



## SUPPLEMENTARY APPENDIX

### Research Report 221

# Assessing the National Health, Education, and Air Quality Benefits of the United States Environmental Protection Agency's School Bus Rebate Program: A Randomized Controlled Trial Design

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## Appendix A: Supplementary Tables and Figure

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Appendix A was reviewed for spelling, grammar, and cross-references to the main report. It has not been formatted or fully edited by HEI. This document was reviewed by the HEI Review Committee.

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**Table A1. Types of School Bus Upgrades Allowed by US EPA School Bus Rebate Program Awardees, 2012–2017<sup>a</sup>**

Lottery Year	Program Details	Funding by Vehicle Class	Retrofit Details
2012	Replacements only. New buses powered by a certified 2012 or newer model year engine or operate solely on electricity. Eligible replacement school buses may operate on conventional diesel (ULSD), battery or hybrid drivetrains, or alternative fuels	Class 3-5: \$20K Class 6-7: \$25K Class 8: \$30K	
2014	Replacements only. New buses powered by a certified 2014 or newer model year engine or operate solely on electricity. Eligible replacement school buses may operate on conventional diesel (ULSD), battery or hybrid drive trains, or alternative fuels	Class 3-5: \$15K Class 6-7: \$20K Class 8: \$25K	
2015	Replacements and Retrofits. New buses powered by a certified 2015 or newer model year engine or operate solely on electricity. Eligible replacement school buses may operate on conventional diesel (ULSD), battery or hybrid drive trains, or alternative fuels Retrofits must be 1994-2006 MYE powered by ULSD	Class 3-5: \$15K Class 6-7: \$20K Class 8: \$25K	Retrofits: up to \$3K for DOC+CCV (per bus)
2016	Replacements and Retrofits. New buses powered by a certified 2016 or newer model year engine or operate solely on electricity. Eligible replacement school buses may operate on conventional diesel (ULSD), gasoline, battery or hybrid drivetrains, or alternative fuels Retrofits must be 1994-2006 MYE powered by ULSD. Encouraged fuel-operated heaters (FOH) for both replacements and retrofits	Class 3-5: \$15K Class 6-7: \$20K Class 8: \$25K	Retrofits: up to \$4K for DOC+CCV, \$6K for DOC+CCV+FOH (all per bus)
2017	Replacements and Retrofits. New buses powered by a certified 2017 or newer model year engine or operate solely on electricity. Eligible replacement school buses may operate on conventional diesel (ULSD), gasoline, battery or hybrid drivetrains, or alternative fuels. Retrofits must be 1994-2006 MYE powered by ULSD.	Class 3-5: \$15K Class 6-8: \$20K	Retrofits: up to \$3K for DOC, \$4K for DOC+CCV, \$5K for DOC+FOH, \$6K for DOC+CCV+FOH (all per bus)

Encouraged fuel-operated heaters (FOH) for both replacements  
and retrofits

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DOC = Diesel Oxidation Catalysts, CCV = Crankcase Ventilation Systems

<sup>a</sup> Data from references 25–29 in the IR reference list.

**Table A2. Number of Applications (%<sup>a</sup>) Receiving US EPA School Bus Rebate Program Funding, by Source of Funding and Year<sup>b,c</sup>**

Awarding US EPA Entity <sup>d</sup>	Lottery Year					Total
	2012	2014	2015	2016	2017	
Headquarters	28 (100%)	53 (75%)	44 (62%)	58 (71%)	92 (67%)	275
Region 1	0 (0%)	3 (4%)	9 (13%)	3 (4%)	4 (3%)	19
Region 2	0 (0%)	0 (0%)	10 (14%)	11 (13%)	6 (4%)	27
Region 3	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	1
Region 4	0 (0%)	0 (0%)	0 (0%)	6 (7%)	11 (8%)	17
Region 5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (7%)	10
Region 6	0 (0%)	2 (3%)	6 (8%)	1 (1%)	0 (0%)	9
Region 7	0 (0%)	13 (18%)	1 (1%)	2 (2%)	14 (10%)	30
Region 8	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	1
Region 9	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0
Region 10	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0
Total:	28	71	71	82	137	389

<sup>a</sup> Percentages represent the within-year distribution of funding sources; column percentages may not sum to 100% due to rounding.

<sup>b</sup> This table only summarizes the applications that were ultimately awarded funding (i.e., it does not include the applications ( $N = 41$ ) that were selected to receive funding but ultimately did not).

<sup>c</sup> This information was derived from data obtained from the US EPA under a Freedom of Information Act request (see section Data – US EPA School Bus Rebate Program Applications, in the main text).

