Charles D. Baker, Governor
Karyn E. Polito, Lieutenant. Governor
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massDOT
Massachusetts Department of Transportation

2020 RESEARCH PROJECT STATEMENT

Research Topic:
Measuring the Energy Consumption, Costs, and Emissions of MBTA Electric Rail
Research Award [max $125,000]

Problem Statement and Objectives

The MBTA spends $38 million on electricity for traction power annually, including $13 million during the grid peak hour of the year. Additionally the MBTA has targets to reduce its greenhouse gas (GHG) emissions annually. A better understanding of how movement of trains relates to traction power consumption, demand, and subsequent cost and emissions is critical to better management of these key metrics.

This project has the following objectives:

- Analyze real-time train position data and real-time electricity consumption data to quantify the energy use, cost, and subsequent emissions of an electric rail vehicle. If a full analysis of the MBTA system is not possible due to data quality and availability issues, conduct a subset analysis of the available data,
- Expand current knowledge on how the acceleration of the trains relates to the demand draw of the traction power network, to assist with planning future energy demand and management.
- Develop planning metrics for energy use per vehicle mile to assist with planning energy and Operations & Maintenance (O&M) budgets.

Anticipated Outcomes and Deliverables

This research project is proposed in two initial phases, with Phase 2 building upon the results of Phase 1.

- Statistical analysis of real-time train position data and real-time electricity consumption data to quantify the energy use, cost, and subsequent emissions of an electric rail vehicle. The analysis will include the use of real-time train location (circuit) data and 5-min & 15-min interval power data from the utilities to correlate train movement to electricity consumption and demand. Phase 1 will include an analysis of the data for a small subset of the system with high data quality and availability. This analysis will not only validate some of the assumptions made but also provided critical information to the structure of the model to be built in Phase 2. Only very basic and generalized information will be produced in Phase one such as the correlation between train movement and power usage. Phase 2 will take the knowledge gained in Phase 1 to build a system-wide model to incorporated all interval meters and train

circuit position data. This phase will also validate the model against new data, and produce most of the metrics such as kWh/Mile of each train set.

- Planning metrics regarding the energy consumption, cost, and emissions of an MBTA electric train. These metrics should include kWh/mile (or its reciprocal), the co-variance of electrical demand to the movement of trains, the hourly cost of moving a train, potential demand savings from better train management, etc. Depending on the phases completed, the results will range from simple planning metrics to specific demand management plans.