

Technical Appendix

Transforming Transit: Accelerating a Zero-Emission Transit Fleet in the Chicago Region will remove existing diesel-powered transit vehicles from service.

GHG Reduction Estimate Method

The emission savings are based on the average annual fuel consumption of each vehicle type and the remaining service life of each vehicle, based on current equipment maintenance and replacement cycles.

Models/Tools Used

EPA's DEQ tool

Measure Implementation Assumptions

RTA manually created lifetime reductions based on assumed remaining useful lives stated below. A spreadsheet is included with these calculations. As noted on the EPA site, the DEQ calculator does not always accurately calculate lifetime savings because some vehicles are past the normal useful life. CTA, Metra and Pace have strong quarter and mid-life overhaul programs which have significantly extended the useful life of vehicles due to insufficient funding to replace all vehicles at scheduled intervals.

CTA Bus Assumptions

- 30,000 Annual Miles Traveled
- 9,000 Diesel-equivalent gallons
- 1,460 Annual idling hours
- 3 years of useful life remaining at the time of bus replacements based on current remaining life after mid-life overhauls

Pace Bus Assumptions:

- 35,612 Annual Miles Traveled
- 6,900 Diesel-equivalent gallons
- 334 Annual idling hours
- 6-7 years of useful life remaining at the time of bus replacements based on purchase date

Metra Locomotive Assumptions:

- 1,302 Annual Usage Hours
- 162,750 Annual Fuel Gallons (125 Gallons per Hour)
- 10-11 years of useful life remaining at the time of locomotive replacements based on current remaining life based on purchase date



Capital Cost Assumptions

CTA and Pace bus purchase costs are based on recent purchases of similar vehicles and evaluation of current market conditions. Metra vehicle costs are based on an option for the trailer cars in an existing contract for purchase of the battery electric train sets to which the trailer cars will be incorporated. Metra's Express Charging Docks is based on market costs of similar equipment.

Service Board	Item	Quantity	Total Cost
Pace	40' Electric Buses	83	\$125,000,000
CTA	60' Electric Buses	50	\$103,500,000
CTA	1440kw Charging Cabinets	2	\$21,500,000
Metra	Trailer Cars	32	\$85,000,000
Metra	Express Charging Docks	8	\$45,000,000
Total			\$375,000,000

Operations and Maintenance Cost Assumptions

Operations and maintenance costs of the diesel vehicles and the electric replacement vehicles are assumed of the same order of magnitude for this analysis. Electrification is expected to yield operating cost savings due primarily to the lower cost of electricity compared to diesel fuel, however a conservative approach is used in *Transforming Transit*.

GHG Reduction Estimate Assumptions

Replacement Year and Remaining Useful Life

Agency / Type	Replacement Year	Final Year of old vehicle	Years Remaining	Number of Vehicles/Engines	Useful Life	Annual Baseline of Vehicles (NOx, short tons)	Annual Baseline of Vehicles (PM2.5, short tons)	Annual Baseline of Vehicles (HC, short tons)	Annual Baseline of Vehicles (CO, short tons)	Annual Baseline of Vehicles (CO2, short tons)	Annual Baseline of Vehicles (Fuel, gallons/year)
CTA 60FT	2029	2032	3	15	13	3.849	0.019	0.618	0.834	1518.750	135000
CTA 60FT	2030	2033	3	35	13	8.981	0.045	1.442	1.947	3543.750	315000
Pace 40FT	2026	2033	7	20	13	2.236	0.003	0.278	1.452	1552.500	138000
Pace 40FT	2027	2033	6	60	13	6.707	0.010	0.714	4.355	4657.500	414000
Metra Loco	2027	2038	11	8	30	41.725	1.012	24.108	10.790	14647.500	1302000
Metra Loco	2028	2038	10	8	30	41.725	1.012	21.916	10.790	14647.500	1302000

GHG Emissions Reduced

Outputs from EPA's DEQ tool follow.