<sup>d</sup> Because some US EPA regional offices had additional funding for school bus replacements, these offices awarded funding to additional applications based on the randomized rank of applications that did not receive funding from the US EPA national program.

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**Table A3. Types of School Bus Upgrades Purchased by US EPA School Bus Rebate Program Awardees, 2012–2017<sup>a,b</sup>**

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Technology	Number	Percent
Vehicle Replacement - ULSD (diesel)	354	93.20%
Vehicle Replacement - LPG/Propane	12	3.20%
Vehicle Replacement - Gasoline	10	2.60%
Vehicle Replacement - CNG	3	0.80%
Diesel Oxidation Catalyst + Closed Crankcase Ventilation	1	0.30%
Total:	380	100%

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<sup>a</sup> Information on the type of school bus upgrade purchased was only available for 380 of the total 430 selected applications of the 2012–2017 lotteries.

<sup>b</sup> This information was derived from data obtained from the US EPA under a Freedom of Information Act request (see section Data – US EPA School Bus Rebate Program Applications, in the main text).

<b>Table A4. Sensitivity Analysis to Evaluate the Potential for Selection Bias in Our Study Due to Excluded Data<sup>a</sup></b>									
<b>Outcome (mean (SD); min, max of change across years)</b>	<b>&lt; 1990 Model Year</b>			<b>1991–1999 Model Year</b>			<b>2000+ Model Year</b>		
	<b>Estimate</b>	<b>95% CI</b>	<b>P value</b>	<b>Estimate</b>	<b>95% CI</b>	<b>P value</b>	<b>Estimate</b>	<b>95% CI</b>	<b>P value</b>
<b>Attendance (0.0 (0.8); -5.0, 5.0)</b>									
<b>Existing Result:</b>	<b>0.45</b>	<b>0.26, 0.65</b>	<b>&lt;.0001</b>	<b>0.10</b>	<b>-0.03, 0.23</b>	<b>0.12</b>	<b>-0.03</b>	<b>-0.16, 0.09</b>	<b>0.62</b>
Maximum Change	0.38	0.07, 0.69	0.02	0.18	-0.05, 0.40	0.12	-0.06	-0.25, 0.14	0.55
99th Percentile Change	0.41	0.15, 0.67	0.002	0.14	-0.02, 0.31	0.09	-0.05	-0.20, 0.10	0.51
95th Percentile Change	0.44	0.22, 0.65	<.0001	0.11	-0.02, 0.24	0.10	-0.04	-0.16, 0.07	0.49
5th Percentile Change	0.46	0.29, 0.64	<.0001	0.07	-0.05, 0.20	0.26	-0.03	-0.15, 0.08	0.57
1st Percentile Change	0.49	0.34, 0.64	<.0001	0.04	-0.12, 0.19	0.65	-0.02	-0.16, 0.11	0.73
Minimum Change	0.52	0.38, 0.66	<.0001	0.0002	-0.21, 0.21	1.00	-0.02	-0.20, 0.17	0.87
<b>PM<sub>2.5</sub> (-0.17 (0.80); -6.4, 4.6)</b>									
<b>Existing Result:</b>	<b>-0.95</b>	<b>-1.45, -0.45</b>	<b>0.0002</b>	<b>-0.04</b>	<b>-0.15, 0.08</b>	<b>0.53</b>	<b>-0.01</b>	<b>-0.08, 0.06</b>	<b>0.83</b>
Maximum Change	-0.98	-1.43, -0.54	<.0001	0.04	-0.20, 0.28	0.77	-0.04	-0.20, 0.11	0.59
99th Percentile Change	-0.95	-1.43, -0.48	<.0001	-0.01	-0.16, 0.14	0.90	-0.03	-0.12, 0.05	0.43
95th Percentile Change	-0.94	-1.43, -0.46	0.0002	-0.02	-0.15, 0.10	0.71	-0.03	-0.10, 0.04	0.39
5th Percentile Change	-0.92	-1.44, -0.41	0.001	-0.05	-0.16, 0.05	0.31	-0.02	-0.10, 0.05	0.54
1st Percentile Change	-0.91	-1.44, -0.38	0.001	-0.07	-0.18, 0.04	0.22	-0.02	-0.12, 0.07	0.67
Minimum Change	-0.87	-1.47, -0.28	0.004	-0.13	-0.34, 0.08	0.22	-0.01	-0.21, 0.19	0.94
<b>Education: RLA (-0.009 (0.093); -0.706, 0.417)</b>									
<b>Existing Result:</b>	<b>0.062</b>	<b>0.050, 0.074</b>	<b>&lt;.0001</b>	<b>-0.003</b>	<b>-0.020, 0.014</b>	<b>0.73</b>	<b>0.003</b>	<b>-0.011, 0.018</b>	<b>0.65</b>
Maximum Change	0.053	0.031, 0.075	<.0001	0.013	-0.018, 0.044	0.42	0.007	-0.020, 0.034	0.62
99th Percentile Change	0.057	0.042, 0.072	<.0001	0.005	-0.016, 0.027	0.62	0.005	-0.013, 0.023	0.59
95th Percentile Change	0.059	0.047, 0.072	<.0001	0.002	-0.016, 0.019	0.84	0.004	-0.011, 0.019	0.60
5th Percentile Change	0.066	0.050, 0.082	<.0001	-0.009	-0.027, 0.009	0.31	0.001	-0.017, 0.019	0.91
1st Percentile Change	0.068	0.048, 0.087	<.0001	-0.013	-0.034, 0.009	0.24	0.000	-0.022, 0.022	1.00
Minimum Change	0.076	0.039, 0.114	<.0001	-0.027	-0.070, 0.015	0.21	-0.004	-0.047, 0.039	0.86

