SIERRA CLUB

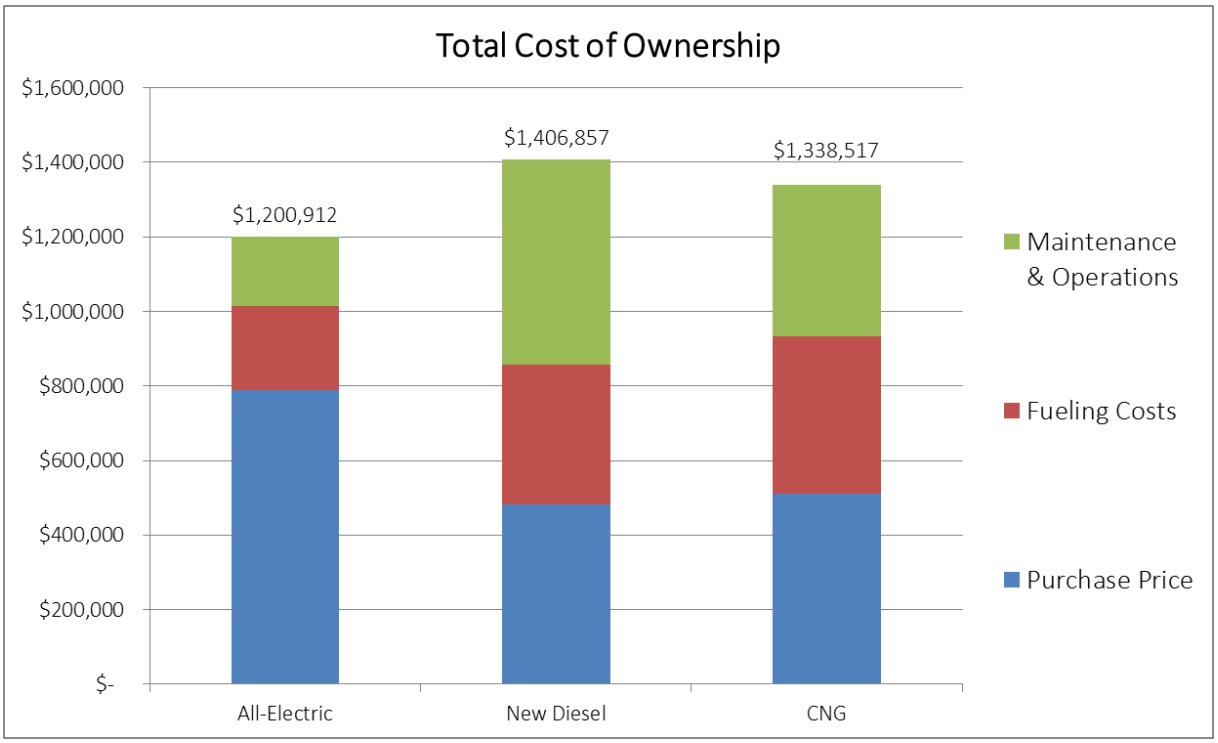
October 26, 2017

Massachusetts Bay Transportation Authority (MBTA) Bus Cost Analysis

Total Cost of Ownership

Despite their greater purchase price, current analysis using Argonne National Laboratory's AFLEET Model demonstrates that zero emission electric buses have a **total cost of ownership that is 15% lower than new diesel buses.** Maintenance costs for electric buses are between 70% and 79% lower than for compressed natural gas (CNG) and new diesel buses respectively, contributing to significant cost savings over the lifetime of a bus. Based on currently reported data, each all-electric bus will save MBTA over $200,000 as compared to a new diesel bus purchase.

Moreover, as this electric bus technology continues to develop, all-electric bus up-front capital costs will continue to drop, whereas CNG and diesel bus capital cost trends are continually increasing.[1] In addition, although reliable, current publicly available data on hybrid diesel-electric buses are lacking, a lifecycle analysis using data compiled by the California Air Resources Board in 2016 shows that hybrid diesel-electric buses have a total cost of ownership of $1,909,847, over $700,000 greater than an electric bus.



Source: Argonne National Laboratory's AFLEET Model (2017); fuel and electricity costs adjusted for Boston, MA

[1] California Air Resources Board. (2016) T*otal Cost of Ownership to Advance Clean Transit*. Presentation Prepared for the 4th Meeting of the Advanced Clean Transit Working Group. <https://www.arb.ca.gov/msprog/bus/4thactwgmtng_costs.pdf>

The total cost of ownership is derived from Argonne National Laboratory's AFLEET Model (2017). Fuel prices are adjusted for the Boston, Massachusetts region. Model inputs are populated using averages of fuel economy and maintenance costs reported directly by transit agencies from the years 2014 to 2017.

