Electrification Analysis: All Aboard America!

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Key Takeaway

An interregional express bus service can use a currently available battery capacity option (676 kWh) at a charge rate of 125 kW to immediately electrify part of its fleet for routes up to 200 miles in moderate climates, but the range of current market options limits full electrification.

Figure 1. A Bustang fleet. *Photo by Cory Sigler, NREL*

Ace Express Coaches is an All Aboard America Holdings Inc. portfolio company that offers interregional public transportation bus services across Colorado through its Bustang-branded fleet of motorcoaches in partnership with the Colorado Department of Transportation. The National Renewable Energy Laboratory collected operational data on nine 45-foot Bustang motorcoaches from May through August 2022. The deployment statistics are summarized in Table 1.

Table 1. Deployment Overview

Location	Number of Vehicles	Type	Vocation	Duration	Miles
Colorado	9	Motorcoaches	Intrastate bus	May–Aug. 2022	33,942

Duty Cycle Analysis

Full electrification of Bustang fleet operations is not achievable today; however, partial electrification may be feasible with commercially available electrified motorcoach options. Figure 2 shows distributions of the daily distance and engine output energy observed from the fleet. The distributions are separated based on which corridor the vehicle primarily traveled (i.e., Interstate 25 vs. I-70).

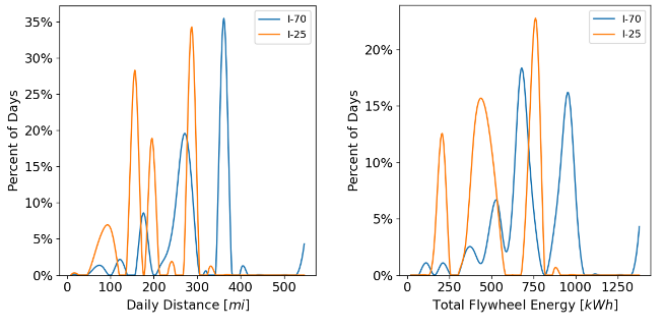

Figure 2. Distributions of daily distance (left) and energy (right), disaggregated across primary travel corridors

Energy and distance requirements are lower on average for I-25 vehicles with significantly lower maximum requirements than the I-70 group, especially considering that midday dwell times for I-25 vehicles allow for additional charging opportunities. Furthermore, 21 of the 32 vehicle-days in the I-25 group were less than 200 miles and 600 kWh of energy, suggesting electrifying travel on the I-25 routes may be feasible with only minor operational changes.

Charging Analysis

Figure 3 shows the probability a vehicle was keyed on at each time of day (left) and the number of observed vehicles whose travel needs could be satisfied across a range of battery size and charge rate combinations (right).

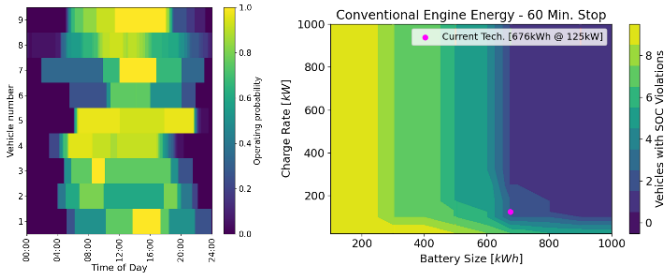

Figure 3. Operating probability vs. time of day (left) and estimated electrification viability (right).
SOC: state of charge

Consistent overnight dwells are present in the operating probability plot; however, the duration, start, and end times of these dwells vary between bus and day, indicating higher depot charging rates may be necessary some days.

None of the combinations of battery size and charge rate presented in the electrification viability plot can satisfy the travel needs of every vehicle observed in the fleet. However, a battery capacity equivalent to an available market option (676 kWh) at a charge rate of 125 kW may be sufficient for seven of the nine buses. Additionally, the electrification viability is shown to be far more sensitive to battery size than charge rate.

Midday charging would be required to meet these electrification targets. Figure 4 shows a heat map highlighting locations where the buses were stopped for 1 hour or more, showing the opportunity for midday charging along routes.

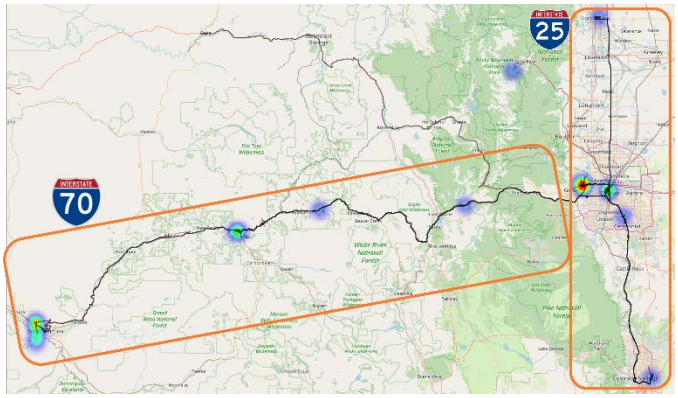

Figure 4. Routes and stop locations ≥1 hour

Conclusion

The Bustang fleet faces significant challenges to electrification given current market options resulting from demanding range requirements and relatively limited charging opportunities. The primary limiting factor for electrification is battery capacity, but vehicles operating on the shorter routes with a lower grade along the I-25 corridor show more immediate electrification potential.

Increases in available battery capacity and the availability of fast charging locations along I-70 routes are both critical for electrifying the full fleet.

Acknowledgments

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