<b>Education: Math (-0.016 (0.099); -0.699, 0.464)</b>									
<b>Existing Result:</b>	<b>0.025</b>	<b>0.011, 0.039</b>	<b>0.0005</b>	<b>-0.012</b>	<b>-0.032, 0.009</b>	<b>0.26</b>	<b>0.001</b>	<b>-0.014, 0.016</b>	<b>0.90</b>
Maximum Change	0.016	-0.011, 0.042	0.26	0.010	-0.029, 0.049	0.63	0.006	-0.028, 0.040	0.74
99th Percentile Change	0.020	0.001, 0.039	0.04	0.002	-0.027, 0.031	0.90	0.004	-0.020, 0.028	0.75
95th Percentile Change	0.022	0.006, 0.037	0.01	-0.002	-0.026, 0.022	0.88	0.003	-0.016, 0.022	0.77
5th Percentile Change	0.030	0.011, 0.048	0.002	-0.017	-0.038, 0.003	0.10	-0.001	-0.018, 0.016	0.92
1st Percentile Change	0.032	0.010, 0.053	0.005	-0.021	-0.045, 0.003	0.09	-0.002	-0.023, 0.019	0.86
Minimum Change	0.040	0.000, 0.079	0.05	-0.037	-0.081, 0.008	0.11	-0.006	-0.048, 0.037	0.79
<b>ED Visits (event rate: -0.006 (0.054); -2.0, 0.520)</b>									
<b>Existing Result:</b>	<b>4.9</b>	<b>-5.0, 15.8</b>	<b>0.34</b>	<b>-8.8</b>	<b>-21.1, 5.5</b>	<b>0.22</b>	<b>9.2</b>	<b>0.8, 18.2</b>	<b>0.03</b>
Maximum Change	-2.1	-22.7, 24.0	0.86	14.6	-21.4, 67.2	0.48	10.6	-10.0, 36.0	0.34
99th Percentile Change	2.4	-9.8, 16.2	0.71	-3.4	-18.6, 14.5	0.69	9.4	-0.3, 20.1	0.06
95th Percentile Change	3.3	-7.8, 15.7	0.58	-5.8	-18.2, 8.6	0.41	9.2	0.4, 18.7	0.04
5th Percentile Change	5.7	-3.8, 16.2	0.25	-9.6	-22.5, 5.3	0.20	8.4	0.2, 17.3	0.04
1st Percentile Change	5.8	-3.7, 16.2	0.24	-9.7	-22.6, 5.4	0.20	8.4	0.2, 17.3	0.04
Minimum Change	5.8	-3.7, 16.2	0.24	-9.7	-22.6, 5.4	0.20	8.4	0.2, 17.3	0.04

<sup>a</sup> Estimates and 95% confidence intervals from our model are reported for scenarios where all districts linked to excluded applications were assigned a range of outcome values spanning the minimum to maximum values observed in our dataset.



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**Table A5. Relationship Between Lottery Status and Missingness, by Outcome Measure**

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Outcome	Parameter Estimate <sup>a</sup>	95% CI	p-value
Attendance	0.003	-0.021, 0.026	0.81
Education: RLA	0.002	-0.030, 0.034	0.89
Education: Math	0.015	-0.018, 0.049	0.37
PM <sub>2.5</sub>	0.001	-0.007, 0.010	0.78
ED visits	0.010	-0.015, 0.036	0.42

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<sup>a</sup> The parameter estimate is the coefficient for lottery status as a predictor of having missing data in an analysis on lottery status. The value represents the change in probability of having missing data that is associated with being selected in the lottery.

Figure A1. Histogram of Applicant Average Model Year of Replaced Buses for Selected Applications (2012–2017)

