NREL battery life

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Research at NREL is optimizing lithium-ion (Li-ion) batteries used in electric vehicles (EVs) and stationary energy storage applications to extend the lifetime and performance of battery systems. Battery lifetime predictive modeling considers numerous variables that factor into battery degradation during use and storage, including:

BLAST-Lite is a simplified version of NREL"s battery lifetime models for a variety of Li-ion battery designs, parameterized from lab data available in Python or MATLAB. BLAST-Lite can be easily implemented into larger techno-economic analysis tools and is currently used by the System Advisor Model and Renewable Energy Integration and Optimization platform. BLAST-Lite incorporates example load profiles for stationary energy storage or vehicle applications and temperature profiles for U.S. cities.

NREL"s BLAST suite provides insight into research or engineering problems related to the design, economics, controls, or thermal management for common use-cases of battery energy storage systems.

Researchers can use BLAST tools to simulate the lifetime performance of stationary energy storage applications, such as behind-the-meter residential systems, corner charging stations for EVs, and utility-scale energy storage.

BLAST tools incorporate realistic lab-based drive-cycles or simulated real-world driving patterns generated by the to anticipate EV battery lifetime. Pack-level simulations can also incorporate the effects of heat generation and thermal management on pack performance and lifetime.

NREL"s collection of battery life models, including BLAST, are able to test data from many cell chemistries, designs, and manufacturers, which allows users to estimate the value of end-of-life batteries if some information on the cell"s history is known. This can inform second-life applications for batteries, such as an EV battery being used for stationary energy storage. Similarly, researchers can quantify the battery life impact of application stacking--or using the battery for multiple purposes, such as behind-the-meter storage.

For general information about batteries and the one of the references used to develop this model, see Linden, D.; Reddy, T.; (2011). Linden"s Handbook of Batteries. 4th edition. New York: McGraw Hill.

D"Agostino, R.; Baumann, L.; Damiano, A.; Boggasch, E. (2014). A Vanadium-Redox-Flow-Battery Model for Evaluation of Distributed Storage Implementation in Residential Energy Systems. IEEE Transactions on Energy Conservation. Vol 30 No 2 June 2015.

DiOrio, N.; Denholm, P.; Hobbs, W. (2020). A Model for Evaluating the Configuration and Dispatch of PV Plus Battery Power Plants. Applied Energy Vol 262 March 2020. This paper inlcudes a detailed description of the implementation of SAM"s "automated dispach" option for front-of-meter batteries and an analysis case study using the option.

DiOrio, N.; Hobbs, W. (2018). Economic Dispatch for DC-connected Battery Systems on Large PV Plants. NREL/PR-6A20-72513. (PDF 653) These presentation slides provide a high-level description of how SAM"s "automated dispatch" option for front-of-meter batteries works.

DiOrio, N. (2017). An Overview of the Automated Dispatch Controller Algorithms in SAM. NREL/TP-6A20-68614. (PDF 770 KB) This paper describes the peak shaving option for behind-the-meter batteries.