Technical Appendix

Measure 1 EV Charging Infrastructure

GHG reduction estimate method

This estimate looks at the emissions difference between a single charge of an electric vehicle, compared to a gasoline power light duty vehicle driving the same distance. This was performed by comparing the gram per mile emissions from a conventional gas light duty vehicle and an electric vehicle. The analysis assumes 31 kWh per charging session at an electric charger, and an average of 3 miles per kWh. Thus, for each charge, we are comparing the emissions from driving 93 miles.

	Emissions per Charging Session or 93 Miles (kg)				
Pollutant	**Gas Vehicle**	**NY Electric Vehicle**	**NY Percentage Change**	**NJ Electric Vehicle**	**NJ Percentage Change**
CO_2	34.72	12.79	-6%	9.46	-73%
CH_4	0.001	0.001	-1%	0.001	1%
N_2O	0.000	0.000	-32%	0.000	-55%
SO_2	0.000	0.000	-47%	0.004	1453%
NO_x	0.007	0.003	-48%	0.004	-39%
$PM_{2.5}$	0.001	0.000	-41%	0.001	96%
PM_{10}	0.004	0.000	-90%	0.002	-66%
CO2e	34.79	12.85	-63%	9.50	-73%

Specification of Tools and Models

EPA 2020. U.S. Environmental Protection Agency. *Motor Vehicle Emissions Simulator MOVES3*. Available at https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves, Downloaded version 3.0.4, November 2020.

Implementation Assumptions

Stations are expected to be operational at the start of year 4 and we expect to see high utilization immediately. We expect to see approximately 19 charging sessions per day per chargers, with an average of 31 kWh per session. These assumptions are based off the month with the greatest utilization from a current DCFC hub at our airport. Charging providers have provided projects of 25 sessions with an average of 40kWh per session but we are using current data as a baseline assumption.

GHG Reduction Estimate Assumptions

- These analyses are built on current emission factors, not forecasts of emission factors in the future. This means that improvements in vehicle efficiency and electricity decarbonization in the 2025-2050 period are not being captured. This was done because there is significant uncertainty in these types of estimates, and in some cases the results will at least somewhat cancel each other out. For example, both a gasoline and an electric light-duty vehicle will have lower emissions in 2030 than today.

- The gram per mile emission factor of a conventional vehicle comes from a MOVES3 2022 run for 10 NY Metropolitan counties. The grams per mile of an electric vehicle in New Jersey comes from EPA's 2022 eGRID electricity emission factor for the NJ region (RFCE). The emission factor for New York is an average of the metropolitan New York eGRID region (NYCW) and the emissions factor calculated by SC&A for JFK's KIAC plant, which provides electricity to that airport. Given that these charging stations could be located at LaGuardia or JFK airports, this seemed appropriate. All of these values were also used to calculate Port Authority's 2022 GHG inventory and have been verified by third parties for previous inventories.
- Note that criteria pollutant emissions from electric vehicles will occur at the power plants themselves; tailpipe criteria pollutant emissions from electric vehicles are zero.
- The emission factor used for this analysis is based on the average of the New York and New Jersey emission factors shown above.

Reference Case Scenario

Port Authority's annual GHG inventory estimates emissions from attracted travel at the five Port Authority airports. This estimate includes categories for taxis and for-hire ridesharing services like Uber/Lyft. These two categories accounted for 177,211 tCO2e emissions in 2022. This is used as the baseline for future emissions from taxis/ridesharing vehicles.

Measure-specific Activity Data

- These analyses assume that electric vehicles or equipment will be used the same amount (in terms of hours or miles) as the vehicles they are replacing.
- Assumes each site has 25 chargers, 19 sessions per day per charger so 475 sessions per site per day. Assume 31kWh per session. Assumes each session is a 23.6CO2e reduction per session. 12,282,752 CO2e =475 sessions * 3 sites * 365 days * 23.6 reduction per session.
- The 19 sessions per day and 31kWh per session from the peak month in 2023 from current DCFC. I am asking NYPA if we can share that data. Projections from charging providers show higher utilization but I think this is a safe justifiable assumption.

