MOVING TRANSPORT FORWARD LAB

Facilitating transit electrification

Empirical analysis of battery-electric bus transit operations in Portland, OR, USA

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Introduction

Technological improvements and a significant reduction in battery production costs have made battery-electric buses (BEBs) a commercially viable alternative to diesel buses. However, there is little information available on how these buses perform based on actual operational data. In this study we used AVL/APC records of electric, diesel, and hybrid buses operated by TriMet in Portland, OR, USA covering the period of September 5, 2021, to June 6, 2022, to perform the following analyses:

- We estimated a running time model to see if there is a difference in running time between electric, hybrid, and diesel buses;
- We estimated a distance until a breakdown occurs model to identify the operational factors that influence the distance an electric bus can travel after regular maintenance before a breakdown takes place.

TriMet operates 8 BEBs exclusively along 4 routes in the Portland Metropolitan region – 6, 8, 20, and 62. These 4 routes are also served by a mix of diesel, and hybrid buses.

Geography of Portland Metro and the routes with BEBs

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Findings

Running Time

When analyzing the running time, a single trip for a unique bus in either an inbound or outbound direction was selected as a unit of analysis. A trip was measured in seconds, from the leave time at the first stop until the arrival time at the last stop of the same route. The most notable findings of this stage of the analysis are:

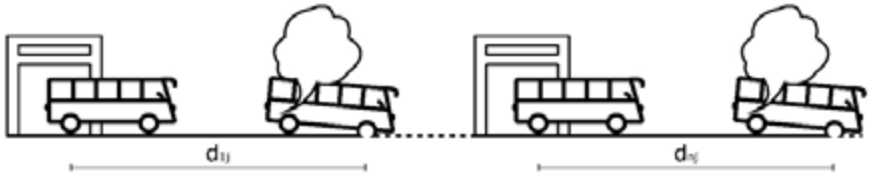
- All buses were running with much fewer boardings and alightings (6 compared to 17 pre-pandemic), and, potentially, without much impedance from other vehicles on the road due to the lingering effects of the COVID-19 pandemic;
- BEBs were running a minute and a half faster than other buses. This may be the result of BEB mechanics, as it gives 100% torque right away;
- Each additional degree of Fahrenheit added 2 seconds to the running time of BEBs, which is likely a reflection of BEBs using battery power for AC units;
- No influence of driver experience on BEB operations was observed.

Breakdowns

We developed the distance travelled until breakdown after a regular maintenance model to identify the weather and operations characteristics that led to bus breakdown. For this model, the dependent variable was chosen as the planned distance travelled by bus between the day it came out of regular maintenance until a breakdown was recorded.

This analysis led to the following insights:

- When controlling for other parameters, BEBs travelled almost 464 miles more before the breakdown when compared to diesel and hybrid buses;
- Every stop made during the time before a breakdown added almost 6 miles to that range of a BEB, which is potentially due to the charging that takes place when a BEB uses breaks;
- Each additional use of a ramp per 100 stops decreased the range of an electric bus by 205 miles.



Methodological approach to modelling the distance traveled until breakdown after a regular maintenance

The d_{nj} stands for the distance a bus j was planned to travel during the time period n before it broke down and went back to the garage for maintenance.

Policy Recommendations

1 BEBs should be used on short routes with many stops (e.g. feeder toutes, on-demand transit). This deployment employs a positive confluence of two different factors of BEB operations – short running time will allow fewer vehicles to serve the area, while frequent stops will extend the range of the bus battery.

2 BEBs underwent fewer instances of maintenance which follows the trend observed in previous studies. While this indicates their lower running costs compared to diesel buses, it is evident that BEBs could benefit from more preventive maintenance

3 Transit providers should consider deploying BEBs on routes with fewer requests for ramp use as a temporary solution. Alternatively, capital projects at known locations with frequent ramp deployment can be designed for near-level or level boarding in the future.

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The full study can be found in the open-source paper at
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