Sierra Club

Mitigation plan goals and overarching principles
Addressing environmental injustice and supporting public policy that is equitable are top priorities of the Washington State Chapter of the Sierra Club. We greatly appreciate that you have incorporated equity principles into many facets of the draft mitigation plan and are proud that Washington is a leader in the nation in this area.

We also appreciate your environmental leadership and approach for achieving emissions reductions in the plan. The categories identified are more or less in agreement with Sierra Club priorities.

We offer one comment in this category to increase transparency and clarity in the plan. In Table 2, the way that funding allocations are presented showing totals that potentially add up to more than 100% is confusing. One suggestion is to show baseline amounts where those all add up to 100% and then the higher levels of fund allocation that are contingent on other categories being less. Here is a suggested alternative format: ?

Mitigation fund allocations (also Table 2 in Proposed Volkswagen Beneficiary Mitigation Plan)

On-Road Heavy Duty Vehicles 36.5%, up to 45%

Non-Road Equipment 4%, up to 5%

Locomotives 4%, up to 5%

Marine Vessels 36.5%, up to 45%

Light Duty Zero Emission Vehicle Supply Equipment 15% (presumably, this is the $16M for EV charging infrastructure to which Brian refers)

Diesel Emission Reduction Act (DERA) Option 4%, up to 5%

Total 100% = sum of baseline amounts

Mitigation fund allocations
1) When determining the balance between different “key opportunities” specified for the mitigation fund, we urge you to consider the total life cycle cost of ownership of zero emission electric buses as opposed to just the initial capital cost. As “cost effectiveness” is one of the prioritization categories, this is especially important.

We have attached a lifetime cost analysis for electric buses. The opportunity in urban and diverse environments for emissions reductions through this investment is notable; in addition to being effective at boosting reductions, they are also a tool for boosting equity.

2) In the draft Mitigation Plan, the statement is made on p. 15, "The relative allocation of funds may change over time depending on project proposals, technology advancement, and analysis of emission benefits and costs for each proposed project."

This suggests some feedback assessments should be included in the implementation of the plan to check on how the emissions reduction benefits and project costs going forward compare with the initial expectations. We recommend that you develop some criteria for what magnitude of changes

relative to expectations would result in a shift in where the funds are spent.

3. We also ask that Ecology clarify the section on Marine Vessels and Switch Locomotives in its references to repowering the engines of the identified vessels and vehicles. Does repowering include overhauls to diesel engines as well as electrification of the vessels and vehicles? We suggest indicating criteria for how allocations would be made among both electrification and overhauls of existing diesel engines.

Disproportionately impacted communities
As stated in our earlier comments, we appreciate the prioritization in the draft mitigation plan for this category. One area for possible improvement is on page 18, where you use the term "to the extent practical". This phrase is open to interpretation, and how this is put into practice could vary widely. We would recommend adding specificity – not just in your language, but in metrics that would more accurately depict how you will create emissions reductions for these communities.

General comments
see attached file

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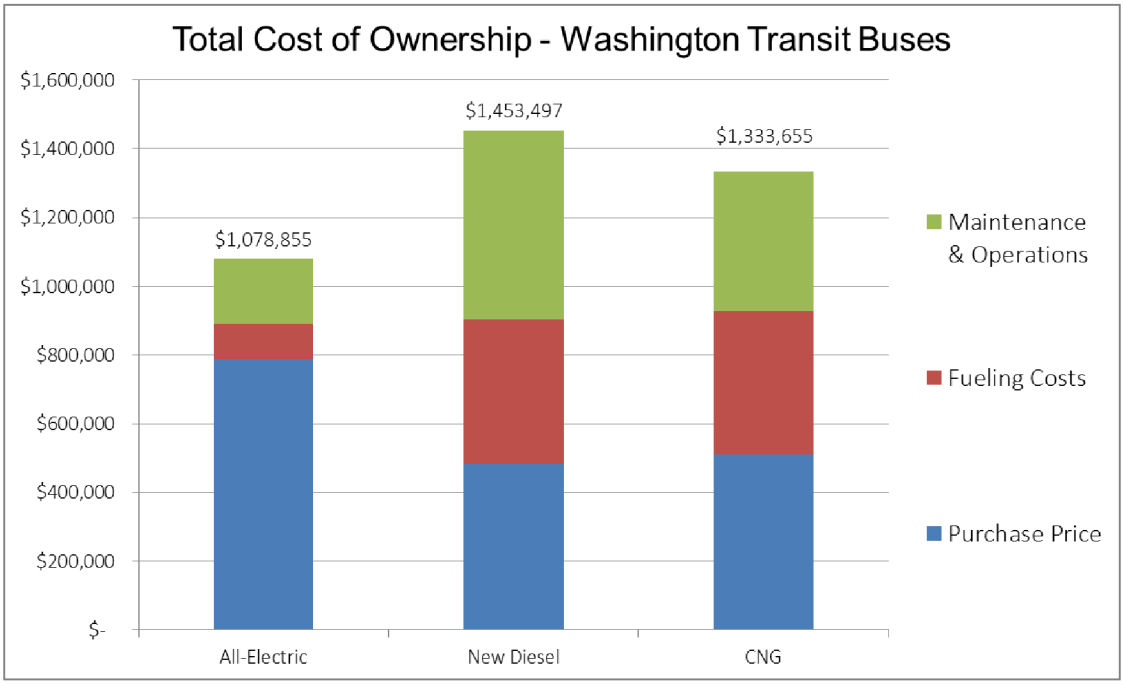
December 8, 2017

Washington Transit Bus Lifetime 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 26% lower than new diesel buses, making electric buses the most economic and cost-effective choice.** Maintenance and fueling costs for electric buses are both 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 Washington's transit agencies nearly $400,000 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 Thurston Co., Washington State.

