

Is the region ready?

Assessing costs and benefits of zero emission buses in the
San Francisco Bay Area

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EXECUTIVE SUMMARY

The following policy analysis assesses the potential costs and benefits, to the San Francisco Bay Area, of the California Air Resources Board's (ARB) Zero Emission Bus (ZEB) purchasing requirement. This mandate requires that when transit agencies with 200 buses or more purchase new vehicles, 15% must be ZEBs. The purchasing requirement is currently scheduled to become effective on January 1, 2011, pending the results of a technology review, and will continue through 2026.

As the name implies, zero emission buses produce no tailpipe emissions and therefore offer the potential to drastically reduce pollution from public transit bus fleets. While there are a couple types of zero emission technology, regulators, manufacturers and transit agencies have focused on developing buses powered by a hydrogen fuel cell propulsion system. Fuel cell buses to be delivered in 2009 are expected to cost \$2.25 million each, which is nearly five times more expensive than a conventional diesel transit bus. Additionally, fuel cell buses require new infrastructure such as hydrogen fueling stations and specialized maintenance facilities, increasing the costs associated with these vehicles. With the effective date of the ZEB purchasing requirement looming in the near future, affected transit operators and the region's metropolitan planning organization are concerned about the potentially high costs of complying with such a mandate.

While in strong support of the regulation's goals, the Metropolitan Transportation Commission and Bay Area transit operators are concerned about the cost of complying with ARB's upcoming ZEB purchasing requirement, particularly when evaluations from the first ZEB demonstration indicate that fuel cell technology is not yet reliable or durable enough for mass transit. Transit agencies are responsible for providing cost-effective and efficient transportation, and while they are in part subsidized by public funds, complying with such a costly mandate could affect their ability to provide such a service. Furthermore, operating unreliable vehicles could risk transit dependent riders' access to public transportation and force more people into their cars, possibly defeating any pollution reduction benefits from zero emission vehicles.

To help inform the Metropolitan Transportation Commission (MTC) of the potential costs and benefits associated with implementing this purchasing requirement a simulation model was created in Microsoft Excel to calculate all of the various costs and benefits. The information in the model and this report was compiled from extensive research on zero emission technology and ZEB demonstrations; interviews with ARB staff, the Bay Area Air Quality Management District, Santa Clara Valley Transportation Authority, Golden Gate Transportation District; and various related studies.

Based on information from these sources, quantifiable costs and benefits were estimated for:

- **Fixed Costs**, including incremental costs of ZEBs over that of conventional diesel transit buses, as well as capital costs of hydrogen fueling stations and specialized maintenance facilities.
- **Operating Costs** relative to diesel busses under scenarios of high, moderate, and low technological progress.
- **Benefits**, including averted expenses for pollution reduction and averted health impacts.

There are also several unquantifiable benefits associated with this regulation, including the commercialization of hydrogen fuel cell technology and associated pollution reductions, securing energy independence by diversifying fuel sources, reductions in noise and brake pad dust, and other avoided unquantifiable health impacts. Some of these benefits have the potential to improve the health and welfare of populations far beyond the San Francisco Bay Area. Accordingly, both quantifiable and unquantifiable costs and benefits must be considered in this analysis and are represented in the following tables.

Summary of Quantifiable Costs and Benefits of ZEB Purchasing Requirement from 2011-2026		
	3% Inflation	7% Inflation
Fixed Costs		
Incremental Costs of ZEB Vehicles (qty. 297)	\$163,350,000	n/a*
Capital Costs of Hydrogen Fueling Stations	\$141,653,154	\$207,871,773
Capital Costs of Maintenance Facilities	\$26,477,454	\$40,222,430
Operating Costs		
Scenario 1: High Technological Progress	(\$86,252,618)	(\$144,718,511)
Scenario 2: Moderate Technological Progress	\$0	\$0
Scenario 3: Low Technological Progress	\$134,675,140	\$225,963,991
Benefits		
Averted Health Care Costs due to Diesel PM	\$5,387,998	\$5,597,241
Averted Costs of Pollution Reduction Policies		
NOx	\$832,739	\$1,405,165
Diesel PM	\$52,214	\$88,105

Total Costs for each Scenario		
Scenario 1: High Technological Progress	\$245,227,989	\$266,725,692
Scenario 2: Moderate Technological Progress	\$331,480,608	\$411,444,204
Scenario 3: Low Technological Progress	\$466,155,748	\$637,408,193
Total Quantifiable Benefits		
	\$6,272,951	\$7,090,512
Total Unquantifiable Benefits		
Commercializing Hydrogen Technology & Related Pollution Reductions	\$U1	\$U1
Diversifying California's Energy Sources	\$U2	\$U2
Reduced Noise & Brake Pad Dust, Increased Visibility	\$U3	\$U3
Avoided Unreported Health Impacts	\$U4	\$U4

*Cost of ZEBs are expected to decrease at the same rate as inflation.

The cost of a ZEB is held at \$1 million through 2026.

Benefit Cost Ratio for Each Scenario			
	3% Inflation	7% Inflation	Unquantifiable Benefits
Scenario 1: High Technological Progress	0.026	0.027	+\$U1+\$U2+\$U3+\$U4
Scenario 2: Mediocre Technological Progress	0.019	0.017	+\$U1+\$U2+\$U3+\$U4
Scenario 3: Low Technological Progress	0.013	0.011	+\$U1+\$U2+\$U3+\$U4

According to the benefit cost ratio above, for nearly every scenario of technological progress, approximately 1.5% to 3% of the costs of this regulation can be justified in terms of expected benefits. Consequently, the remaining 97% to 98.5% must be justified on other grounds based on policymakers' perception of potential and unquantifiable benefits.