

# Second-Use Li-Ion Batteries to Aid Automotive and Utility Industries

Highlights in  
Research & Development

Repurposing lithium-ion batteries at the end of useful life in electric drive vehicles could eliminate owners' disposal concerns and offer low-cost energy storage for certain applications.

Increasing the number of plug-in electric drive vehicles (PEVs) is one major strategy for reducing the nation's oil imports and greenhouse gas emissions. However, the high up-front cost and end-of-service disposal concerns of their lithium-ion (Li-ion) batteries could impede the proliferation of such vehicles. Re-using Li-ion batteries after their useful automotive life has been proposed as a way to remedy both matters.

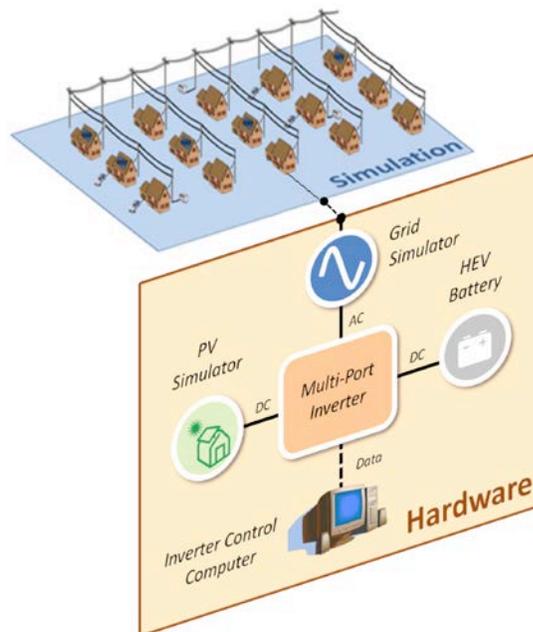
In response, the National Renewable Energy Laboratory (NREL) and its partners are conducting research to identify, assess, and verify profitable applications for the second use of PEV Li-ion batteries after their end of useful life in vehicles.

A framework for analyzing the second use of such batteries has been created to assess repurposing costs, second-use applications, and other factors. Applying this framework to Li-ion PEV batteries has highlighted the need for efficient repurposing strategies, identified a promising market for repurposed batteries, and begun to quantify the potential of second-use strategies to affect the cost of energy storage.

The analysis also concluded that validating real-world performance of used automotive batteries is critical. Accordingly, a flexible second-use field testbed has been installed on the University of California, San Diego's microgrid, and a hardware-in-the-loop (HIL) platform with advanced simulation and test capabilities is under development at NREL. These resources are being used to design optimal strategies for and validate performance of second-use batteries in real-world environments.

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**Reference:** Ferry, M.; William, T.; Neubauer, J.; Dempster, P. (2013). "Second-Life Applications for PEV Battery Systems: Early Testing to Early Commercialization." *EESAT*, Oct. 2013.



*An HIL simulation at NREL will enable evaluation of complex scenarios and testing of second-use batteries in real-world conditions, without risking damage to utility hardware or interruption of service.*

## Key Research Results

### Achievement

NREL and its partners have created a detailed framework for analyzing the second use of advanced automotive batteries, addressing repurposing costs, sale price, automotive discounts, and second-use applications. Analysis has provided several key findings, furthering knowledge of this ongoing research topic.

### Key Result

The current research highlights the need for efficient repurposing strategies and life forecasting for Li-ion batteries, and identifies a promising market for repurposed batteries.

### Potential Impact

As testing continues, researchers will assess the real-world performance and degradation characteristics of second-use batteries to learn more about optimizing deployment strategies for this resource.

**NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.**

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