GHG Emissions Reduced

  - For EV charging, savings are 12,286 tCO2e per year for 3 sites. Attracted travel emissions from taxis and Uber/Lyft in 2022 were 177,211 tCO2e in 2022 across the five airports. This would represent a 7% reduction in attracted travel emissions from those two categories.
  - Cumulative savings are as follows:
    2025-2030 – 36,858
    2025-2050 – 122,859

Uncertainties Associated with Estimates or Key Assumptions

- Electric charging station hardware is assumed to last 10 years. Chargers are assumed to all go online in 2028, and last through 2037. However, given the expected high utilization of the site, normal wear and tear may lead to the need to replace parts and even full stations. These replacements should be covered by the warranty and/or charging provider.
- The analysis is based on the emissions savings which can be achieved from vehicles today. There is uncertainty in forecasting what the vehicle fleet will look like in future years. It is likely that electric vehicles will have lower emissions in 2030 as grid decarbonization continues. However, it is also expected that gasoline power vehicles will continue to see efficiency improvements as well.

Therefore, this analysis assumes that those improvements will mostly cancel each other out, and that overall savings will be comparable to those seen in 2022.

Measure 2 GSE Voucher Program

GHG reduction estimate method

- This analysis is looking at replacing diesel and gasoline ground support equipment with electric GSEs. These electric GSEs (746 in all) would be coming online in 2028 and 2029.
- Emissions from GSE were estimated using default annual hours and horsepower from FAA's AEDT model (version 3e), based on a run performed for JFK airport. This is the same model and methodology used to estimate GSE emissions for Port Authority's annual GHG inventory. AEDT also includes a default equipment lifetime, which ranges between 10-14 years for the equipment modeled here. For the cumulative emissions savings, we estimate that each piece of equipment will be in service for this 10-14 year lifetime and then be retired. It is likely that this is undercounting the lifetime of this equipment, as many pieces of GSE at Port Authority airports have been in use 20 or even 30 years. It is likely that many pieces of electric GSE purchased in 2028 will still be in use in 2050, although in this analysis all equipment has been retired by the end of 2041.
- The GHG and CAP savings are displayed in the two tables below. Note that this is organized by the type of equipment which is being replaced with electric GSE. Emissions savings in the 2025-2030 period would be higher, except that the equipment will not be delivered until 2028 or 2029. The tables attribute only 30% of the total GSE saving GHG savings to the program as the Voucher program design is to cover incremental cost between traditional internal combustion engines and an equivalent zero-emission model. This incremental difference is on average 30% of the zeGSE cost. The overall impact of the GSE and the program will be much greater.

Cumulative GHG and CAP Savings from Ground Support Equipment Electrification, 2025-2030 (metric tons)

Equipment Type	Fuel	NOx	SOx	PM 2.5	PM 10	CO2
Wollard TLS-770 / F350 - Lavatory Truck	Diesel	6.1	0.0	0.7	0.7	846.3
F250 / F350 - Hydrant Truck	Gasoline	3.7	0.0	0.3	0.3	2131.0
Stewart & Stevenson TUG MA 50 - Baggage Tractor	Gasoline	10.5	0.1	0.9	1.0	6056.8
"Stewart & Stevenson TUG GT-35 MC - Aircraft Tractor"	Gasoline	2.0	0.0	0.2	0.2	1122.4
F250 / F350 - Hydrant Truck	Diesel	24.2	0.0	3.0	3.1	2668.1
Eagle Bobtail / F350 - Bobtail	Gasoline	2.0	0.0	0.2	0.2	1161.6
"F750 Dukes Transportation Services DART 3000 to 6000 gallon - Fuel Truck"	Diesel	1.9	0.0	0.2	0.2	406.8
(None specified. EPA default data used.) - Lift	Gasoline	2.3	0.0	0.2	0.2	1320.5
"TLD 28 VDC - Ground Power Unit"	Diesel	19.1	0.0	1.6	1.7	1744.7
FMC Commander 15 - Cargo Loader	Diesel	1.3	0.0	0.2	0.2	244.4
Total		**73.0**	**0.1**	**7.5**	**7.9**	**17,703**

Cumulative GHG and CAP Savings from Ground Support Equipment Electrification, 2025-2050 (metric tons)

