'Smart' power grid needed for electric vehicles

April 22 2011, by Emil Venere

(PhysOrg.com) -- While an upcoming Electric Vehicle Grand Prix may reflect a growing popularity of electric vehicles, their widespread adoption will require innovations to the power grid, say researchers at Purdue University.

The researchers are working in areas related to the development of a "smart" power grid capable of handling the demands posed by thousands of charging electric vehicles.

A smart grid would use computers and sensors to coordinate the distribution of power and accommodate the increased demand caused by electric vehicles. The innovation also would help optimize the use of electricity from renewable sources, including solar and wind power, said J. Eric Dietz, an associate professor of computer and information technology.

"It will use better dynamic modeling and the ability to predict what's happening on the grid," he said. "It will, for example, coordinate the use of wind turbines and solar sources and take into consideration when air conditioning and major appliances are being used."

If such factors aren't properly coordinated, the system could overload.

"It could literally melt the wires running between power companies and users," Dietz said.

Purdue's Electric Vehicle Grand Prix will begin at 1 p.m. April 30 on the university's Grand Prix course northwest of campus. The event is a prelude to the inaugural Purdue Collegiate evGrandPrix on May 7 at the Indianapolis Motor Speedway.

Purdue faculty members and students also are involved in educational and research aspects related to various technologies surrounding electric vehicles. The university will develop a smart grid lab and a series of laboratory capabilities at colleges, universities and industrial sites across the state, said Joseph F. Pekny, a Purdue professor of chemical engineering.

Other smart grid work at Purdue involves understanding how to operate the power grid reliably given the demands posed by the introduction of plug-in hybrid vehicles. Not only will the grid need to reliably handle vehicle charging, but it also will need to deal with hundreds or thousands of cars putting power back into the grid, said Andrew Liu, an assistant professor of industrial engineering.

"Your car can be used as a generator to not only power your house but also put electricity into the grid," Liu said. "But in our current infrastructure there is only one-way communication. You can only charge, you cannot send electricity back to the grid. If you could, you should be compensated for that, which could help the adoption of electric vehicles because then the cost of owning an electric vehicle would come down."

Such a two-way communication between electricity consumers and power providers requires specialized electricity meters, communication software and market rules, as well as new types of transformers to accommodate these two-way communications.

"If you want wide adoption of electric vehicles and to modernize the

electricity system you need a systematic way of coordinating policies and technologies," Liu said. "What if a charging station can only take one vehicle at a time? Then the waiting time will be enormous, and will people do that?"

Further interdisciplinary research and simulations are needed to understand the interplay between economics, demographics and driving behavior.

"The way electricity is priced now, you pay an average price no matter when you use it, even if it's the hottest time of day during a heat wave," said Douglas Gotham, director of the State Utility Forecasting Group, a state-funded panel based at Purdue. "It's one of the few commodities priced that way. If you look at how long-distance telephone service changed when they broke up AT&T, instead of paying the average price for long-distance service that everybody was used to paying, you had all these pricing schemes where nights and weekends were cheaper. You would wait until after 8 at night to make a long-distance phone call. The only reason electricity can't be the same way is the way we meter it now.

"There is a mechanical meter on the side of your house with a little disk that goes around and somebody comes once a month and reads it, but you can't do time-of-day pricing based on that system."

However, new smart meters would allow two-way communication with the utility company. The meters are being tested in a pilot program in 10,000 South Bend homes.

"The smart grid is not hard to do," Gotham said. "You need a system that tells customers what the price is. The hard part is getting consumer behavior to change. Most people won't want to watch the price indicator for their electricity 24 hours a day. But if you start making people pay the real price of electricity during peak periods, they may wait until later

to run the dishwasher, and so on."

Before new metering technology can be implemented, a standard is needed, Gotham said.

"Without a standard, utilities are hesitant to make major investment in it," he said. "You don't want five years from now to have the smart grid equivalent of a Betamax."

More information: Information about the evGrandPrix is available at www.evgrandprix.org

Provided by Purdue University