



**Massachusetts Bay
Transportation Authority**

Bus Electrification: Battery Electric Bus Performance

Submitted by the MBTA to MEPA

EEA #16267 - Quincy Bus Maintenance Facility

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Overview

- Battery Electric Bus (BEB) technology is a promising solution for long-term environmental and emissions improvements to MBTA bus service
- Based on the five buses that the MBTA has been testing, the technology is not yet mature enough to support full bus service operation
 - Operating range (mileage) is too short
 - Operating time is too short
 - Charging time is too long
- Since delivery of our pilot buses, there have been advancements in technology. With this continued change, we envision BEBs being capable of eventually meeting the Authority's service needs, but a measured roll-out approach is recommended.
- In an upcoming board presentation, MBTA staff will present near-term and long-term strategies to support the bus fleet and facilities, including a recommendation on how best to expand our BEB fleet incrementally over time as the technology matures.



MBTA's Battery Electric Bus Fleet

The MBTA purchased five 60-foot Battery Electric Buses (BEB) in 2019 specifically designed to operate with zero emissions on MBTA Silver Line routes.

Vehicle Highlights:

- 480 kW-hr battery capacity
- Advertised range of 100-120 miles
- Actual range of 60-110 miles
- Zero on-board emissions with all-electric HVAC system (many other BEB's have diesel heaters to keep buses warm in winter increasing emissions)
- Equipped with "4-wheel drive" for superior traction in winter storms (all current MBTA 60-ft hybrid buses are "2-wheel drive" only)
- Plug-in style charging with the capability for overhead "fast charging"



Charging Infrastructure:

- Three 150kW plug-in chargers are installed at Southampton bus garage
- No upgrades to existing power infrastructure were required (transformers, switchgear, new power feeds etc.)



The MBTA's BEB Journey Today

The MBTA is actively learning from the latest BEB technology

Comparing BEBs to Existing Bus Fleet

Diesel (Circa 2004)	Hybrid	Enhanced Electric Hybrid (EEH)	BEB
Baseline Emissions	~25% reduction in GHG*	>40% reduction in GHG**	100% reduction in GHG
20 min to fuel			6-8 hours charge w/ 150 kW
400+ mile range			60-110 mile range
No weather impact			>40% reduction in range due to cold weather
1:1 Replacement			Up to 1:3 Replacement

These large changes in performance are driving significant changes in our operations.

* Estimation from MBTA mixed fleet performance of 40' and 60' buses

** Data from latest EEH bus pilot

Operational Challenges

- Not enough hours in a day
 - 18 hours and up to 170 miles of daily service on the Silver Line
 - 6-8 hours total required charging to meet service needs
 - One daily scheduled charge is not enough - midday charging required to finish scheduled route.
- Choreographed central planning is required for charging a small fleet of BEBs.
 - Missing scheduled service due to charge scheduling
 - Fueling historically has not been bottleneck of bus service

The Result

- Limited service due to operational challenges
 - BEB pilot accumulated ~5,000 miles/bus
 - EEH pilot accumulated ~30,000 miles/bus