Maintenance & Fuel Costs

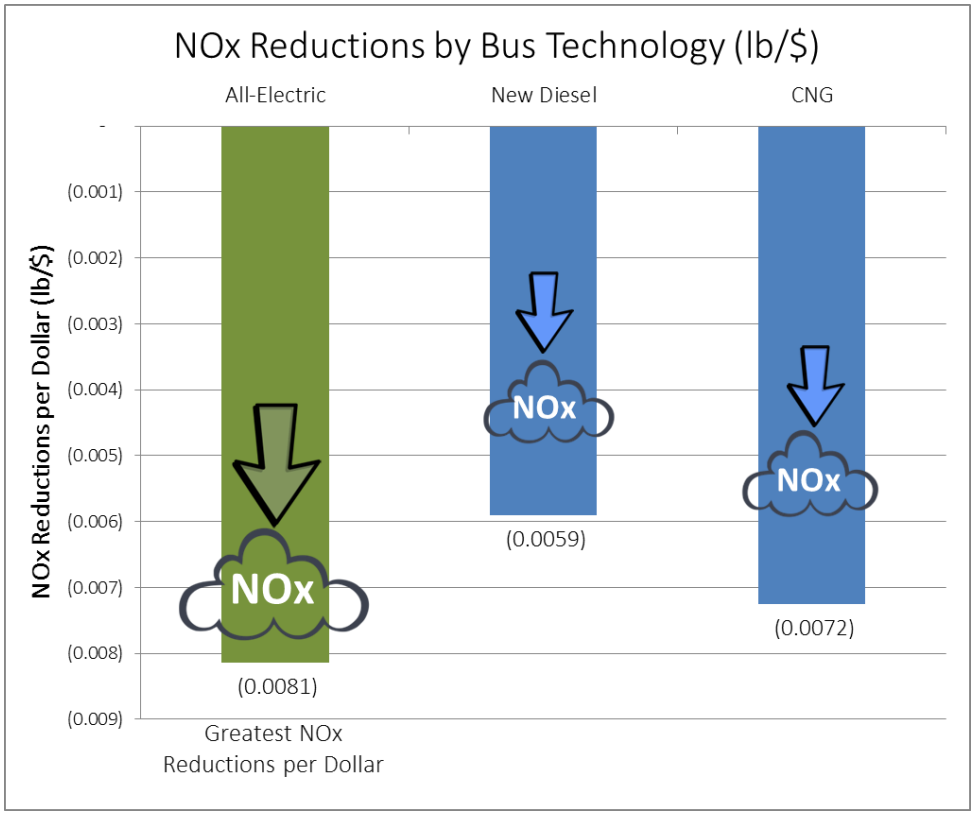
According to the MBTA's own analysis of its bus maintenance activities, the MBTA's costs on a per-vehicle-mile basis were more than twice the national average for comparable transit systems (those with more than 100 buses and an average fleet age of at least 9 years).[2]

	Fuel Economy (MPGDE)	Maintenance & Repair ($/mi)
Electric	**19.44**	**$0.17**
Diesel	4.16	$0.80
CNG	3.87	$0.56

An investment in zero-emission vehicles will dramatically reduce this figure. As highlighted above, all-electric bus maintenance and repair costs are 79 and 70% lower than the maintenance and repair costs for new diesel and CNG respectively.[3] Moreover, all-electric buses are fueled by regionally generated electricity, which has demonstrated far more reliable pricing as compared to diesel oil and natural gas.[4]

NOx Reductions (lb/$)

Specific to the Volkswagen Settlement, agencies are instructed to demonstrate their anticipated NOx reductions as a result of their state's environmental mitigation transportation investments. Many agencies are in search of the investment that results in the greatest NOx lb/$ ratio, but they are only considering the upfront purchase costs in these calculations. If the total lifetime costs are considered, the **bus technology with the greatest NOx lb/$ ratio is a zero-emission bus**.



[2] https://www.mbta.com/uploadedfiles/About_the_T/Board_Meetings/pachecoreportwaiverreport2017v2.pdf
[3] Metrics derived from Argonne National Laboratory's AFLEET Model (2017) and ZEB transit studies
[4] https://www.afdc.energy.gov/fuels/prices.html

SIERRA CLUB

Electric Transit Bus Studies

Eudy, L., & Post, M. (2015). *American Fuel Cell Bus Project Evaluation: Second Report* (No. NREL/TP--5400-64344). National Renewable Energy Lab.(NREL), Golden, CO (United States). <https://www.nrel.gov/docs/fy15osti/64344.pdf>

Eudy, L., & Jeffers, M. (2017). *Foothill Transit Battery Electric Bus Demonstration Results: Second Report* (No. NREL/TP-5400-67698). National Renewable Energy Laboratory (NREL), Golden, CO (United States).

Eudy, L., & Post, M. (2015) *Zero Emission Bay Area (ZEBA) Fuel Cell Bus Demonstration Results: Fourth Report*. <https://www.nrel.gov/docs/fy15osti/63719.pdf>

J. Aber (2016) *Electric Bus Analysis for New York City Transit*. Columbia University, New York, NY, Rep. Available at: www.columbia.edu

Metro, F. P. K. C. (2017) *King County Metro Battery Electric Bus Demonstration—Preliminary Project Results*. National Renewable Energy Laboratory. https://www.afdc.energy.gov/uploads/publication/king_county_be_bus_preliminary.pdf

Literature Reviews & Presentations:

California Air Resources Board (ARB). (2016) *Advanced Clean Transit Program – Literature Review on Transit Bus Maintenance Cost (Discussion Draft).* Prepared for the 3rd Meeting of the Advanced Clean Transit Working Group. <https://www.arb.ca.gov/msprog/bus/maintenance_cost.pdf>

California Air Resources Board (ARB). (2016) *Advanced Clean Transit – Battery Cost for Heavy-Duty Electric Vehicles (Discussion Draft)*. Prepared for the 3rd Meeting of the Advanced Clean Transit Working Group. https://www.arb.ca.gov/msprog/bus/battery_cost.pdf

California Air Resources Board (ARB). (2016) *Total Cost of Ownership to Advance Clean Transit*. Presentation Prepared for the 4th Meeting of the Advanced Clean Transit Working Group. <https://www.arb.ca.gov/msprog/bus/4thactwgmtng_costs.pdf>

Additional Resources:

Live Tracking of King County Metro's Electric Buses: http://energy.proterra.com/KCM/

Proterra's Electric Bus Spec Sheet: https://www.proterra.com/performance/fuel-economy/