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Vehicle to Micro-Grid: Leveraging Existing Assets for Reliable Energy Management

Mike Simpson, Tony Markel, and Michael O'Keefe
National Renewable Energy Laboratory

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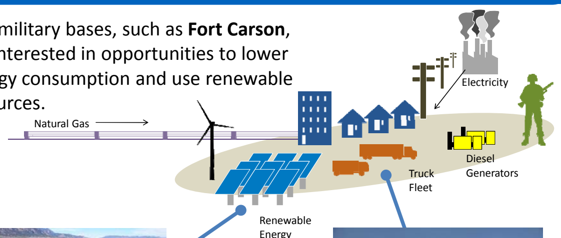
INTRODUCTION

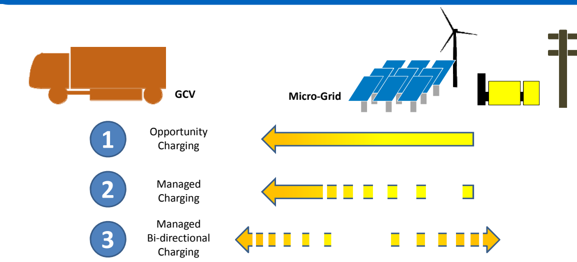
U.S. military bases, such as **Fort Carson**, are interested in opportunities to lower energy consumption and use renewable resources.



Fort Carson Photovoltaic Installation
Courtesy of U.S. Army Fort Carson

The Smith Electric Newton all-electric truck
Courtesy of Smith Electric Vehicles

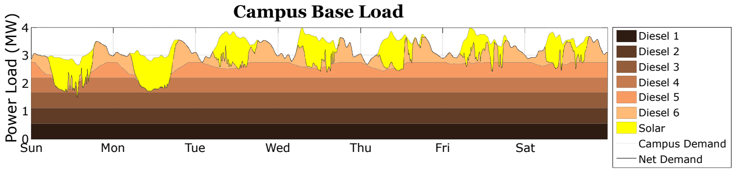
OPPORTUNITY



Can the substantial battery packs of the on-site grid-connected vehicles (GCVs) improve the stability and performance of the Fort Carson micro-grid during day-to-day, islanding, and emergency operation?

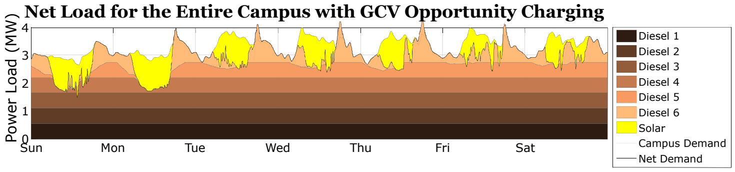
ANALYSIS

Campus Base Load



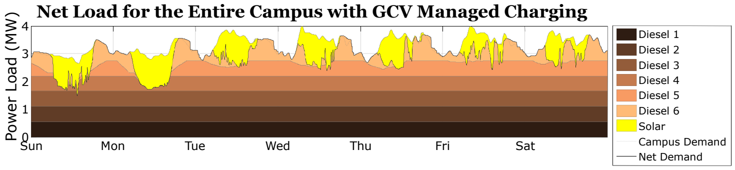
The figure above shows the emergency generation profile during a mid-summer week, presenting up to 25% load variance between peak and trough.

Net Load for the Entire Campus with GCV Opportunity Charging



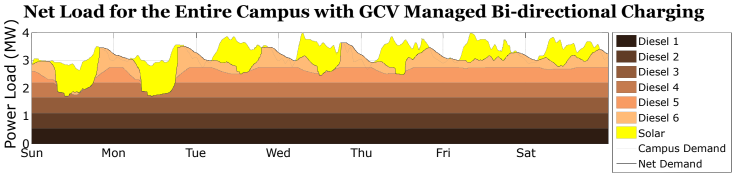
The figure above shows vehicle charging at full power beginning as soon as the vehicle parks and plugs in; this is called "Opportunity Charging". Arrival times align with peak loads and spike demand above previous peaks.

Net Load for the Entire Campus with GCV Managed Charging



By managing the charge rate relative to change in demand, the load becomes slightly flatter. Minor ripples can be smoothed and sharp drops in demand (or sharp rises in intermittent renewables) can be delayed to mitigate generator ramp times.

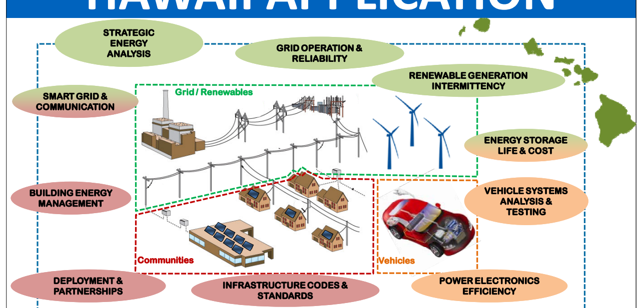
Net Load for the Entire Campus with GCV Managed Bi-directional Charging



The greatest flexibility comes with bi-directional charge management. With the ability to send power back to the grid, these vehicles now become a storage asset. Although even a large fleet of electric trucks cannot absorb strong solar events (such as those seen on Sunday and Monday), they can buffer the effect, leaving time for generators to catch up without creating a disastrous drop in micro-grid voltage.

During emergency operations, NREL assumed that the post will run a series of diesel generators to meet the needs of mission-critical loads while still incorporating the same level of solar power. Any grid instabilities created by power fluctuations from on-site variable renewable generation will be magnified in a critical load scenario.

HAWAII APPLICATION

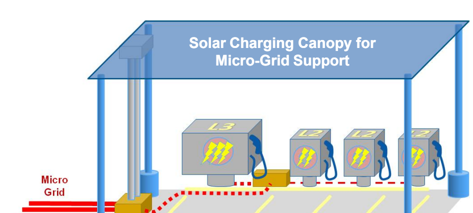


The Hawaii Clean Energy Initiative (HCEI) has set a goal of 70% clean energy generation in Hawaii by 2030. This includes a 40% Renewable Portfolio Standard and aggressive targets for EV market penetration. The integration of EVs with high penetration of wind and solar in Hawaii presents a number of challenges and opportunities. Vehicle grid integration tools and experience from this effort are being leveraged to support systems research and deployment to achieve HCEI goals.

SUMMARY

Even at relatively small adoption rates, we found that control of electric vehicle charging at Fort Carson will aid in regulation of variable renewable generation loads and help stabilize the micro-grid.

NREL plans to further develop and validate this tool with component testing using actual vehicles and equipment such as a solar carport and electric trucks at Fort Carson and other installations in areas such as Hawaii.



For further information, please contact Mike Simpson at 303-275-3209, mike.simpson@nrel.gov
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