[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 Thurston Co., Washington region. Model inputs are populated using averages of fuel economy and maintenance costs reported directly by transit agencies from the years 2014 to 2017 (see 'AFLEET Inputs and Sources' attached).

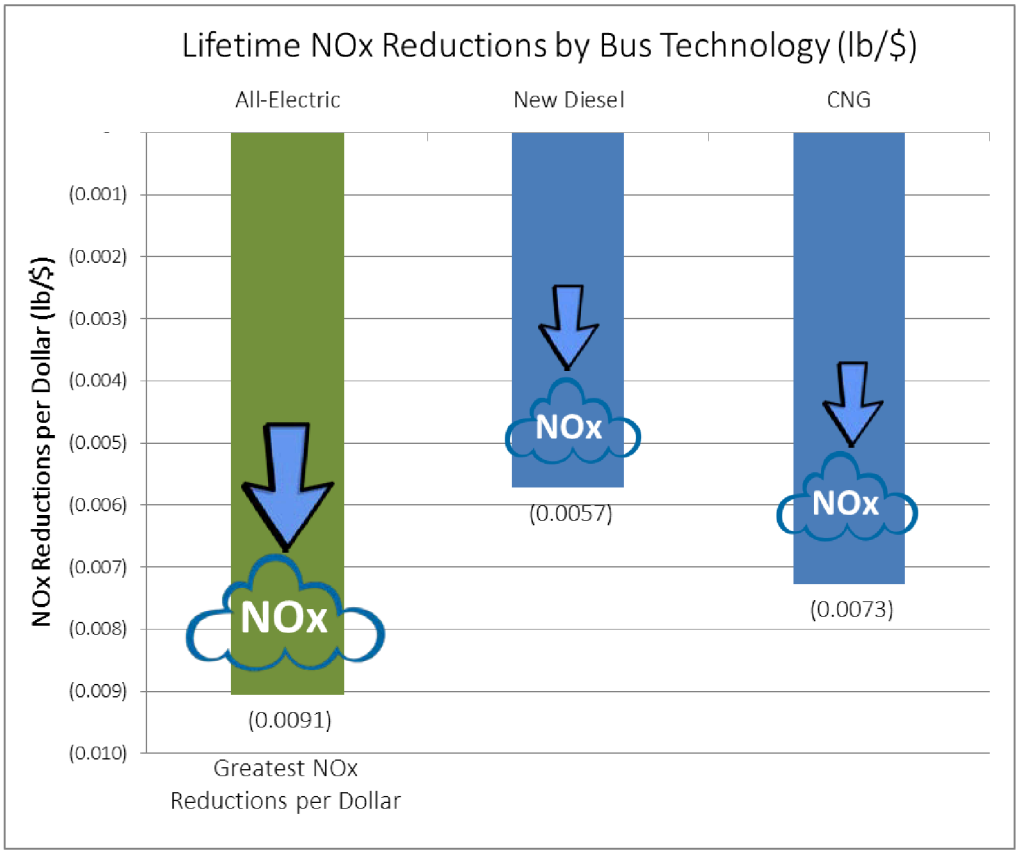
Maintenance & Fuel Costs

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

Maintenance and fueling expenses typically account for a significant portion of transit bus's lifetime costs. 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.[2] 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.[3]

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] Metrics derived from Argonne National Laboratory's AFLEET Model (2017) and ZEB transit studies
[3] https://www.afdc.energy.gov/fuels/prices.html

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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/

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AFLEET Inputs and Sources:

	Maintenance ($/mi)		Fuel Economy (MPDGE)		Purchase Price ($)	
	Average	**Source(s)**	**Average**	**Source(s)**	**2015 Value**	**Source(s)**
Electric	$0.17	Foothill Transit Battery Electric Bus Demonstration (2017) Electric Buses at Stanford (2015) King County Metro Battery Electric Bus Demonstration (2017)	19.44	Foothill Transit Battery Electric Bus Demonstration (2017) Proterra Catalyst Performance Spec Sheet (2017)	$789,000	Foothill Transit Battery Electric Bus Demonstration (2017)
Diesel	$0.80	CARB Literature Review on Transit Bus Maintenance Cost (2016)	4.155	Zero Emission Bay Area (ZEBA) Fuel Cell Bus Demonstration Results: Fourth Report (2015)	$483,155	CARB Total Cost of Ownership to Advance Clean Transit (2016)
CNG	$0.56	CARB Literature Review on Transit Bus Maintenance Cost (2016)	3.87	American Fuel Cell Bus Project Evaluation: Second Report (2015) Foothill Transit Battery Electric Bus Demonstration (2017)	$509,756	CARB Literature Review on Transit Bus Maintenance Cost (2016) American Fuel Cell Bus Project Evaluation: Second Report (2015)