Electric Transit User Group Forum
Meeting Summary

Topic: Electric Bus Reliability and Maintenance

Dates: Nov. 6 and 12, 2024

The Electric Transit User Group (ETUG) regularly gathers to inform the National Renewable Energy Laboratory's (NREL) strategic direction to help address pressing needs associated with electrifying transit fleets, including technical challenges, workforce development, operations and maintenance, procurement, and other hurdles. Information collected through ETUG listening sessions generates key insights that could inform future research, technical assistance needs, and funding opportunities.

The following is a summary of the discussion and key takeaways from the November 2024 sessions on electric bus reliability and maintenance. NREL will use participant input and insights into fleet concerns to help tailor its resources.

Participant Discussion Summary

A summary of information participants shared during the electric bus reliability and maintenance sessions is provided below.

High-Voltage Systems

- **Battery systems integration:** Changes to traction battery systems between model years require maintenance technicians to spend time puzzling out new diagnostics, often in conjunction with transit vehicle manufacturer engineers. Consistent, long-term battery system commitments by transit vehicle manufacturers will be important for ongoing electric bus maintainability.
- **Faults in high-voltage battery systems:** Participants expressed frustration with electric bus battery management systems frequently dropping portions of battery capacity offline while vehicles were in revenue service. These temporary losses of access to battery capacity were attributed to parameters set too tightly, problems with low-voltage monitoring and communication systems, and even battery equalization cycles that initiated automatically while in revenue service.
- **Battery replacements:** Most vehicles in participating fleets were less than six years old and had not yet needed any battery replacements due to degradation or out-of-warranty failures.
- **Roof-mounted battery access:** Work platforms and cranes are becoming indispensable tools for fleets that need to be able to access and install high-voltage batteries mounted on the roof of vehicles.
- **Electric drive units prove reliable:** Electric drive units (electric motors and associated gearing) are proving extremely reliable. Only one participant experienced reliability issues with drive units.

Electric Bus Accessories

- **Electric air compressors** have experienced high failure rates and challenging lead times. Newer models may be more reliable.
- **Electric HVAC systems** have experienced high rates of air conditioning compressor problems.
- **DC-DC converters** have been a failure point for some fleets.

Repairs

- **Manage lead times with electric bus parts inventory:** Electric bus uptime can be improved by carrying inventory of electric bus-specific parts to avoid delays from long lead times.
- **Lack of diagnostic tools:** Most maintenance operations use Cummins INSITE for diesel diagnostics, but there is no equivalent near-universal system for electric buses. For many electric bus fault codes cases, there seem to be no diagnostic trees available at all.
- **Telematics as diagnostic aid:** Third-party telematics systems can be useful diagnostic aides for electric buses.

Fuel Cell Degradation

- Fuel cells may degrade in efficiency over time, reducing range and increasing fuel consumption.

Thermal Events

- **Coolant leaks:** Maintenance technicians have serious concerns about the potential for coolant leaks from coolant connections inside battery packs and the challenges of diagnosing leaks in a sealed battery container.
- **Post-crash safety verification:** Without a clear standard for reusing battery packs after a crash, even minor crashes can cause electric buses to be taken out of service due to battery safety concerns.
- **Electric bus parking separation:** Electric buses present challenges for parking due to increased spacing requirements for fire containment.

Key Takeaways

NREL identified the following key takeaways from the ETUG listening sessions on electric bus reliability and maintenance. NREL will seek opportunities to help address these takeaways through the lab's technical assistance offerings.

- **Importance of considering options to better address coolant leaks inside battery packs:** New engineering solutions may be needed to avoid in-pack leaks and mitigate their potential for damage.
- **Consider the appropriate balance between consistent battery capacity and long battery life:** Tight operational parameters may prolong battery life but may also sometimes render portions of the battery unusable while the vehicle is in operation.
- **Electric buses necessitate a new diagnostics paradigm:** Without access to legacy engine diagnostics software, electric buses need a new diagnostics approach to improve uptime.

- **Clarify electric bus parking separation for fire safety:** The industry is waiting for more nuanced guidance on appropriate fire safety measures in electric bus depots.
- **Consider a method to verify post-crash battery pack safety:** Fleets are interested in a means to certify the safety of battery packs onboard a vehicle involved in a minor crash to facilitate returning the bus to service.