NATIONAL RENEWABLE ENERGY LABORATORY

ENERGY SYSTEMS INTEGRATION

ESI optimizes the design and performance of electrical, thermal, fuel, and water pathways at all scales.

PARTNERSHIPS

NREL + BOSCH + BONNEVILLE POWER ADMINISTRATION

RESIDENTIAL ENERGY STORAGE SIZING AND VALUE ANALYSIS

NREL is partnering with Bosch and Bonneville Power Administration to develop cyber-secure home automation algorithms that deliver high-reliability demand response while avoiding negative homeowner impacts. The home automation system can simplify energy system integration of controllable air conditioning, water heaters, dishwashers, refrigerators, washing machines, dryers, rooftop solar photovoltaic (PV) systems, and home batteries. NREL's key contributions to this multi-industry challenge are: developing foundational machine learning algorithms for no-training operation of diverse residential building assets; developing novel strategies for continuous multi-criterion decision-making model predictive control; and defining methods to flow down grid-level cybersecurity and resiliency requirements to participating end-use devices.

To increase the impact of this project, NREL will develop market guidance for home battery sizing, and demonstrate aggregation of next-generation residential demand-side resources under multiple grid scenarios.

Researcher Scott Carmichael works with a home battery that integrates with a solar inverter and other controlled appliances as part of a home energy management system. *Photo by Dennis Schroeder, NREL 45555*

R&D STRATEGY

NREL will define a methodology for sizing batteries in several steps:

- Define battery loads: Perform parametric simulations with a small number of home designs—for various climates, with and without PV, and with varied levels of controllable loads—to assess optimal techno-economic battery charge and discharge profiles. This approach will use home automation software developed through the project to define the operational parameters for the battery and controllable loads.

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- Develop battery models: Continue development of lithium-ion battery modeling to include battery degradation due to cycling and temperature effects.
- Determine battery performance under assessed loads: Apply the loads to the models, and determine if any excessive rate, capacity, or cycling excursions occurred. Analyze multiple available battery sizes to calculate unmet battery load in each case.
- Perform techno-economic sizing analysis: Integrate battery analysis results with utility tariff structures to identify homeowner economic impacts of battery ownership. Identify the battery's net present value in each scenario studied.

The outcome of this project will be a white paper describing the draft methodology and a plan to validate the sizing methodology via laboratory testing.

In 2018, NREL will use its hardware-in-the-loop capabilities to validate the battery's use case benefits for some scenarios studied in the prior year. NREL will also refine the sizing methodology by establishing an industry advisory group to ensure that it is practical and broadly applicable. NREL's goal is to produce a revised battery sizing methodology that can help inform a standards-making process by the conclusion of the project. Finally, NREL plans to develop simplified guidance documents for immediate use by industry stakeholders when considering storage alongside controllable loads.

POTENTIAL IMPACTS

Building-integrated batteries currently have no sizing standards or broad application guidelines. This is causing slow market uptake, an insufficient set of comparable products, and uncertainty in battery lifespan. Establishing practical guidance for sizing, use case expectations (cycling rates, depth of discharge), and economic outcomes could stimulate sales and competition in the home battery systems market, while accelerating energy storage into markets where it could provide immediate value for manufacturers, utilities, and consumers.

Photo by Dennis Schroeder, NREL 40870

Partner with NREL at the ESIF

User facility access to the ESIF is awarded through the review and approval of user proposals, depending on the scientific merit, suitability of the user facilities, and the appropriateness of the work to DOE objectives, and includes a signed user agreement for the facility.

For more information, please visit:
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The Energy Systems Integration Facility (ESIF) at the National Renewable Energy Laboratory (NREL) provides the R&D capabilities needed for private industry, academia, government, and public entities to collaborate on utility-scale solutions for integrating renewable energy and other efficiency technologies into our energy systems.

To learn more about the ESIF, visit: ***www.nrel.gov/esif***.

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