Hawai'i Natural Energy Institute Research Highlights

Electrochemical Power Systems

Path Dependence of Battery Degradation, EV Batteries for Grid Support

OBJECTIVE AND SIGNIFICANCE: The objective of this work was to characterize the impact of fast charging and grid-vehicle interactions on the performance and durability of Li-ion batteries in electric vehicles. The knowledge gained in this project inform best practices to help implement successful electric vehicle fast charging, vehicle-to-grid (V2G), and grid-to-vehicle (G2V) programs.

BACKGROUND: Electrification of automobiles and fossil-fuel displacement by renewable energy sources are crucial to combat climate change. The successful adoption of these clean energy technologies could benefit from integration strategies such as fast charging and the sourcing/sinking energy to/from the electric grid known as V2G and G2V, respectively. Understanding and mitigating battery degradation is key to improving the durability of electric vehicles and the reliability of power grids. Battery degradation is path dependent; this means that not only the degradation pace is affected by usage but also the type of degradation the batteries experience. Lithium-ion batteries are known to degrade slowly at first before a rapid acceleration of which starting time will depend on the degradation mechanisms.

PROJECT STATUS/RESULTS: Our study showed that a simplistic approach to V2G, namely that an EV is discharged at constant power for 1h without consideration of battery degradation, is not economically viable because of the impact additional V2G cycling has on battery life. However, we showed that if the batteries are to be used for frequency regulation, there is a much lesser impact.

It must be noted that, because of path dependence, different usages might lead to different results and thus that our results should not be generalized. This was proved further through the fast charging side of this project where batteries were shown to have 4x shorter life even though they were used less aggressively than other similar cells.

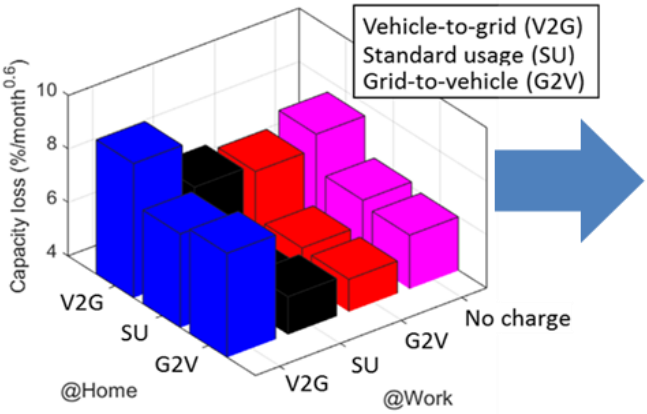
Overall, our work showed that, with good battery prognostic models and further advances in understanding the causes, mechanisms and impacts of battery degradation, a smart control algorithm could take all these aspects in consideration and make V2G and fast charging a reality. Research conducted for this project is completed in the **PakaLi Battery Laboratory**.

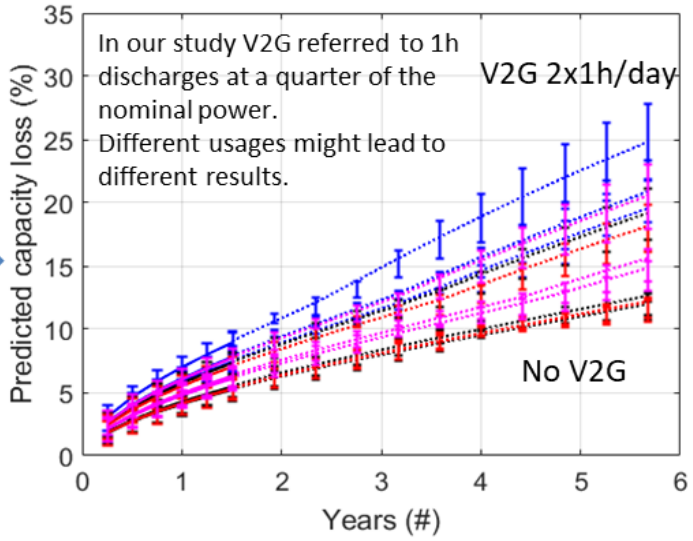
This project is ongoing. This project led to 10 publications so far, including: "**The viability of vehicle-to-grid operations from a battery technology and policy perspective**" in Energy Policy, Vol. 113, pp. 342-347 and "**Durability and Reliability of Electric Vehicle Batteries Under Electric Utility Grid Operations: Bidirectional Charging Impact Analysis**" in the Journal of Power Sources, Vol. 358, pp. 39-49.

Funding Source: Office of Naval Research

Contact: Matthieu Dubarry, matthieu@hawaii.edu

Last Updated: October 2020





Hawai'i Natural Energy Institute | School of Ocean & Earth Science & Technology
University of Hawai'i at Mānoa, 1680 East-West Road, POST 109 • Honolulu, HI 96822
Phone: (808) 956-8890 • Fax: (808) 956-2336 • www.hnei.hawaii.edu