RITA Office of Research, Development, and Technology

UTC Spotlight

University Transportation Centers Program

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Modeling Best Locations for Electric Vehicle Charging Stations

Electric vehicles, previously only spectacles of auto shows, science fiction, and a failed launch attempt in the late 1990s, are now becoming a consumer reality; there are an estimated 56,000 electric cars (mostly retrofitted) currently in use in the United States. The Nissan Leaf and Chevy Volt recently became the first electric cars released by major automotive companies, and projections show that by 2015, a million electric vehicles will be on U.S. streets.

But while drivers of gas-powered vehicles can easily stop at a station to fill up, drivers of electric vehicles currently have no such option. That, combined with electric vehicles' limited battery capacity (the Nissan Leaf has a range of 100 miles, in the best conditions), leads to "range anxiety" — the fear that the car will run out of juice before getting to a battery charger.

But how many charging stations are needed, and where should they go? That is the question Diego Klabjan, associate professor of industrial engineering and management sciences at Northwestern University's McCormick School of Engineering and Applied Science, aims to answer. Working with the Chicago Area Clean Cities Coalition and other partners, Klabjan and his team are using innovative analytical methodologies to determine the best locations in the Chicago area for electric vehicle charging stations.

"Because Chicago does not yet have many electric vehicle drivers, we must use proxy data to develop a smart way to model where charging stations should go," Klabjan says. "That way, the infrastructure will be in place as more people turn to alternative energy vehicles."

Klabjan, who is part of the school's Center for the Commercialization of Innovative Transportation Technology, uses several factors to determine charging locations, including where and how people drive, and where potential electric vehicle drivers might live. To determine this, Klabjan has collected data on areas with a large number of solar installations (under the premise that residents who use solar power are more likely to adapt alternative energies), data on where drivers of hybrid cars live, and some additional contemporary and relevant data streams.

But gathering data on potential electric vehicle drivers is not enough; researchers must also consider where these drivers might want to spend their time while their car charges. Charging an electric vehicle can take anywhere from a half hour (through direct current, called "fast charging") to two hours (through standard alternating current charging), so charging locations would ideally be near places where people could go while their car charges (like the grocery store or the mall).

"It wouldn't make sense to put a 3-hour charging station near a coffee shop, but it could make sense to put it in the parking lot of a mall where people could charge their cars while they shop," Klabjan says.

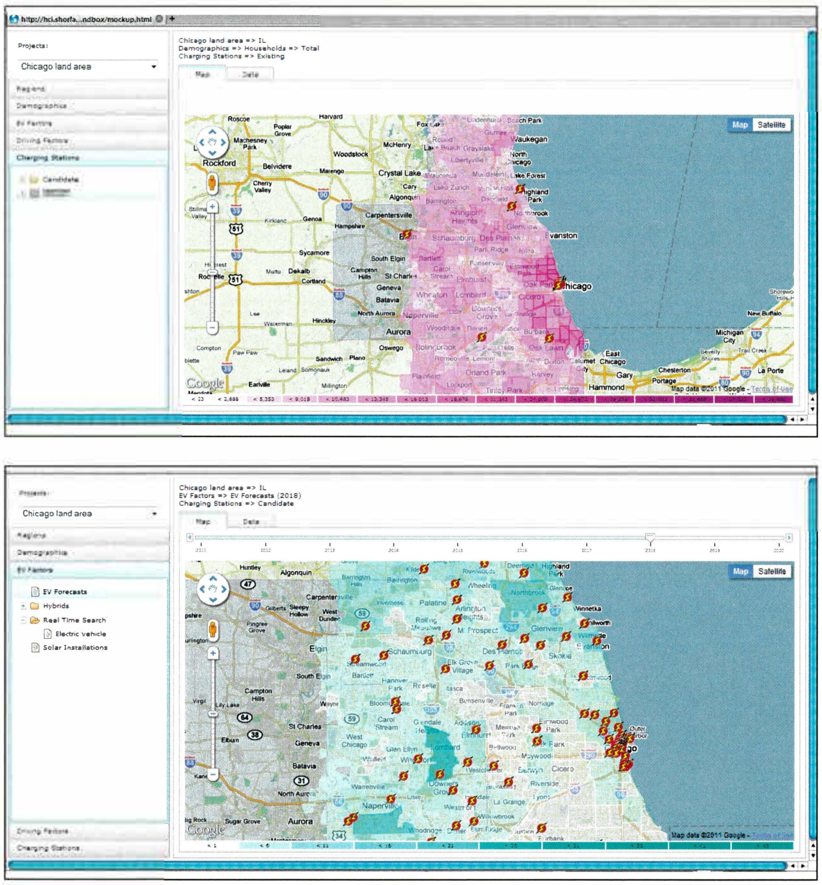
Klabjan takes this data and uses discrete choice modeling to determine demand measurement, optimization techniques to find the best locations, and simulations to assess system performance. Eventually, his results will drive a web-based decision support software application where users can conduct what-if studies on investment budget, electrical power-grid, geographic, and infrastructure constraints.

"We are in the early stage of electric vehicles, so right now the main goal is to make customers happy," Klabjan says. "We want to make it easy for people to drive electric vehicles."

Klabjan has been working on this project since last summer and hopes to have a prototype model within a month. Although this research project focuses on the charging network, the underlying concepts and methodologies are also applicable to other alternative fueling technologies, such as compressed natural gas, hydrogen, or biofuels.

Klabjan was drawn to this project because of his interest in environmental issues. He has previously used data analytics to answer environmental policy questions, like how subsidies influence buying patterns, and he himself is on a list to purchase a Nissan Leaf.

"My goal is that this type of decision making will be adopted across the United States," he says. "It's data driven, and will save a substantial amount of time deploying charging stations."



Map of household demographics and existing vehicle charging stations in Chicago and surrounding suburbs (top) and map of analytics-generated charging station locations in the same geographic region (bottom).

About This Project

The Center for the Commercialization of Innovative Transportation Technology (CCITT) is operated within the Northwestern University Transportation Center in the Robert R. McCormick School of Engineering and Applied Science at Northwestern University. The Director of CCITT at Northwestern University is Bret Johnson (bretj@northwestern.edu). Diego Klabjan is an associate professor of industrial engineering and management sciences at the McCormick School. Conrado Borraz, a post-doctoral student at Northwestern University, is developing the optimization and demand modeling modules, while Timothy Sweda, a Ph.D. student working under the advisement of Professor Klabjan, is developing an agent-based decision support system for deploying EV charging infrastructure. Another Ph.D. candidate, Owen Worley, is exploring a slightly different version of locations of so-called battery swapping stations. This research is supported by the Department of Transportation through the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU), and matching funds were provided by software company LogicBox.