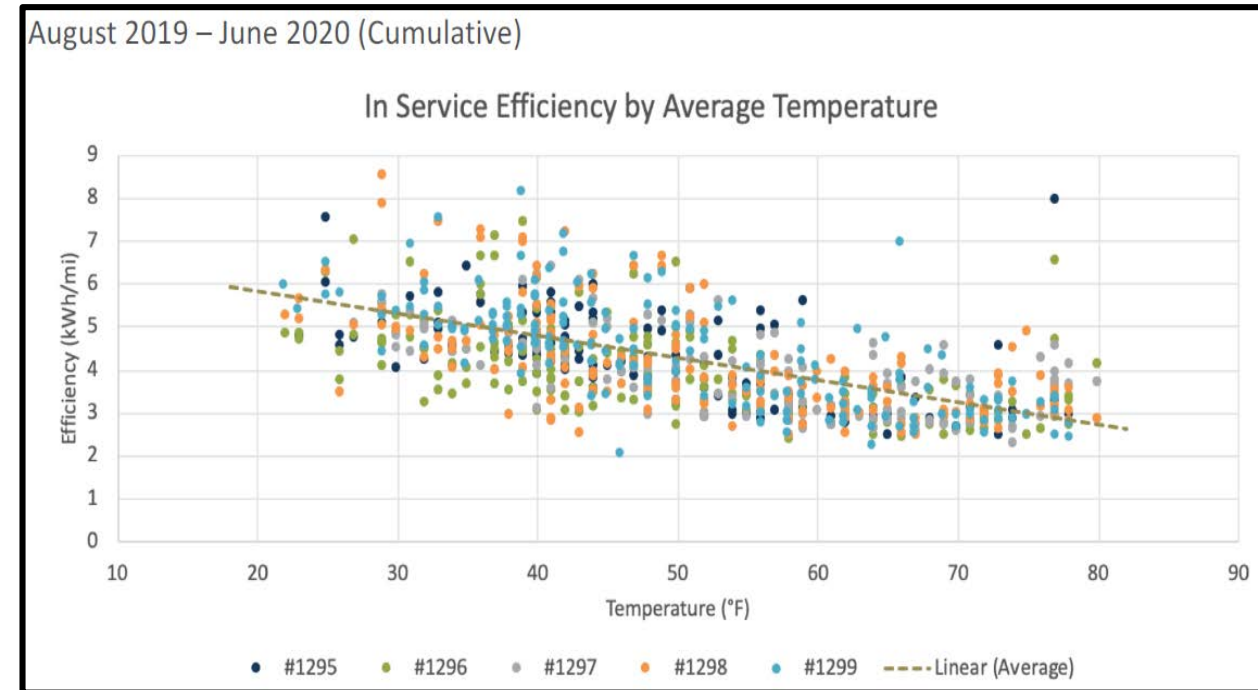
BEB Cold Temperature Performance

Range limitations are a major concern for the current BEB fleet – MBTA only has three depot chargers

- 60-110 mile range with full charge (brand new battery, temperature / route dependent)
- Range decreases as battery degrades
- 40%+ range reduction in cold temperatures

Temperature	Max Range (full charge)
20° F	60 mi
30° F	65 mi
60° F	90 mi
70° F	110 mi

**Limited low temperature data due to mild 2019/20 winter. BEB performance during colder winter will result in further reduced range.*



Considerations for the MBTA's BEB Approach

Technology

Technology does not meet existing service needs today, but is rapidly changing, battery capacity has increased 15% over last year. There is risk associated with adopting this technology before it is ready for large-scale transit service

Facilities

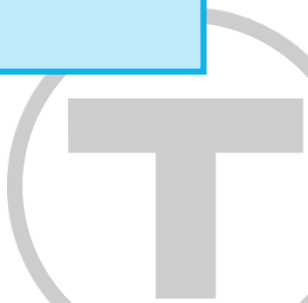
All 9 MBTA bus facilities will need to be upgraded to accept BEB fleet
Facilities currently land & bus capacity constrained
Estimated \$3B in capital to execute

Infrastructure

Need redundancy plan so when we lose power, our customers do not lose service
Vehicle charging Infrastructure could be needed in-route and off MBTA property

Organization

Current bus routes built for fleet without charging constraints
Operations & Maint. will learn how to charge and deploy BEB fleet
New skills required for electric fleet



Committed to Progress

- **Keep reducing emissions:** Having eliminated purchases of new diesel buses, continue using Enhanced Electric Hybrids to offer reliable service while reducing Greenhouse Gas emissions by more than 40% from mid-2000s level.
- **Accelerate learning about BEBs:** Keep learning from the existing pilot BEBs and actively coordinate and discuss BEB experiences with other transit systems
- **Expand BEB test fleet:** Identify one or more specific opportunities to expand the test fleet and continue to test and understand the rapidly evolving state of the technology
- **Develop longer-term purchase plan:** While BEB technology is not yet ready for full deployment, integrate BEB purchases into overall procurement strategy for maintaining state of good repair of the bus fleet as rapidly, as possible given the need for the technology to support fleet operational needs
- **Integrate charging into bus facilities plan:** Ensure that all bus facilities include are built assuming that they will ultimately support a fully BEB fleet

