County Connection

INTER OFFICE MEMO

To: Board of Directors

Date: August 7, 2017

From: Rashidi Barnes
Director of Innovation & Mobility

Reviewed by:

SUBJECT: Battery Electric Trolley Bus Update

Background

The Route 4 requires three (3) vehicles to operate during peak hours through the Walnut Creek downtown area. In 2012 County Connection received an FTA Clean Fuels grant to purchase four (4) battery electric trolleys (BEBs). This included the related charging infrastructure as well. The trolleys were delivered to County Connection over last November and December. Between December and March, the four trolleys were slowly and methodically introduced into revenue service. We also used this time to train all staff on the finer points of operating and maintaining the battery electric buses (BEB). Furthermore, we have been and continue work diligently with our vendor partners including GILLIG, BAE, and WAVE to make adjustments and corrections as needed. As time goes by this need to make such adjustments are generally decreasing, but remain nonetheless.

Overall, we are pleased with the performance of both the trolleys and the associated charging system. Since the introduction of the first trolley in November, we have logged over 18,000 miles and over 4,000 service hours with this BEB fleet. This is a bit better than staff anticipated. As you may recall, this project is classified as a “Prototype”. Thus, we have kept the three old diesel powered trolleys in reserve to “protect” the service. Since early March of this year, these reserve old diesel trolleys have been used less and less with each passing month as the BEBs become fully integrated into revenue service.

Data Collection and Performance Assessment

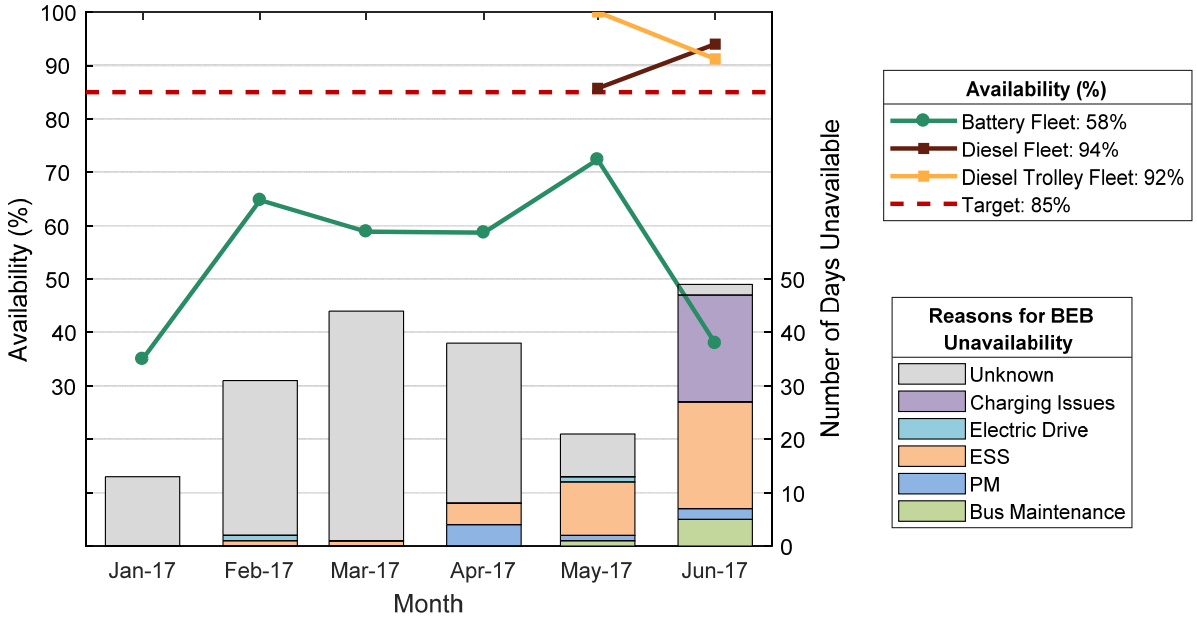
Data collection on the performance of the four trolleys has been underway for a few months now. At this point, we have better data regarding the questions of what are the trolleys costing to operate and maintain than regarding how do they perform as compared to a diesel bus.

Included in this report are some preliminary data generated in part by the National Renewable Energy Laboratory (NREL), who is conducting a third-party evaluation of our BETs. NREL is using January 2017 as data collection start point in this initial report.

Ultimately, using April 1, 2017 as a data collection start point for the purpose of analysis may be used as that matches the date when the implementation period ended. Nonetheless, the initial ENRL report provides a good deal of useful data and information on our experiences with the BEBs thus far.

Vehicle Availability

ENRL has looked at vehicle availability since January, 2017. Based on the data they are using the BEB's have been available 58 percent of the time between January and June. As noted above, November 2016 through March 2017 is considered to be our implementation period where we ramped up revenue service with the trolleys. Again, we and our vendors recognized going in that we would likely need at least six months for training, de-bugging, and adjusting to reach a point of eventual reliability expectations. Thus, between the months of March and May availability began to increase as we reached a level of regularity and predictability with the system as whole. Below is a chart from the ENRL report that is illustrative of the relative availability of the trolleys for the first six months of 2017.