DEQ Summary and Detailed Reports

Project Name: Final Run New Vehicles
User Name: Brian Lowenberg
Total Project Funding: \$ 375,000,000

Run Date: 04/01/2024
User Email: brian.lowenberg@rtachicago.org

Summary Emission Results¹ for Project:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline for Project	105.223	2.100	5.229	30.166	40,567.5	3,606,000
Amount Reduced After Upgrades	105.223	2.100	5.229	30.166	40,567.5	3,606,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline for Project	970.616	21.514	49.076	271.213	361,597.5	32,142,000
Amount Reduced After Upgrades	970.616	21.514	49.076	271.213	361,597.5	32,142,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	
Total Cost Effectiveness ⁴ (includes all project costs)	\$386,353	\$17,430,392	\$7,641,191	\$1,382,677	\$1,037	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Detailed Emission Results¹ for CTA 60ft Buses 2029:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline of Group	3.849	0.019	0.206	0.834	1,518.8	135,000
Amount Reduced After Upgrades	3.849	0.019	0.206	0.834	1,518.8	135,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline of Group	11.547	0.058	0.618	2.503	4,556.3	405,000
Amount Reduced After Upgrades	11.547	0.058	0.618	2.503	4,556.3	405,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Inputs:

CTA 60ft Buses 2029:

Type: Onroad

Target Fleet: Transit Bus

Class: Class 8

Quantity: 15

Engine Model Year: 2008

Upgrade Year: 2029

Remaining Life: 3

Fuel Type: ULSD (diesel)

Annual Fuel Gallons: 9,000

Diesel-equivalent Gallons: 9,000

Annual Miles Traveled: 30,000

Annual Idling Hours: 1,460

Vehicle Replacement:

Upgrade: Vehicle Replacement - All-Electric

Upgrade Cost per Unit: \$0

Labor Cost per Unit: \$0

Percent Reduction:

NO_x: 100%

PM2.5: 100%

HC: 100%

CO: 100%

CO₂: 100%

Detailed Emission Results¹ for CTA 60ft Buses 2030:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline of Group	8.981	0.045	0.481	1.947	3,543.8	315,000
Amount Reduced After Upgrades	8.981	0.045	0.481	1.947	3,543.8	315,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline of Group	26.942	0.135	1.442	5.840	10,631.3	945,000
Amount Reduced After Upgrades	26.942	0.135	1.442	5.840	10,631.3	945,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Inputs:

CTA 60ft Buses 2030:

Type: Onroad

Target Fleet: Transit Bus

Class: Class 8

Quantity: 35

Engine Model Year: 2008

Upgrade Year: 2030

Remaining Life: 3

Fuel Type: ULSD (diesel)

Annual Fuel Gallons: 9,000

Diesel-equivalent Gallons: 9,000

Annual Miles Traveled: 30,000

Annual Idling Hours: 1,460

Vehicle Replacement:

Upgrade: Vehicle Replacement - All-Electric

Upgrade Cost per Unit: \$0

Labor Cost per Unit: \$0

Percent Reduction:

NO_x: 100%

PM2.5: 100%

HC: 100%

CO: 100%

CO₂: 100%

Detailed Emission Results¹ for Pace 40ft bus 2026:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline of Group	2.236	0.003	0.040	1.452	1,552.5	138,000
Amount Reduced After Upgrades	2.236	0.003	0.040	1.452	1,552.5	138,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline of Group	15.650	0.022	0.278	10.161	10,867.5	966,000
Amount Reduced After Upgrades	15.650	0.022	0.278	10.161	10,867.5	966,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Inputs:

Pace 40ft bus 2026:

Type: Onroad

Target Fleet: Transit Bus

Class: Class 8

Quantity: 20

Engine Model Year: 2017

Upgrade Year: 2026

Remaining Life: 7

Fuel Type: ULSD (diesel)

Annual Fuel Gallons: 6,900

Diesel-equivalent Gallons: 6,900

Annual Miles Traveled: 35,612

Annual Idling Hours: 334

Vehicle Replacement:

Upgrade: Vehicle Replacement - All-Electric

Upgrade Cost per Unit: \$0

Labor Cost per Unit: \$0

Percent Reduction:

NO_x: 100%

PM2.5: 100%

HC: 100%

CO: 100%

CO₂: 100%

Detailed Emission Results¹ for Pace 40ft bus 2027:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline of Group	6.707	0.010	0.119	4.355	4,657.5	414,000
Amount Reduced After Upgrades	6.707	0.010	0.119	4.355	4,657.5	414,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline of Group	40.242	0.057	0.714	26.127	27,945.0	2,484,000
Amount Reduced After Upgrades	40.242	0.057	0.714	26.127	27,945.0	2,484,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Inputs:

Pace 40ft bus 2027:

Type: Onroad

Target Fleet: Transit Bus

Class: Class 8

Quantity: 60

Engine Model Year: 2018

Upgrade Year: 2027

Remaining Life: 6

Fuel Type: ULSD (diesel)

Annual Fuel Gallons: 6,900

Diesel-equivalent Gallons: 6,900

Annual Miles Traveled: 35,612

Annual Idling Hours: 334

Vehicle Replacement:

Upgrade: Vehicle Replacement - All-Electric

Upgrade Cost per Unit: \$0

Labor Cost per Unit: \$0

Percent Reduction:

NO_x: 100%

PM2.5: 100%

HC: 100%

CO: 100%

CO₂: 100%

Detailed Emission Results¹ for Metra Locos 2027:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline of Group	41.725	1.012	2.192	10.790	14,647.5	1,302,000
Amount Reduced After Upgrades	41.725	1.012	2.192	10.790	14,647.5	1,302,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline of Group	458.980	11.127	24.108	118.686	161,122.5	14,322,000
Amount Reduced After Upgrades	458.980	11.127	24.108	118.686	161,122.5	14,322,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Inputs:

Metra Locos 2027:

Type: Locomotive

Target Fleet: Passenger Locomotive

Sector: Transit

Quantity: 8

Engine Model Year: 2008

Tier: Tier 2

Horsepower: 3,000

Fuel Type: ULSD (diesel)

Annual Fuel Gallons: 162,750

Diesel-equivalent Gallons: 162,750

Annual Usage Hours: 1,302

Upgrade Year: 2027

Remaining Life: 11

Locomotive Replacement:

Upgrade: Locomotive Replacement - All-Electric

Upgrade Cost per Unit: \$0

Labor Cost per Unit: \$0

Percent Reduction:

NO_x: 100%

PM2.5: 100%

HC: 100%

CO: 100%

CO₂: 100%

Detailed Emission Results¹ for Metra Locos 2028:

<u>Annual Results (short tons)²</u>	NO _x	PM2.5	HC	CO	CO ₂	Fuel ³
Baseline of Group	41.725	1.012	2.192	10.790	14,647.5	1,302,000
Amount Reduced After Upgrades	41.725	1.012	2.192	10.790	14,647.5	1,302,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Results (short tons)²</u>						
Baseline of Group	417.255	10.115	21.916	107.896	146,475.0	13,020,000
Amount Reduced After Upgrades	417.255	10.115	21.916	107.896	146,475.0	13,020,000
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<u>Lifetime Cost Effectiveness (\$/short ton reduced)</u>						
Capital Cost Effectiveness ⁴ (unit & labor costs only)	\$0	\$0	\$0	\$0	\$0	

¹ Emissions from the electrical grid are not included in the results.

² 1 short ton = 2000 lbs.

³ In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

⁴ Cost effectiveness estimates include only the costs which you have entered.

Inputs:

Metra Locos 2028:

Type: Locomotive

Target Fleet: Passenger Locomotive

Sector: Transit

Quantity: 8

Engine Model Year: 2008

Tier: Tier 2

Horsepower: 3,000

Fuel Type: ULSD (diesel)

Annual Fuel Gallons: 162,750

Diesel-equivalent Gallons: 162,750

Annual Usage Hours: 1,302

Upgrade Year: 2028

Remaining Life: 10

Locomotive Replacement:

Upgrade: Locomotive Replacement - All-Electric

Upgrade Cost per Unit: \$0

Labor Cost per Unit: \$0

Percent Reduction:

NO_x: 100%

PM2.5: 100%

HC: 100%

CO: 100%

CO₂: 100%