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UTC Spotlight

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Preparing Infrastructure and Consumers for Plug-in Electric Vehicles

As the United States races to put 1 million plug-in electric vehicles (PEVs) on the road by 2015, several questions remain unanswered. Where will these vehicles be charged? Can our electrical grid handle the increase in demand? How will these vehicles impact the economy? Partnered with FirstEnergy, Akron Metropolitan Area Transportation Study (AMATS), NorTech, and others, the University of Akron's (UA) PEV Rollout Coalition, led by Ping Yi, Ph.D., at the Ohio Transportation Consortium, is searching for answers to these questions and more. Yi's *Plug-in Electric Vehicle (PEV) Readiness* study is evaluating market growth and the economic impact of PEVs, green transportation, and energy (including "smart grid" and battery technology), and the best charging station locations.

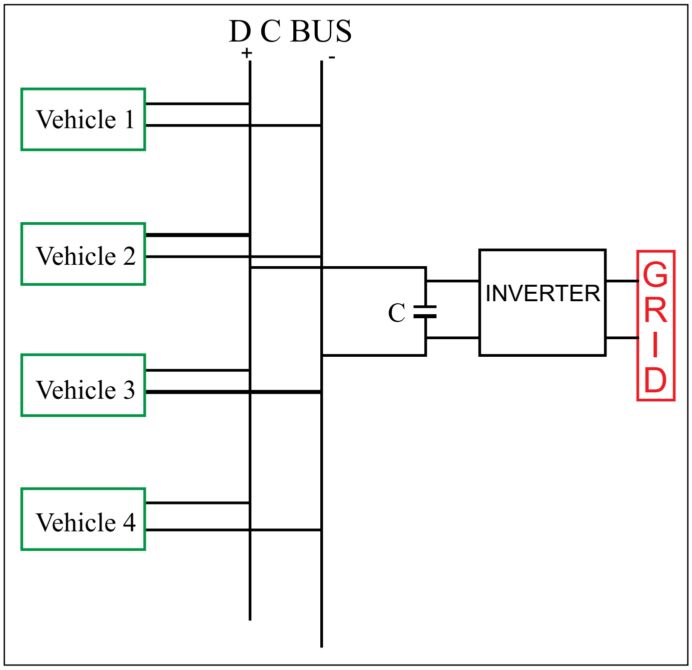
FirstEnergy is working with the UA Coalition and others to create a microgrid testing facility to evaluate the potential grid impacts that large-scale adoption of PEV technology would pose to Ohio's electric infrastructure. UA, FirstEnergy, and the Electric Power Research Institute (EPRI) are investigating the best approaches to developing "smart charging" technologies that will minimize the impact of PEVs on the electrical power grid during peak usage (figure 1).

Charging Levels

The power demand for Level I charging is 110–120 volts and 16 amps with a recharge time of approximately 8–10 hours; this is ideal for home charging. Level II charging requires 240 volts and 30 amps. This increase in power demand leads to a decrease in charging time (4–8 hours). Level II charging can be used either at home or in locations where people spend a substantial amount of time, such as parking lots near work places. Level III, or direct charge, helps consumers maintain their busy schedule by recharging a depleted battery in roughly 15–30 minutes. This level consumes 480 volts and 125 amps of power. Ideal locations for level III stations include shopping malls, department stores, and restaurants where people spend a relatively short amount of time.

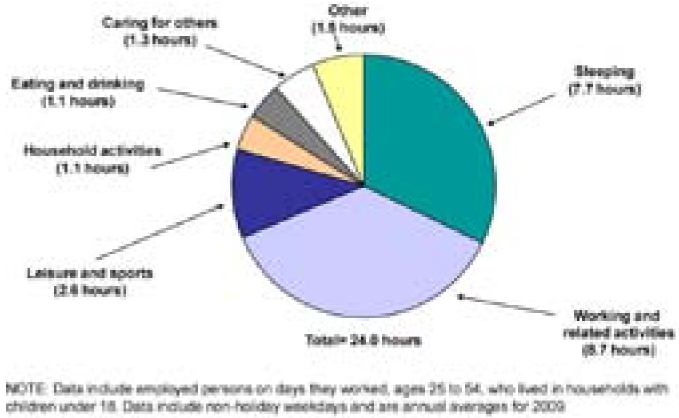
PEVs generally can travel approximately 40–100 miles per charge, as opposed to 300–400 miles per fill-up for conventional gasoline vehicles. Thus to make PEVs practicable, easy and convenient recharging must be ensured, and the deployment of recharging stations must encourage adoption of PEVs and support fast market growth. Dr. Yi's research team is preparing and testing a methodology that maps charging station installation using a layered intersection of demographic and transportation data that may be applicable to all U.S. urban areas.