1. Target of 85% fleet availability is a general expectation for transit agencies

Staff would note that our vendor partners have been excellent in responding to issues behind the reasons for unavailability of the BEBs. All three vendors have been with us every step of the way so far.

With a project of this type, unanticipated events cannot be avoided. These can be seen as opportunities to learn from and ultimately increase overall system performance. One such example that has occurred was a partial power outage at the Walnut Creek BART station. On that occasion, we were unable to use the WAVE charger at the BART station and we decided to pull the trolleys off the road. On another occasion, we pulled them off the road when a political protest put the trolleys at risk of being away from the WAVE charger for too long.

The ENRL chart states that a "*Target of 85% fleet availability is a general expectation for transit agencies*". That does make a useful comparison note. However, at County Connection we look at this from a more basic place. That is, our daily goal and minimum standard is to meet "pull out". That means having a number of ready buses to put into revenue service to meet the schedule on that day.

The four BEBs are designated for Route 4. That route has three buses on it at peak. Thus, we have a goal and a standard that at least three BEBs are available for revenue at any one time.

Fuel Economy

The BEBs operate on the route 4 that has limited road inclines, daily medium to heavy passenger loads, low average speed and excessive congestion during peak hours of travel. These vehicles also experience high idle times due to the need to charge every time that they stop at the Walnut Creek BART station. All of these route characteristics have an affect the fuel economy of buses (both electric and diesel) on Route 4.

Between January and June of 2017, the BEBs average miles per gallon equivalent was 13.4. The monthly readings were very consistent from month-to-month.

To compare the fuel economy of all the bus fleets, NREL converted kilowatt hours (kWh) of electricity to diesel gallon equivalents using an energy conversion factor of 37.6 kWh/gallon.

ENRL's results show that fuel economy for the BEBs are is 3.5 times better than the old diesel trolleys. It's very important to note that these old diesel trolleys have not been in regular service since late last year and that they are well over 12 years old (buses are meant last 12 years). As a diesel bus ages, its fuel economy drops. Moreover, newer diesel buses are more fuel efficient than older diesel buses. So, we would expect to see the electric bus/diesel bus fuel economy gap shrink when comparing newer diesel buses to electric buses versus older diesel buses and electric buses.

ENRL has also done a comparison of the four trolleys to the entire diesel fleet. The entire diesel fleet have an average miles per gallon equivalent of 5.0. This comparison is somewhat limited. A more useful comparison that has yet to be done is one where the four BEBs are compared to the newest 29 foot diesels that recently went into service in somewhat similar operating conditions within our service area.

It is likely safe to say though that based on the data ENRL has generated that our BEBs are more "fuel efficient" than our diesel buses in terms of miles per gallon equivalent.

Broad Cost Comparisons

Costs comparisons ought to consider energy costs, maintenance costs, and operating costs. Maintenance costs and operating – particularly one-time costs such as training, etc. are one thing. However, on-going maintenance and operating costs are another thing.

With the current trolley project, on-going operating costs are primarily related to having to send out a replacement bus when an issue arises with an electric bus in service. This is due to the ability to charge in-route using the WAVE inductive charging system.

Maintenance costs related to maintaining an electric bus versus a diesel bus have been roughly equal in terms of routine maintenance. It is too early (vendor involvement, warranties, etc.) to provide you with a sense of on-going maintenance cost differences. These will of course emerge as we get further along in the project.

The main costs that we expect to have an effect on us are the costs related to price of fuel and how that interacts with fuel efficiencies.

Staff is working with NREL on determining the cost of operating and maintaining the trolleys. At this point, we have a pretty good sense of the fuel costs – electric versus diesel. Based off of the preliminary data, the trolleys average fuel cost per mile is $.71 compared to an average of $.43 for the diesel trolleys. On average County Connection is currently paying $.25/kWh or $9.40/dge (diesel gallon equivalent) for the trolleys while only $1.54/gal for the diesel buses.

At these prices, the greater fuel economy of the electric buses is currently being fully negated and more by the cost of electricity form PG&E.

Conclusions

This is just a preliminary report. We hope to get you a more comprehensive report early in the fall. Then, we will provide you with regular and routine updates. However, with this report, we can state a few early conclusions.

With diesel costs relatively low and electricity costs in the Bay Area relatively high, efforts should be made to bring electricity costs more in line with current diesel cost. Furthermore, there are a multitude of variables with electricity rates (peak vs. demand charges) which all impact the operational cost when compared to a very stable fuel cost like diesel.

If the bus transit systems in the Bay Area are to find using electric buses to be economically viable in the long term, energy providers like PG&E are going to need to treat public transit systems in a different manner than the usual commercial customer. This will likely take further state action.

The reliability of the trolleys is progressing as anticipated and shows the promise of meeting our reliability goals. A long term item to watch will be how well the inductive charging process works over time. The ongoing success of that charging process may be the ultimate key to our project.

Finally, it is way too early to make any definitive determinations with our project so far. Moreover, with the related technology and political climate changing rapidly, the overall viability of battery electric buses will no doubt change rapidly as well.