 kW/kg), extended cycle life, and undergo no chemical or structural changes during charge and discharge. Presently available battery technologies have attractive energy densities (8-600 W/kg), but are limited in power density (0.005-0.4 kW/kg). Traditional aqueous and non-aqueous carbon-carbon capacitors cannot meet the energy densities required for many emerging applications. Hybrid or so-called asymmetric capacitor systems combine a battery (or faradaic) electrode and a double-layer charge storage electrode. These systems are currently under development and represent the next generation of electrochemical cells to enhance the energy density available from an electrochemical capacitor.

We are currently developing two asymmetric or hybrid electrochemical capacitor technologies based on organic electrolytes and carbonaceous electrode materials. The hybrid systems will have operating cell voltages exceeding 4.2V, thus achieving high energy densities. The application of carbon nanomaterials as active materials will allow these devices to maintain excellent power densities (rapid charge/discharge) as well.