Equipment Type	Fuel	NOx	SOx	PM 2.5	PM 10	CO2
Wollard TLS-770 / F350 - Lavatory Truck	Diesel	33.2	0.0	3.8	3.9	4570.1
F250 / F350 - Hydrant Truck	Gasoline	15.1	0.1	1.3	1.4	8818.0
Stewart & Stevenson TUG MA 50 - Baggage Tractor	Gasoline	55.8	0.3	4.8	5.2	32314.6
"Stewart & Stevenson TUG GT-35 MC - Aircraft Tractor"	Gasoline	11.7	0.1	1.0	1.1	6608.8
F250 / F350 - Hydrant Truck	Diesel	101.7	0.1	12.6	13.0	11194.7
Eagle Bobtail / F350 - Bobtail	Gasoline	8.3	0.0	0.7	0.8	4882.1
"F750 Dukes Transportation Services DART 3000 to 6000 gallon - Fuel Truck"	Diesel	10.9	0.0	1.1	1.2	2385.9
(None specified. EPA default data used.) - Lift	Gasoline	10.0	0.1	0.9	0.9	5798.6
"TLD 28 VDC - Ground Power Unit"	Diesel	77.9	0.0	6.7	6.9	7105.4
FMC Commander 15 - Cargo Loader	Diesel	6.6	0.0	1.2	1.2	1226.3
Total		**331.2**	**0.7**	**34.1**	**35.6**	**84,904**

Specification of Tools and Models

- AEDT 2022. Aviation Environmental Design Tool, Version 3e. May 2022. Available at https://aedt.faa.gov/3e_information.aspx
- Jae Kim, Mansour Rahimi & Josh Newell (2012): Life-Cycle Emissions from Port Electrification: A Case Study of Cargo Handling Tractors at the Port of Los Angeles, International Journal of Sustainable Transportation, 6:6, 321-337. Available online at: http://urbansustainability.snre.umich.edu/wp-content/uploads/2012/10/Life-Cycle-Emissions-from-Port-Electification-A-Case-Study-of-Cargo-Handling-Tractors-at-the-Port-of-Los-Angeles.pdf
- Vehicle inventories for projections were pulled from Port Authority's airport license plating database and based on conversion trends tracked in through the ZAEV Rule Technology Workgroup on Commercial Availability. (https://www.panynj.gov/content/dam/airports/pdfs/final-TWG-technical-report.pdf)

Implementation Assumptions

This analysis assumes that electric ground support equipment will be ordered and delivered in three groups. The first group will come online in January 2028, followed by the second group in the middle of 2028 and the final group in early 2029. The equipment types are estimated based on existing inventory, commercial availability projections, and traditional fleet transition rates. The actual vehicle type make up may vary based on voucher requests and scoring to get the best available GHG reductions per voucher dollar.

GHG Reduction Estimate Assumptions

These analyses are built on current emission factors, not forecasts of emission factors in the future. This means that improvements in vehicle efficiency and electricity decarbonization in the 2025-2050 period are not being captured. This was done because there is significant uncertainty in these types of estimates, and in some cases the results will at least somewhat cancel each other out. For example, both a gasoline and an electric light-duty vehicle will have lower emissions in 2030 than today. GHG emissions from electrified GSE is assumed to be 33% of gasoline/diesel powered equipment (Kim, 2012). This is a conservative estimate, as the electricity grid is significantly cleaner than it was when this study was performed, and grid decarbonization will continue through the study period. CAP emissions from electricity are not included in this analysis. These emissions would not necessarily occur on Port Authority property, and may be far away from population centers, making such emissions much less relevant.

Reference case scenario (GHG emission or activity level)

The annual emissions savings of the electrified GSE in this analysis is 7,319 tons of CO_2. That represents a 3% reduction in CO_2 emissions from Port Authority's entire GSE fleet (251,000 tons CO_2 in 2022). GSE emissions typically do not vary significantly year to year, and this is useful as a baseline forecast for annual GHG emissions from GSE in future years.

Measure specific activity data

These analyses assume that electric vehicles or equipment will be used the same amount (in terms of hours or miles) as the vehicles they are replacing. In the case of GSE, this seems like a safe assumption, as the key factor is the amount of work that needs doing, not vehicle capabilities.

GHG emissions reduced

- **2025-2030: <u>17,703 metric tons (30% to account for voucher cost of vehicle)</u>**
- **2025-2050: <u>80,344 metric tons (30% to account for voucher cost of vehicle)</u>**

Uncertainties Associated with Estimates or Key Assumptions

The assumption that these vehicles will only last 10-14 years comes from AEDT default equipment lifetimes. Actual experience with the PA fleet is that most equipment lasts longer than this, so cumulative GHG savings for the 2025-2050 period may significantly underestimate the savings achieved from electric GSE.