

**FY2008 Renewable and Distributed Systems Integration Peer Review
Project Summary Form for Existing Projects**

Project Title:	Development of a Smart PHEV Charger Technology
Organization:	Pacific Northwest National Laboratory
Presenters:	Michael Kintner-Meyer
FY 2008 Funding:	\$300,000

Overall Project Purpose and Objectives:

Background and Purpose

Plug-in hybrid electric vehicles (PHEV) promise to shift future vehicle fuel consumption from imported oil to domestic resources using a national asset, the U.S. electricity grid. By using electricity, overall greenhouse gas emissions can be reduced and vehicle emissions can become effectively and economically shifted from millions of tailpipes to a few power plants that are usually far away from population centers and, potentially, amenable to carbon capture and sequestration. With growing market adoption of PHEV in the U.S., PHEV battery charging will need to be managed such that this new load does not set new system peaks, cause grid stress, and incur new infrastructure costs for generation, transmission and distribution upgrades. If the load can be managed to fill the generation valley during the night, the entire grid could be operated at higher utilization, benefitting both the customer and the utility industry. Furthermore, with the anticipated growth in intermittent renewable generation resources, smart charging technologies may mitigate the impacts of the variability in energy supply by modulating the charging rate or even deliver electricity out of the battery back into the grid. The energy storage in the vehicle coupled with advanced control strategies for charging could be of great value for large-scale integration of distributed and central station renewable generation resources.

Objectives

- 1) Influence the development of transportation-based battery chargers to accommodate load leveling, mobile transportation billing, ancillary grid services, energy storage, and other anticipated needs of the evolving smart grid
- 2) Identify, advocate, and engage in development of industry standards that will enable smart charger advancement, stakeholder collaboration, and cost reduction
- 3) Work with leading industry and research groups toward the rapid development and demonstration of smart PHEV charge systems

The outcome of this project directly supports the DOE's RDSI program by: 1) developing smart grid technology and 2) engaging with industry to facilitate for the rapid adoption of the smart charger.

2008 Approach and Results:

- *Established Project Advisory Board.* In late 2007, we composed an advisory board with representatives from GM, SAE, Bosch, CEC, EPRI, SCE, INL, ORNL, NREL, IBM, ZigBee Alliance, Google. Held two web-based teleconference calls.
- *Completed charger and charger testbed design.* We completed the specifications with block system diagrams of the entire testbed of the charger technology including all of the switch-gear for safely performing high voltage component testing. We finalized the definition and specification for the full set of control strategies to be implemented in the charger.

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- *Built testbed.* We completed the implementation of the hardware for charging and discharging full-size Li-Ion and NiMH batteries with full data acquisition capabilities.
- *Engagement with the standards-making bodies.* Michael Kintner-Meyer became associated Member of the Society of Automotive Engineers (SAE)'s standards committees J1772 (EV conductive charger coupler) and J2836 (Communication between Plug-in Vehicles and the Utility Grid).
- *Engagement with the standards-making bodies.* We explored demonstration opportunities of the smart charger with GM, Ford, and BMW. Thus far, BMW is interested to further discuss specifics of demonstration.

The biggest risk of this project is to be irrelevant to the real industry needs or too late for this fast-moving field. By being engaged with SAE and the automotive companies (GM, Ford, BMW), we hope to drive and influence the discussion and standards developments. We are planning to invite automakers to the lab for demonstrating our first prototype to be completed in November/December timeframe.

2009 Plans and Expectations:

- 1) *Complete Prototype #1 expected in January '09.* Complete and test prototype #1 with smart charging control strategies, except for the reversal of electricity from the battery to the grid. At that time, we will invite automakers to the lab for a demonstration. BMW indicated interest in reviewing our technology and coming to the lab.
- 2) *Explore opportunity to participate in a Smart PHEV pilot study in January '09.* Early expression of interest by BMW to test smart charging concepts will be firmed up to perform a one or two vehicle pilot.
- 3) *Continue to engage with SAE.*

Technology Transfer, Collaboration, Partnerships:

Significant technology transfer opportunities exist for the smart charger technologies. The core will be a set of control strategies that provide customer and utility benefits. Key for the technology transfer is to collaborate with the ultimate deliverer to the market—the automaker or supplier of automotive components. We are already directly engaged with GM, Ford, and BMW through existing contacts and interactions in other DOE PHEV analysis projects.

Collaboration with SAE and utility organizations, such as DTE Energy, Seattle City Light, Snohomish County PUD, and AEP, is already under way. The goal is to utilize state and local governments funding opportunities for PHEV/smart grid demonstration projects.