Electric School Bus Program Update and Cost Effectiveness

School Bus Replacement Program
Advanced Vehicle Technology Office
Fuels and Transportation Division

December 3, 2018

Program Background

- Senate Bill 110 (SB 110) allocates up to $75 million for school bus replacement grants.
- Under SB 110 all replaced school buses must be scrapped.
- All project expenditures from the Job Creation Fund shall be cost effective: total benefits shall be greater than project costs over time.
- Total benefits may include consideration of non-energy benefits, such as health and safety, in addition to energy benefits.

Program Design

Three complementary funding components:

1. School bus replacement (2 phases)
   - Phase 1: Solicit public school districts, county offices of education, and joint power authorities to establish a ranked list of buses eligible for replacement based on applications received.
   - Phase 2: Solicit manufacturers to design, construct, and deliver the replacement electric buses to applicants awarded in Phase 1. This phase is a separate solicitation which is planned for release in late 2018.

Cont. Program Design

2. Provide fueling infrastructure to support awarded school buses (Alternative and Renewable Fuel and Vehicle Technologies Program funding – ARFVTP).
3. Provide workforce training and development opportunities and resources to support electric school bus maintenance, charging, and operations (ARFVTP funding).

Milestone Targets

Activity	Date
School District Solicitation Release	**May 31, 2018**
Applications Due	**September 20, 2018**
Post Electric School Bus Rank List and CNG School Bus Notice of Proposed Awards (NOPA)	**November 2018**
Release Bulk Pricing for Electric Buses Solicitation	Q4 2018
Business Meeting Approval - CNG School Buses	Q1 2019
Award Manufacturer(s)/Dealer(s)	Q1 2019
Award Electric School Buses (Final NOPA)	Q1 2019
Install Infrastructure	April - December 2019
Begin Delivering Electric School Buses	Q4 2019

GFO-17-607 Scoring Results

Analysis of All Buses Eligible for Electric Vehicle Replacement				
Regions	**Number of Applying Local Education Agencies**	**Number of Buses 1999 and Older**	**Total Number of Buses Eligible for Replacement**	**Percentage of Eligible Buses 1999 and Older**
Northern	53	249	444	56%
Central	99	420	602	70%
LA County	12	53	86	62%
Southern	35	256	417	61%
TOTALS	199	**978**	1,549	63%

GFO-17-607 Scoring Results

Ranking: Analysis of Top 75 Buses in each Region								
Regions	**Number of Applying Local Education Agencies**	**Age Range of Buses**	**Total Score Range**	**Bus Type A Requests**	**Bus Type C Requests**	**Bus Type D Requests**	**TBD Bus Type Requests**	**TOTAL**
Northern	24	1983 - 1997	81.9 to 98	20	14	41		75
Central	32	1978 - 1992	87.7 to 99.2	5	5	61	4	75
LA County	12	1984 - 2004	59.2 to 95	24	17	34		75
Southern	15	1985 - 1997	82.5 to 95.4	2	11	62		75
TOTALS	**83**			**51**	**47**	**198**	**4**	**300**

Cost Effectiveness Methodology

- Savings to Investment Ratio: $\frac{Total\ Project\ Benefits}{Total\ Project\ Costs}$
- If quotient is greater than or equal to 1, total project benefits exceed total project costs.
- If quotient is less than 1, total project costs exceed total project benefits.
- Our quotient for this project equals 1.15.

Equations Used

- Present value given an annual value:

$$P = A * \frac{1 - (1 + i)^{-n}}{i}$$

- Present value given a future value:

$$P = F * \frac{1}{(1 + i)^{n}}$$

Assumptions and Givens

- Analyzed most expensive type of bus: Type D
- Lifespan = 20 years
- 2% discount rate
- 1 battery replacement at year 12 of operation
- Fuel Efficiency of Diesel Buses: 5.5 mpg*
- Fuel Efficiency of Electric Buses: 19.6 mpdge
- 13,666 vehicle miles traveled annually**

*Fuel Efficiencies provided by Greet's AFLEET tool

**Annual vehicle miles traveled provided by South Coast AQMD courtesy of California Air Resources Board

Bus Used for Modeling Purposes

Assumed Costs

- Cost of Type D School Bus: Approximately $415,000
- Cost of Electric Vehicle Infrastructure: Up to $60,000
- Combined Cost: $475,000

Defined Benefits

1. Fuel Savings
2. Emissions Reductions
3. Maintenance Savings
4. Health
5. Economic

Potential Other Benefits

- Safety Benefits
- Grid Benefits
- Scrappage
- Job Creation

1. Fuel Savings

- Cost of diesel: $3.71 per gallon*
- Cost of electric: $3.26 per diesel gallon equivalent
- Forecasted price increase for diesel: 3.9% annually
- Forecasted price increase for transportation electricity: 3.1% annually

