OCTOBER 2020

BATTERY ELECTRIC BUS PILOT

Marin Transit's Board of Directors approved the purchase of two BYD Battery Electric Buses on November 21, 2016. The buses entered service in July 2019 and are operated by Golden Gate Transit. The results here are from July 1, 2019 to June 30, 2020. Staff continues to monitor the bus performance.

Miles Operated: 32,283

Average Range Observed: 133 miles

Maintenance Issues: Broken Mirror

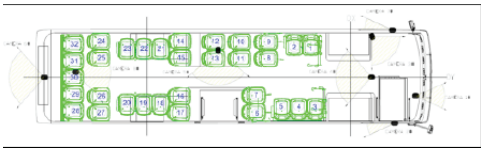
Average Fuel Cost/Mile: $1.09

Carbon Savings: 5,285 kg CO_2

Routes: 23, 23X, 29, 17, 71X

PROJECT BACKGROUND

Vehicle Information



Make/Model: BYD K9S Low-floor Transit Bus
Length: 35.8 ft
Battery: BYD Iron Phosphate 270kWh
Advertised Range: 145 mi
Seating Capacity: 32
Wheelchair positions: 2
Charging: Overnight, 3-4 hours
Capital Project Cost: ~$1.6 Million

Federal Transit Administration

Measure A — Marin's Transportation Sales Tax

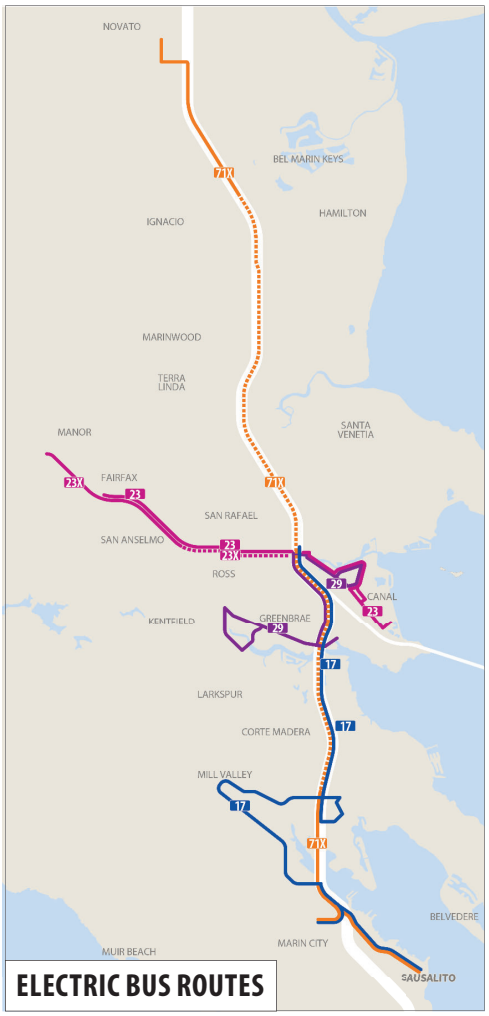
Bay Area Air Quality Management District

Vehicle Routing

Operated by Golden Gate Transit, the vehicles ran on Routes **23**, **23X**, **29**, **17**, and **71X**. Each of these routes is relatively flat. Route **71X** travels the most time on the freeway with the fewest stops.

Bus Charging

Marin Transit chose depot charging for the first two buses. Due to electrical rate schedules, this method is the most cost effective. Charging infrastructure only had to be installed in the yard. Buses operated in service during the day and charged overnight.

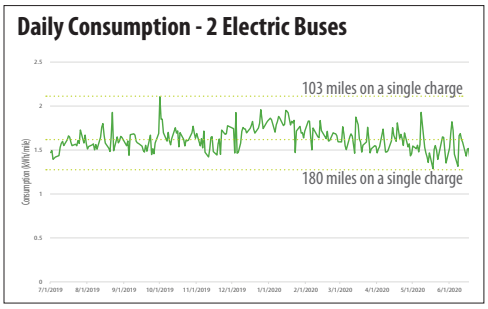


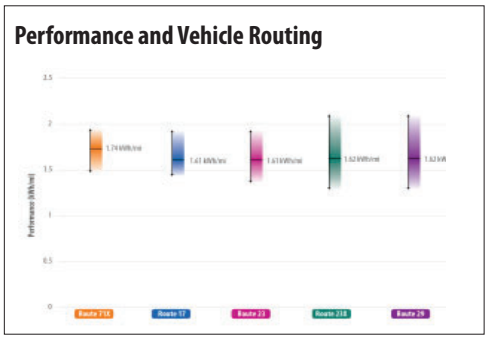
ELECTRIC BUS ROUTES

PILOT PROJECT EVALUATION

Marin Transit evaluated vehicle performance, cost to operate, vehicle reliability, and emissions reductions. The full board report and analysis can be found at www.marintransit.org/projects/two-battery-electric-buses.

Vehicle Performance and Consumption





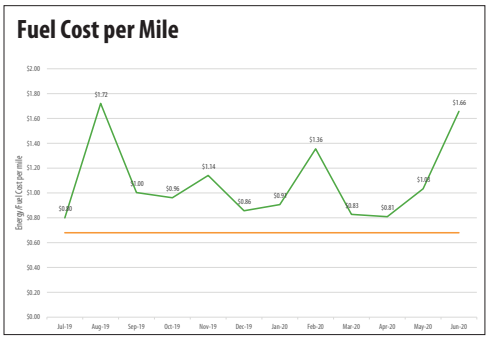
- Average vehicle consumption averaged **1.63 kWh/mile** (about 133 miles on a single charge). This is 8 miles short of the advertised vehicle range of 145 miles.
- Temperature had some impact, cooler temperatures resulting in slightly higher consumption.
- No relationship was found between consumption and speed.
- Average Performance on each route was similar.
- The average performance on route 71X was the highest, likely because it buses on this route travel at faster speeds on the freeway with less stops to take advantage of regenerative braking.
- Marin Transit feels comfortable operating the buses to 120 miles on a single charge under all conditions.

Conclusions:

Buses can reliably travel 120 miles on a single charge

More analysis is needed throughout the buses' lifecycle and on more routes

Fleet Comparisons



- The fuel cost per mile to operate the electric buses is more variable and more expensive than the cost to operate our diesel fleet
- The battery electric buses average about 17 miles per diesel gallon equivalent, compared to the hybrid diesel-electric buses which average 6 mpg.

Conclusions:

Fuel costs are higher

The battery electric buses use energy more efficiently than traditional fuel buses.

Reliability/Availability

- No roadcalls
- Vehicles are constrained by range.

Vehicle:	1801	1802
Days Used in Service:	216	210
Days Available:	338	352
Days Unavailable:	27	13

Conclusions:

The technology is reliable

Emissions Reductions

- During their one year of operation, the two electric buses saved:
  - **5,285 kg** of CO2
  - **127,000 g** of NOx
  - **3,182 g** of Particulate Matter
- This is equivalent to the yearly carbon sequestration of 7 acres of forest.

Conclusions:

Battery Electric Buses reduce emissions.

Next Steps...

- Continue to monitor performance
- Test on routes with different profiles
- Expand to more routes
- Invest in more battery electric buses
- Purchase additional land for bus charging