

## Quick Facts

NREL's Isothermal Battery Calorimeters (IBCs) make it possible for battery developers to predict thermal performance before installing batteries in vehicles. The IBCs received a prestigious R&D 100 Award from *R&D Magazine* in 2013, declaring them to be among the 100 most significant innovations of the year.

A well-designed thermal management system is critical to the longevity, safety, and performance of electric-drive vehicles. Electric-drive vehicle batteries are currently expensive, and extreme temperatures can shorten their lifespan and, in rare cases, can result in vehicle fires.

The U.S. Department of Energy's Vehicle Technologies Office supported the development of the IBCs, allowing U.S. battery developers to precisely measure the heat generated by batteries for electric-drive vehicles, analyze the effects of temperature on battery systems, and help pinpoint ways to manage battery temperatures for the best performance and maximum life.

Members of the U.S. Advanced Battery Consortium, which includes Chrysler, Ford Motor Company, and General Motors, acknowledge that in-depth analysis of battery heat management issues can help automakers troubleshoot thermal issues and engineer systems capable of maintaining batteries within their ideal temperature range.

**National Renewable Energy Laboratory**  
15013 Denver West Parkway, Golden, CO 80401  
303-275-3000 • [www.nrel.gov](http://www.nrel.gov)

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## NREL's Isothermal Battery Calorimeters are Crucial Tools for Advancing Electric-Drive Vehicles

With average U.S. gasoline prices hovering in the \$3 to \$4 per gallon range and higher fuel economy standards taking effect, drivers and automakers are thinking more about electric vehicles, hybrid electric vehicles, and plug-in hybrids. But before more Americans switch to electric-drive vehicles, automakers need batteries that can deliver the range, performance, reliability, price, and safety that drivers have come to expect from gasoline-powered vehicles. In addition, a well-designed thermal management system is critical to the safety and performance of electric-drive batteries.

The innovative Isothermal Battery Calorimeters (IBCs), developed by the National Renewable Energy Laboratory (NREL), are the only calorimeters in the world capable of performing the precise thermal measurements needed to make safer, longer-lasting, and more cost-effective batteries for the next generation of electric-drive vehicles. Now being commercialized in collaboration with NETZSCH, the IBCs are the most accurate devices of their kind and are capable of testing a wide range of sample sizes. The calorimeters can accurately determine the heat generated by battery cells, modules, sub-packs, and even some full-size packs that produce up to 4 kilowatts of heat.

The IBCs can also measure heat rates that are eight orders of magnitudes smaller, as low as 10 milliwatts, and heat inputs as low as 10 Joules—about the amount of energy released while rubbing your hands together. This degree of sensitivity relies on patent-pending design innovations including superior thermal isolation, designs to channel all of the heat generated through measuring sensors, and the ability to simulate real-world driving conditions without compromising safety. The instrument is able to determine heat levels and battery energy efficiency within 98% of actual values.

The IBCs allow auto manufacturers to address battery safety and life issues long before cars are delivered to dealers' lots, making hybrid and electric vehicles viable options for more consumers. As one example, General Motors and LG Chem Power Inc. used an IBC prototype to size the thermal management system for the Chevrolet Volt battery.



NREL researchers attach the cover on the Isothermal Battery Calorimeter that is used for advanced battery research at NREL's Thermal Test Facility in Golden, Colorado.

Photo by Dennis Schroeder, NREL 18916

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