UNIVERSITY OF CENTRAL FLORIDA

PV Power Generation Using Plug-in Hybrid Vehicles as Energy Storage

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Description: The objective of this project is to develop and demonstrate an alternative PV power generation architecture that uses plug-in hybrid vehicle as the energy storage and transfer element with a total system cost target of $3.50/W. The tasks include developing efficient, reliable, and inexpensive maximum power tracking DC/DC battery chargers and 3-phase converters. A 10kW demonstration solar carport charging station will be built on UCF campus. A plug-in hybrid vehicle with a 25kWh battery bank (battery-only driving range of 50-100 miles) and onboard bidirectional AC charging system will be demonstrated

Budget: $380,816
Universities: UCF
External Collaborators: City of Tavares, FL

Progress Summary

Research Objectives for Current Reporting Period: The main research objectives for the current reporting period include the development of power electronics hardware and fine tuning of control software.

Progress Made Toward Objectives During Reporting Period: A 10kW smart solar plug-in electric vehicle charging station was constructed on UCF campus. The PHEV Smart Solar Carport is configured as two 5 kilowatt systems providing a total power output of 10 kilowatts. Most PHEVs currently available today are configured to receive standard "household" 120 volt Alternating Current (AC), so an inverter converts the DC into the required AC power for the vehicle chargers. The new system not only offers this feature but also facilitate future deployment of experimental technologies that will interface the DC produced by the photovoltaic modules directly with the DC batteries in the electric vehicles. This would allow direct DC transfer to the vehicle batteries, thereby eliminating losses associated with converting the DC to AC, and then back to DC power. A unique control strategy is implemented, allowing efficient energy transfer while reducing the conversion stages between the source and the load. All of the pedestals are reconfigurable and include provisions to accommodate future vehicle charging configurations. The solar carport system is "grid interactive" in that the inverters produce AC voltage that is synchronized with the electrical grid. This means that power produced from the PV panels in excess of what is needed to charge the electric vehicles will "go back" into the University's electrical grid. This allows the campus grid to act as an energy "bank" in which the excess capacity from the solar carport can be used to power other electrical demands on the

campus. The interactive system also allows for non-sunlit period vehicle charging. On an annual net metering basis, the carport is anticipated to be a net exporter of power to the grid as there will be a significant number of sunlit hours during a year when the majority of electric vehicles parked at the facility are fully charged, and during semester breaks and weekends. A communication link will be established between the system and the power grid to facilitate intelligent control.

Several hardware prototypes have been built to facilitate the three-way energy flow control. Final prototyping for the DC/DC converter is shown here. Each converter consists of a power board, a power supply board, and a controller board. The power supply board is designed to supply 12V from an input between 100V and 400V. The controller board is a generalized design with built-in sensing amplifiers. These boards are mounted vertically in the power board of each DC/DC converter included in the carport charging station. In order to increase the efficiency, soft switching was implemented in both converters (1.2kW solar DC/DC and 4kW DC/DC converters). These prototypes operate at a high overall efficiency (above 95%). Research activities for the next reporting period will focus on fine tuning of the hardware and the software control algorithms, and make efficiency comparison between the new system and the convention configuration over a wide range of conditions.