What do electric vehicle drivers think of the charging network they use?

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For instance, the conventional wisdom that drivers prefer private stations to public ones appears to be wrong. The study also finds potential problems with charging stations in larger cities, presaging challenges yet to come in creating a robust charging system that meets all drivers' needs.

"Based on evidence from consumer data, we argue that it is not enough to just invest money into increasing the quantity of stations, it is also important to invest in the quality of the charging experience," Asensio wrote.

Perceived Lack of Charging Stations a Barrier to Adoption

Electric vehicles are considered a crucial part of the solution to climate change: transportation is now the leading contributor of climate-warming emissions. But one major barrier to broader adoption of electric vehicles is the perception of a lack of charging stations, and the attending "range anxiety" that makes many drivers nervous about buying an EV.

While that infrastructure has grown considerably in recent years, the work hasn't taken into account what consumers actually want, Asensio said.

"In the early years of EV infrastructure development, most policies were geared to using incentives to increase the quantity of charging stations," Asensio said. "We haven't had enough focus on building out reliable infrastructure that can give confidence to users."

This study helps rectify that shortcoming by offering evidence-based, national analysis of actual consumer sentiment, as opposed to indirect travel surveys or simulated data used in many analyses.

Asensio directed the study with a team of five students in public policy, engineering, and computing. Two were from Georgia Tech.
Catharina Hollauer, a recent graduate of the H. Milton School of Industrial and Systems Engineering, and Sooji Ha, a dual Ph.D. student in the School of Civil and Environmental Engineering and the School of Computational Science and Engineering.

The other three were participants in the 2018 Georgia Tech Civic Data Science Fellows program, which draws talented students from around the country to the Georgia Tech campus for a summer of research and learning. They are Kevin Alvarez of North Carolina State University, Arielle Dror of Smith College, and Emerson Wenzel of Tufts University.

**EV Charging Sore Spots Revealed**

Asensio's team used deep learning text classification algorithms to analyze data from a popular EV users smartphone app. It would have taken most of a year using conventional methods. But the team's approach cut the task down to minutes while classifying sentiment with accuracy similar to that of human experts.

The study found that workplace and mixed-use residential stations get low ratings, with frequent complaints about lack of accessibility and signage. Fee-based charging stations tend to get more poor reviews than free charging stations. But it is stations in dense urban centers that really draw complaints, according to the study.

When researchers controlled for location and other characteristics, stations in dense urban areas showed a 12—15% increase in negative sentiment compared to nonurban locations.

This could indicate a broad range of service quality issues in the largest EV markets, including things like malfunctioning equipment and an insufficient number of chargers, Asensio said.

The highest rated stations are often located at hotels, restaurants, and convenience stores, a finding that may support incentive-based management practices in which chargers are installed to draw customers. Stations at public parks and recreation facilities, RV parks, and visitor centers also do well, according to the study.

But, contrary to theories predicting that private stations should provide more efficient services, the study found no statistically significant difference in user preferences when it comes to public versus private chargers.

That finding could be an inducement to invest in public charging infrastructure to meet future growth, Asensio said. Such a network was cited in a study by the National Research Council as key to helping overcome barriers to EV adoption.

**Improving Policy Evaluation Beyond EV's**

Overall, Asensio said the study points to the need to prioritize consumer data when considering how to build out infrastructure, especially when it comes to requirements for charging stations in new buildings.

But EV policy is not the only way the study's deep learning techniques can be used to analyze this kind of material. They could be adapted to a broad range of energy and transportation issues, allowing researchers to deliver rapid analysis with just minutes of computation, compared to time lags measured sometimes in months or years using more traditional methods.

"The follow-on potential for energy policy is to move toward automated forms of infrastructure management powered by machine learning, particularly for critical linkages between energy and transportation systems and smart cities," Asensio said.


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