



Hawai'i Natural Energy Institute Research Highlights

Grid Integration & Energy Efficiency

Bidirectional EV Charging Demonstration Project

OBJECTIVE AND SIGNIFICANCE: The main objective of this project is to develop, evaluate, and demonstrate the performance of novel algorithms to optimize the charge/discharge of shared fleet vehicles for energy cost minimization. Project experience and results will not only advance energy research but also inform the university's consideration of options such as the electrification of fleet vehicles, advanced car share applications, integration of distributed renewable energy resources on campus, and the optimal management of campus energy use and cost containment.

BACKGROUND: HNEI GridSTART is collaborating with IKS Co., Ltd. (IKS) on technology development, testing, and demonstration of advanced control of two bidirectional electric vehicle (EV) chargers ("H-PCS") on the campus of the University of Hawai'i at Mānoa (UH). The two designated parking stalls, indicated by the red rectangle, are located adjacent to the Bachman Annex 6 building indicated by the orange rectangle (Figure 1). The H-PCS was developed by IKS with support from Hitachi Limited as part of the earlier JUMPSmart Maui smart grid demonstration project, where GridSTART was one of the partners.



Figure 1. Location of bidirectional EV chargers.

Two EVs procured by the project for this research are currently used by designated university personnel in a car-sharing system accessed via a secure web-based car scheduling application developed by HNEI GridSTART.

The novel H-PCS control algorithms developed by HNEI GridSTART first ensures that the shared vehicles for UH personnel use are efficiently assigned and readily available for transport needs. Simultaneously, the autonomous controls deliver ancillary power and energy services through intelligent EV charge and discharge commands, at times allowing the stored energy in the EV batteries to be strategically withdrawn to minimize the overall

cost of energy supply to UH campus loads. The autonomous controls may also support the operational needs of the local utility operator (Hawaiian Electric Company) through the supply of grid ancillary services in return for financial compensation.

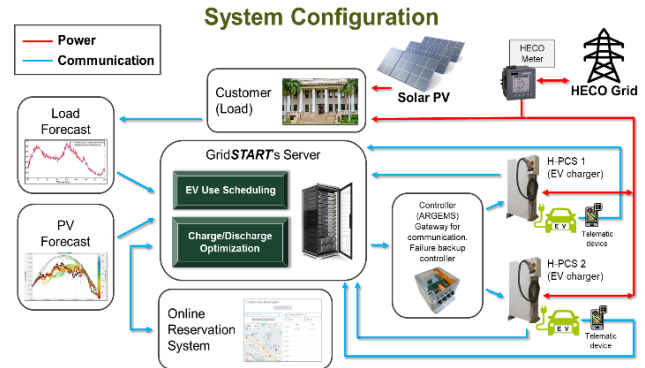


Figure 2. Functional system diagram.

HNEI GridSTART's novel algorithms also incorporate data fed from state-of-the-art in-house developed forecasts of campus building demand and on-campus solar PV power production. This allows the system to maximize the use of renewable energy as the preferred source for EV charging and supply to building loads while minimizing costly energy purchases from the grid.

PROJECT STATUS/RESULTS: The project was field operationalized in July 2023, with research focus now on analyzing system performance data and exploring enhancements of the integrated autonomous control algorithms hosted on the project's dedicated server. The system's energy cost minimization benefit is being assessed across a range of alternative building load and PV profile cases, EV use patterns, charging modes, and utility tariff structures to explore system scale up. A vehicle telematic system was successfully installed to capture real-time car use data while on the road including EV battery state of charge, vehicle location, and energy consumption. Data from the telematic system is planned for enhancement of predictive algorithms – enabling more informed projections of EV use patterns to improve the scheduling of EV charge and discharge controls.

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