

Quick Facts

Through a collaboration called Computer-Aided Engineering for Electric Drive Vehicle Batteries (CAEBAT), NREL and its industry partners are accelerating battery design, prototyping, and testing, using sophisticated software tools to boost the performance and consumer appeal of electric-drive vehicles.

CAEBAT was initiated by the U.S. Department of Energy (DOE) in 2010, and participants include national labs, U.S. auto manufacturers, battery developers, and automotive simulation tool developers.

The CAEBAT partners work in three teams to develop software tools for battery pack design, drawing on NREL's Multi-Scale Multi-Domain model framework, which makes it much easier to develop sub-models at the cell and pack levels.

The three teams of CAEBAT partners include:

- EC Power LLC, Pennsylvania State University, Johnson Controls Inc., and Ford Motor Company
- General Motors, ANSYS, and ESIm
- CD-adapco, Battery Design LLC, A123 Systems, and Johnson Controls Inc.

As part of the CAEBAT project, Oak Ridge National Laboratory is developing an open architecture software platform to enable interactions among the software components provided by participants.

While primary funding for this activity is provided by DOE, the industry partners are contributing 35% (\$7 million) of the project budget.

NREL-Led Team Improves and Accelerates Battery Design

The National Renewable Energy Laboratory (NREL) is leading some of the best minds from U.S. auto manufacturers, battery developers, and automotive simulation tool developers in a \$20 million project to accelerate the development of battery packs and thus the wider adoption of electric-drive vehicles. The Computer-Aided Engineering for Electric Drive Vehicle Batteries (CAEBAT) collaboration is developing sophisticated software tools to help improve and accelerate battery design and boost the performance and consumer appeal of electric-drive vehicles—with the ultimate goal of diminishing petroleum consumption and polluting emissions.

Most battery models and simulation tools developed prior to CAEBAT did not strike the balance of precision and ease-of-use needed by battery developers, pack integrators, and automakers. The CAEBAT project, launched by the U.S. Department of Energy (DOE) in 2010, addresses these issues with a suite of battery cell, module, and pack engineering tools formulated to:

- Investigate a full range of chemistry, cell design, thermal management, and battery pack options for particular vehicle platforms
- Factor in electrochemical, thermal, and mechanical interactions
- Shorten battery development, prototyping, testing, and optimization processes
- Improve overall battery performance, safety, and lifespan
- Reduce costs for suppliers, manufacturers, and consumers.

At the outset of the CAEBAT project, NREL unveiled a development crucial to filling the gap in existing tools: a predictive computer simulation of lithium-ion batteries known as the Multi-Scale Multi-Domain (MSMD) model framework. MSMD's modular, flexible architecture connects the physics of battery charge and discharge processes, thermal control, safety, and reliability in a computationally efficient manner. This makes it much easier to independently develop sub-models at the cell and pack levels.

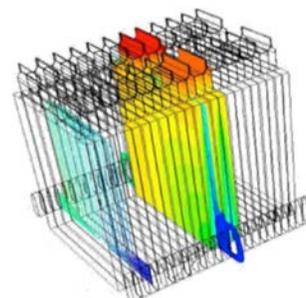
In 2011, DOE and NREL used a competitive procurement process to select three teams (see sidebar) to develop three separate, competitive, validated, and easy-to-use CAEBAT software tools for battery pack design, with technical support provided by NREL. As a result, CAEBAT has produced models of pack thermal networks and of cell performance in a variety of configurations. These models are being validated from the cell to the pack level, and the resulting software tools are currently being offered as beta versions for evaluation at the original equipment manufacturers. The tools are expected to become competitive marketplace offerings for battery and automotive engineers in 2014.

National Renewable Energy Laboratory
15013 Denver West Parkway, Golden, CO 80401
303-275-3000 • www.nrel.gov

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.

NREL/FS-6A42-60650 • November 2013

NREL prints on paper that contains recycled content.



GM used the CAEBAT modeling tools to evaluate the performance of this computer-designed prototype of a 24-cell battery module.

Computer-generated illustration provided by GM