Powering Cars and the Grid

The Smart Solar Carport

Mounting solar panels on roofs is nothing new, but researchers at the University of Central Florida (UCF) have taken the idea one step further. And it's a step that will provide increased efficiency along with some much needed shade.

John Shen and graduate students at the solar carport.

Dr. John Shen is a principal investigator with the smart solar carport project and a professor with the School of Electrical Engineering and Computer Science at UCF. Shen has been working with photovoltaic (PV) for years, and as part of his research with the Florida Energy Systems Consortium (FESC) he's pairing two important pieces of the electric power puzzle.

"On one hand, solar power PV has been a big thing coming to the market place," says Shen. "Another is the plug-in hybrid electric vehicle, or PHEV. We thought, why not combine the two?"

The system developed by Shen and his colleague, Dr. Issa Batarseh, professor and director of UCF's School of Electrical Engineering and Computer Science, not only allows fixed transfer of direct current (DC) from the PV units to the vehicle batteries, but also provides the ability to transfer excess power produced by the PV units out to the grid.

The conventional method to charge PHEVs from PV involved a two step process. First, solar power, which is generated as DC, needs to be converted to alternating current (AC) because most homes are configured to operate on AC. And then the AC power is converted to DC again to charge the battery at the PHEV. But power is lost at each conversion, making a one-step transfer much more efficient.

"When you transfer power to the grid and then take it from the grid, you lose efficiency," Shen says. "When you transfer it directly from the solar cells you get considerable improvements in efficiency. The [percent] efficiency of transferring power from solar panels to the grid is in the low 90s. From the grid to charging a PHEV it's about 80 percent, which takes the total efficiency down to the low 70s. That means the efficiency going directly from the solar panel to the PHEV can be in the middle 80s. Considering solar power is only about 15 percent efficient, you want to maximize every bit of juice you can."

Because PHEVs are not readily available on the market, Shen and his group will initially use batteries as a load test to simulate the PHEVs. And when the batteries are completely charged, excess power collected from the solar panels will go out on the grid. The panels are expected to produce approximately 10 kW of power. Shen's calculations assume six hours on sunlight over 300 days in a year. With this, the system is expected to generate 18,000 kW-hours of electricity every year.

"This really boils down to a research project," says Shen. "It's been a real challenge to build up the energy conversion between all three components. We intend the research to go on for years, maybe the next 10 or 15, to test different concepts. And while the research is going on the carport serves as a practical parking spot."

Solar Carport parking spaces on the UCF campus.

The project includes four parking spaces in an existing lot near the center of UCF's campus (above). The architecture of the system is modular and can be expanded in pairs of parking spots. The construction of the first carport is complete and the group is in the process of transitioning the bench-scale electronics to the carport within the next six months.

To allow more realistic testing while reducing carbon emissions on campus, Shen is in negotiations with Toyota, Ford Motor Company, and GM and expects to receive PHEVs as they become available.

On March 2, 2010, the UCF Smart Solar Plug-in Facility was officially dedicated in conjunction with the launch of the first Ford PHEV in Florida, an event sponsored by Ford Motor Company and Progress Energy. Representatives from Ford Motor Company and Progress Energy were in attendance along with the Mayor of Orange County, Mr. Richard Crotty, and UCF President, Dr. John Hitt. Beyond acknowledging the work Shen has done with FESC, he hopes that this

ceremony will foster an important dialog between the auto industry, power companies, and research institutions.