Figure 1: PEV Impact on Electrical Grid



Source: The University of Akron

Figure 2: Average Time Spent by Americans on Primary Activities

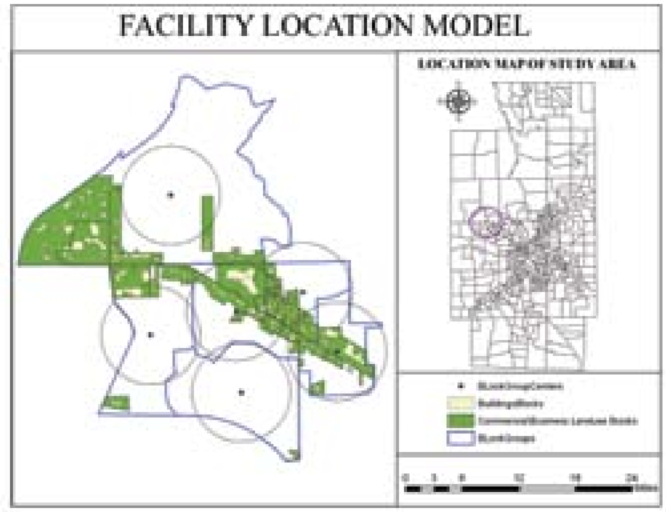


Source: Bureau of Labor Statistics, US

Using U.S. Bureau of Labor Statistics information (figure 2), a facility location model was developed to identify charging station locations that would best serve recharging needs. Land-use data was used to identify work-related activities and parking needs for level II charging stations. In addition to land-use data, roadway network and traffic data were also used to determine locations for level III charging stations. The objective of the maximization in the model is to increase the utilities for users while addressing the constraints of geographic coverage of PEV demand, power grid capacity, and available budget (figure 3).

In order for a full-scale adoption of PEVs to occur, PEV education must be provided to future consumers. UA is collaborating with a number of area schools and colleges to develop such curriculums. In 2010, UA, Lorain County Community College, and Stark State College entered into an unprecedented alliance that will accelerate educational efficiency by combining the resources of a number of community colleges with a research university. This

Figure 3: Global Information System (GIS) Based Potential Charging Station Location Map Showing Block Groups and Centroids



Source: The University of Akron

consortium offers an opportunity to share curriculums for electric automobile safety training, which will speed deployment. Safety training (fire, police), which is currently offered in community colleges, will play an important role in PEV-readiness needs in the region.

Additionally, a hybrid-electric, 12-seat, handicap-accessible bus is being purchased through the assistance of EPRI as a UA “Roo Express” university shuttle in collaboration with The City of Akron and FirstEnergy, each of which will use it for various shuttle purposes. Plans are to download energy usage data and savings for curriculum use in the Akron Public Schools middle schools. These students, who will reach driving age at about the same time electric vehicles are projected to be widely available, will learn about electric power generation, energy conservation, and environmental sustainability.

About This Project

Ping Yi, Ph.D., (pyi@uakron.edu) is Director of the Ohio Transportation Consortium (OTC) at The University of Akron. He is a professor in Civil Engineering with research expertise in Safety, Efficiency, and Sustainability of Transportation Systems. His current research collaboration on Plug-in Electric Vehicles joins the expertise of both the Electrical and Civil Engineering Departments at The University of Akron as well as the City of Akron and Akron Area Metropolitan Area Studies. Dr. Yi’s work is assisted by graduate students Aaron Cordill and Yudhveer Kandukuri.