Helping transit agencies visualize the transition to electric bus fleets

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The transit industry is rapidly moving toward battery electric bus fleets because of the environmental and financial benefits they offer. As electric vehicles become more prevalent, transit agencies have several

questions to consider: What is the most cost-effective and equitable way to make the transition to electric buses? How can the buses' charging needs be incorporated into the existing city power grid? In which parts of the city should electric buses be introduced first, and what impacts will all this have on transit operations? A new modeling and visualization tool can help agencies answer those questions.

A team of University of Utah (UU) researchers led by Xiaoyue Cathy Liu and Jianli Chen have created a model—a "bi-objective optimization framework"—which takes both cost and environmental equity into consideration, helping transit agencies achieve their desired environmental and public health-related outcomes in the most cost-effective way. The flexible framework is a helpful tool for doing cost-benefit analysis on a range of transit-related objectives. The research team also created two products to help transit agencies use the model:

- A step-by-step guide to implementing the model: Implementing The Bi-Objective Optimization Model
- An online visualization tool: The BEBExplorer Visualization Framework Prototype

What do these tools do?

The bi-objective optimization framework model allows transit operators, planners and decision-makers to explore the interdependency of an electric bus transit system and a city's energy infrastructure, in both spatial and temporal dimensions with high resolution. It allows agencies to make short and long-term decisions based on their investment resources and strategic goals.

Building on that framework, the research team developed their prototype visualization tool, the BEB Explorer. BEB stands for battery-electric bus, and the visualization tool lets users test, visualize, and explore different

BEB deployment scenarios given constraints of budget, bus schedules, routing, charging station locations, and other factors. The explorer includes an interactive map of routes and charging locations, with data tables that dynamically update. Also, users can zoom in and create overviews at different resolutions.

The guide offers step-by-step instructions to help practitioners implement the model for their own transit network, using their own customized data. From compiling the data, to running the model, to interpreting the results and setting up visualizations for presentations to assist with decision-making, the guide aims to make it easy for agencies to get the most out of this model.

Why is it important?

Last year, we reported on the project team's original research effort to roll out electric buses while improving air quality in high-pollution, low-income areas. "We are making investments based on [Dr. Liu's] recommendations, from the model and the tool, for five more high-powered chargers in our system.... You can optimize to a lot of different factors using her model. It's a really good tool in that you can use it in multiple ways to make better business decisions for both your agency and the community," says Hal Johnson, Manager of Systems Planning and Project Development, Utah Transit Authority

Building upon this body of work, Liu and Andy Hong of UU's Department of City & Metropolitan Planning are also partnering with the Utah Transit Authority (UTA) to design a dynamic service with zero-emission transit vehicles to enhance service equity and efficiency for vulnerable populations. That effort is aimed at creating better transit for residents who have limited or no transportation options.

Project team members Gabrielius Kudirka, Xinyuan Yan, Sarah

Kunzler, Yirong Zhou, Bei Wang and Xiaoyue Cathy Liu of UU presented their latest work on this topic at the 2023 annual meeting of the Transportation Research Board (TRB) in a poster session on Current Issues in Alternative Fuels and Technologies. Check out their poster, Enable Decision Making for Battery Electric Bus Deployment Using Robust High-Resolution Interdependent Visualization, or read the full research paper.

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