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NREL Explores Benefits of Solar-Powered Charging For Plug-in HEVs

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Story by David Morrison

A solar-powered recharge station for electric and plug-in hybrid electric vehicles (PHEV) built by the Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) will allow researchers to explore the potential benefits of renewable energy and PHEVs to consumers and electric utilities. Developed as part of a project run by NREL senior engineer, Tony Markel, the recharge station consists of a 3.5-kW solar array that provides shade and power for two PHEVs.

The solar array was supplied by Envision Solar, which created its Solar Tree design specifically for NREL's renewable recharge station. This station is located at NREL's South Table Mountain site in Golden, Colorado. The structure features 20 photovoltaic panels atop a single-post, grid-tied parking canopy. The PV canopy, tilted at a 30-degree angle, was designed to produce an estimated 10-kWh while providing two shaded parking spaces. But Markel notes that the installation actually produced 14 kWhr during its first day of operation.

The Solar Tree design incorporates one 120-V outlet per parking space and supports 20 photovoltaic KC200GT Kyocera Solar modules. An additional outlet supplying 240 Vac is also included to accommodate higher-energy vehicles that may be available in the future. The first parking space is reserved for NREL's Toyota Prius PHEV and the second parking space will accommodate other visiting vehicles for experimental purposes.

"Envision's Solar Tree design provides NREL with key equipment to explore the linkage between renewable energy resources and transportation energy demands," says Markel. "Collecting energy from the sun and using it as a fuel for EVs and PHEVs helps us address our dependence on imported petroleum."

Beyond using renewable energy to reduce petroleum consumption, the solar-powered recharge station will be able to supply excess energy back to the grid. What's more, when a PHEV is present, its battery can be used by the utility as a "dispatchable" generator," provided a communications link is present from utility to vehicle.

Being able to take advantage of the vehicle's battery overcomes one of the limitations of solar power—the variation in a solar panel's power output over the course of the day and the time of year. Markel notes that a vehicle is typically on the road about 5% of the time, so the potential is there for doing more with the very expensive battery installed in the hybrid.

Markel's group is currently installing the hardware needed to permit controlled charge and discharge of the Prius PHEV's battery. Markel expects that in the next couple of months, the vehicle will start generating data on the charge and discharge capabilities of the vehicle.

One of the issues that this research will address is how can utilities and auto consumers get the greatest value out of the battery. One aspect of this issue is the amount of wear and tear on the battery that will result from the utility using it for storage of the solar-generated energy.

Markel hopes that the experiments on the recharge station will highlight how PHEVs could potentially expand the market for renewable energy by powering both vehicles and the grid. He notes that the recharge station will also serve as an example of what NREL would like to do on a larger scale within its own facilities. NREL is currently planning an expansion that will provide the lab with additional parking lots. Experiments on this first recharge station could pave the way for NREL to install charging stations in the new lots.

NREL's Prius was originally a standard model that was converted to a plug-in hybrid by Energy CS, an engineering firm that provides consulting and design services. Among the changes made in the conversion was the replacement of the Prius's original battery pack with a unit supplied by Hymotion, a green technology company. This battery pack uses Li-ion phosphate technology (a less volatile version of the Li-ion chemistry used in consumer electronics) supplied by battery developer Valence Technology.

According to Markel, the Li-ion phosphate battery pack has an available battery capacity of 9 kWhr. However, Markel notes that actual capacity in the Prius is about 6 kWhr because the Prius's power train was not originally

designed for the PHEV application. The 6-kWhr capacity equates to 50 miles of “blended” driving range where the vehicle is taking power from both the batteries and the gas engine.

For NREL’s Prius PHEV, the mode of operation depends on both vehicle speed and acceleration. Below 35 mph and with only light accelerations, the PHEV runs purely off battery power. Above those thresholds, the vehicle transitions into the blended driving mode. For more information, email Tony_Markel@nrel.gov.