*Fuel costs and forecasting provided by U.S. Energy Information Administration

Fuel Savings Analysis

Diesel Lifetime Costs:

$$\frac{13{,}666\ miles}{5.5\frac{miles}{DGE}} \times \frac{\$3.71}{DGE} \times \frac{1-(1+.02+.039)^{-20}}{.02+.039} = \mathbf{\$106,597.34}$$

Electric Lifetime Costs:

$$\frac{13{,}666\ miles}{19.6\frac{miles}{DGE}} \times \frac{\$3.26}{DGE} \times \frac{1-(1+.02+.031)^{-20}}{.02+.031} = \mathbf{\$28,088.18}$$

Difference: $78,509

2. Emissions Reductions

- Carbon intensity of diesel: 102.01 gCO2e/MJ*
- Carbon intensity of electricity: 105.16 gCO2e/MJ
- Cost of carbon: $15.10/MTCO2e**

*Low Carbon Fuel Standard stated carbon intensities

**Cap and Trade carbon price

Emissions Reductions Analysis

Diesel Lifetime Costs:

$$\frac{13{,}666\ miles}{5.5\frac{miles}{DGE}} \times 134.47\ \frac{MJ}{DGE} \times \frac{102.01\frac{gCO2e}{MJ}}{1{,}000{,}000\frac{gCO2e}{MTCO2e}} \times \frac{\$15.10}{1\ MTCO2e} \times \frac{1-(1+.02)^{-20}}{.02} = \mathbf{\$8,415.49}$$

Electric Lifetime Costs:

$$\frac{13{,}666\ miles}{19.6\frac{miles}{DGE}} \times 134.47\ \frac{MJ}{DGE} \times \frac{105.16\frac{gCO2e}{MJ}}{1{,}000{,}000\frac{gCO2e}{MTCO2e}} \times \frac{\$15.10}{1\ MTCO2e} \times \frac{1-(1+.02)^{-20}}{.02} = \mathbf{\$2,434.41}$$

Difference: $5,981

3. Maintenance Savings

- Per mile maintenance cost of diesel: $0.88*
- Per mile maintenance cost of electric: $0.71
- Projected cost of replacement battery: $18,000 in 2030 or $14,193 in 2018 dollars**
- Per mile projected cost of replacement battery: $0.09

*CARB study of transit buses

**2018-2019 IEPR

Maintenance Savings Analysis

Diesel Lifetime Costs:

$$13{,}666\ miles \times \frac{\$0.88}{mile} \times \frac{1-(1+.02)^{-20}}{.02} = \mathbf{\$196,643.65}$$

Electric Lifetime Costs:

$$13{,}666\ miles \times \frac{\$0.71}{mile} \times \frac{1-(1+.02)^{-20}}{.02} = \mathbf{\$158,655.67}$$

Difference: $37,988

4. Health Benefits

- Diesel Emissions Quantifier (DEQ) used quantify dollar savings due to emissions reductions.*
- Monetary values based on avoided incidences of:
  - Premature mortality
  - Chronic bronchitis
  - Acute bronchitis
  - Upper and lower respiratory symptoms
  - Asthma exacerbation
  - Nonfatal heart attacks
  - Hospital admissions
  - Emergency room visits
  - Work loss days
  - Minor restricted-activity days

*U.S. Environmental Protection Agency

DEQ Outputs and Analysis

County and Region	Annual Diesel PM2.5 Reduction (short tons)	Annual Health Benefits
Modoc, North	0.003	$85*
Los Angeles, Los Angeles	0.003	$7,800
Mono, Central	0.003	$190*
Imperial, South	0.003	$780
Totals:	0.014	$8,900

Lifetime Benefit Calculation: $\$8{,}900 \times \frac{1-(1+.02)^{-20}}{.02} =$

$\mathbf{\$145,527.76}$

*Indicates no applicants from these counties through GFO-17-607

5. Economic Benefits

- Used Regional Input-Output Modeling System (RIMS II).*
- Multipliers:

  1.4516 for construction

  1.4105 for motor vehicles, bodies and trailers, and parts manufacturing

  1.4467 for out of state industry

*Bureau of Economic Analysis

Economic Multipliers

Description	Amount	Multiplier	Product
Construction	$55,000	1.4516	$79,838
Motor vehicles, bodies and trailers, and parts manufacturing	$108,750	1.4105	$153,392
Other out-of-state industry	$31,125	1.4467	$45,029
Totals:	$194,875		**$278,258**

Results

Benefit	Amount
1. Fuel Savings	$78,509
2. Emissions Reductions	$5,981
3. Maintenance Savings	$37,988
4. Health	$145,528
5. Economic	$278,258
Total Benefits:	**$546,264**

Cost Effectiveness Conclusion

$$\frac{Total\ Project\ Benefits}{Total\ Project\ Costs} = \frac{\$546{,}264}{475{,}000} = 1.15$$

Total Project Benefits exceed Total Project Costs by $71,264.

Thank You!