Deploying Electric Buses to Improve Air Quality in Low-Income Areas

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Led by Xiaoyue Cathy Liu of the University of Utah, researchers have created a web-based modeling tool (visit the project web page, linked at the end of this document, to access the GitHub repository built for the Utah Transit Authority) that enables U.S. transit providers to explore the impacts of changing over their systems to electric buses*. The researchers ran the model for TriMet in Portland, OR, as well, with TriMet results and analysis presented in the final report.

> "The interactive visualization platform lets users explore various electric bus deployment budget scenarios, so that transit agencies can plan the most cost-effective way to transition their fleet from diesel to electric buses – while prioritizing disadvantaged populations," Liu said.

The research team, at University of Utah, Portland State University and the University of California, Riverside, set out to answer three questions:

1. What costs and benefits are associated with electric bus deployment?
2. How can transit agencies balance their diverse goals and objectives when considering electric bus deployments – such as reducing costs, mitigating emissions, and providing equitable transit services?
3. What are the optimal deployment strategies, given the specified planning goals of transit agencies?

UNIQUE CONTRIBUTIONS OF THIS PROJECT

The transit industry is rapidly transitioning to battery-electric fleets (Los Angeles, New York, Boston, Portland, Seattle and Salt Lake City are among the U.S. cities that have started pilot testing electric buses in the last few years) because of the direct environmental and financial benefits they can offer. They are quieter, have lower maintenance costs, and produce significantly lower greenhouse gas emissions than diesel, diesel hybrid and natural gas-powered buses, which is good news for tackling our climate crisis. But this research project doesn't focus solely on climate goals and lowering costs for transit agencies: The modeling tool also allows agencies to prioritize environmental equity.

People with lower incomes tend to suffer more from health conditions caused by air pollution. It's a result of historically inequitable planning processes, with lower-income neighborhoods often placed close to industrial land uses and freeways with high emissions. As a way of addressing this problem in tandem with environmental goals, researchers developed the tool to help transit agencies replace their current fleets with electric buses that is both cost-effective and prioritizes deployment near low-income populations that suffer most from unhealthy air quality.

> "Electric buses are a whole new ballgame," shared Aaron Golub, a PSU urban planning professor and co-investigator on the project, "and the deployment of this clean technology is inherently politically fraught. Typically, new types of amenities are first introduced in affluent neighborhoods, and our hope is that this decision-making tool enables agencies to overcome those biases."

HOW DOES IT HELP TRANSIT AGENCIES?

Liu and her research team worked with two agencies in the planning process of the electric bus deployment modeling tool: the **Utah Transit Authority (UTA)** in the Wasatch Front of Utah and **TriMet** in the Portland metropolitan area of Oregon. Each transit system is unique, and so the team needed to tailor the modeling tool to work with the software that UTA uses to dispatch their bus routes. Rather than route by route, UTA uses a service pattern called "blocking" to dispatch routes; with more than one route per block. Liu looked at UTA's blocking software and made the model work with their system.

**Electric buses here refers to Battery Electric Buses, or BEBs*

Hal Johnson is the Manager of Systems Planning and Project Development at UTA, and said the model developed at the University of Utah is "a really useful tool" for deployment and operation of battery buses. "The blocking piece is one of the more unique and helpful elements of this tool. We are making investments based on her recommendations, from the model and the tool, for five more high-powered chargers in our system," Johnson said.

UTA used the tool to "bridge the gap between high and low-income," placing one electric bus on a route that connects to a mixed-income community. "You can optimize to a lot of different factors using her model. It's a really good tool in that you can use in multiple ways to make better business decisions for both your agency and the community," Johnson said.

Given the uniqueness of each transit system, this tool is not plug and play. However, with the investments to do the tailored programming - this tool can be adapted to work with the software and data of other transit agencies. Visit the project web page linked at the end of this document, or reach out to Xiaoyue Cathy Liu at cathy.liu@utah.edu with additional questions.

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THE FULL REPORT and ONLINE RESOURCES

For more details about the study, download the full report **Bi-objective Optimization for Battery Electric Bus Deployment Considering Cost and Environmental Equity,** or access the online tool, at nitc.trec.pdx.edu/research/project/1222

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