Philadelphia's Municipal Clean Fleet Plan

October 2021

City of Philadelphia


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ONE WAY
NO TURN ON RED
12th St
POLICE
KLN-3278

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Abbreviations, Acronyms, and Definitions

Electric Vehicle (EV): A vehicle powered at least in part by electricity, usually from an on-board battery – a Battery Electric Vehicle (BEV), Plug-in Hybrid Electric Vehicle, or (rarely) a Hybrid Electric Vehicle (HEV).

> **Battery Electric Vehicle (BEV):** A vehicle solely powered by electricity which has no internal combustion engine. It must be charged from a utility power supply and includes regenerative braking technology. An example of this vehicle would be the Chevrolet Bolt.
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> **Hybrid Electric Vehicle (HEV):** A vehicle with an internal combustion engine (ICE) which runs on gasoline or diesel. The vehicle has a regenerative braking system which captures energy as it slows down, stores it in a small battery, and then uses it to provide a boost to the vehicle upon subsequent acceleration. All power for the vehicle originates from gasoline or diesel. The hybrid technology only serves to improve fuel efficiency. An example of this vehicle would be a Toyota Prius.
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> **Plug-in Hybrid Electric Vehicle (PHEV):** A vehicle with the features of the HEV except the onboard battery is slightly larger and can be charged from a utility power supply while parked. Thus, these vehicles can be powered by gasoline or directly by grid charging. An example of this vehicle would be a Ford Fusion Energi.

Electric Vehicle Supply (or Support) Equipment (EVSE): A free-standing or mounted piece of equipment which supplies electric energy from a power source for the safe resupply (charging) of electric vehicle (EV) batteries. Typically referred to as charging stations with one of more units/'heads' or ports, EVSE is often categorized by level which specifies the voltage input. For the City's immediate purposes, levels are simplified as follows: Level 1 (AC, alternating current) at 120V; Level 2 AC at up to 240V; and Level 3 (DC, direct current) at 400-600+V. The most popular types of charging/plug connectors are the SAE J1772 for Level 1 and 2 charging, and CHAdeMO or CCS for Level 3 charging.

EV-Capable Space: Capable of future Level 2 charging infrastructure installation. Installed electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for each parking space and the installation of continuous raceways, from the panel to the intended EV parking space. Foundational electrical capacity installed but lacks conduit to an electrical outlet with required voltage and amperage.

EV-Ready Space: A parking space with installed electrical panel capacity (EV-Capable, as above) for future Level 2 charging infrastructure installation, in close proximity to a conduit terminating in a junction box (with service loop) or a 240-volt charging outlet. Ready for installation of charging station equipment to supply electrical power for an EV. Overcurrent protection devices are also recommended.

EVSE-Installed Space: A vehicle parking space with completed EV-Capable and EVSE-Ready work, with fully operational Level 2 charging station already installed.

Fossil-Fuel-Free (F3): As per the City of Seattle Green Fleet Plan – 'Liquid fuels that are renewable hydrocarbon biofuels (also called "green" hydrocarbons, bio-hydrocarbons, drop-in biofuels and sustainable or advanced hydrocarbon biofuels).'

Internal Combustion Engine (ICE) vehicle: A vehicle whose propulsion is powered by the combustion (burning) of fuel and oxidant which produces heat and power – as well as carbon monoxide, nitrogen oxides, hydrocarbons, other pollutant vapors, and greenhouse gases.

Metric Tons of Carbon Dioxide Equivalents (MTCDE or MT CO2e): A metric measure used to compare the emissions from various greenhouse gases based on their global warming potential.

Executive Summary

Background and Context

In January of 2021, Mayor Jim Kenney announced Philadelphia's commitment to achieving carbon neutrality by 2050, along with the release of the City of Philadelphia's Climate Action Playbook. This goal requires the elimination of emissions in the buildings, energy, transportation, and waste sectors by 2050 and is in line with what experts indicate is needed to prevent the worst effects of climate change.

Nationally, transportation is the largest source of carbon emissions. This is why the Biden Administration has prioritized vehicle electrification in its efforts to address climate change and to protect and grow American jobs. Government agencies around the country are transitioning their fleets and seeing the benefits of doing so, including major operational savings. Auto manufacturers are also getting in the game, such as General Motors who announced their plans to stop making gas-powered cars by 2035

The City of Philadelphia's Municipal Clean Fleet Plan lays out a strategy to transition the City's fleet- which represents around 13% of the municipal government's carbon footprint- to clean and electric vehicles. This transition will allow the City to lead by example in reducing carbon pollution. But additionally, the transition will allow the City to achieve cost savings, to support local job creation, and to enhance Philadelphia's competitiveness among peer cities.

It is no small feat to transition a large fleet that serves many functions. This Plan provides guidance and recommendations that will ensure the City's fleet transition is cost-effective and results in tangible outcomes. An overview of the recommendations is provided in the Action Plan below.

This Plan is the culmination of multiple analyses which considered the City's current fleet, its vehicle and supporting infrastructure procurement projections, the current electric vehicle market, and future trends in transportation electrification. The plan draws heavily from reports produced by two city consultants (Wilson Engineering Services/WES, see Appendix B; and ICF's Infrastructure Analysis, see Appendix C) which reviewed the 2020 market for vehicles and fuels and made projections on charging infrastructure needs to support a zero-emissions fleet. The plan is also supported by regional efforts like Pennsylvania's participation in the multi-state Memorandum of Understanding on medium- and heavy-duty electric vehicles and the Pennsylvania Department of Environmental Protection's Alternative Fuels Incentive Grant (AFIG) program.

Action Plan: Clean Fleet Recommendations

The following provides a summary of the recommendations outlined within the body of this Clean Fleet Plan, for both fleet vehicles and necessary supply infrastructure. The Plan prioritizes the electrification of Philadelphia's fleet to achieve reduced operating costs and emissions, in line with the City's goal for carbon neutrality by the year 2050.

1. Adopt goals for the fleet that will provide a pathway to zero emissions:

- By 2025, lay out a procurement strategy to achieve 100% procurement of EVs for sedans, sport utility vehicles (SUVs), vans, and light duty pickup trucks by 2030.
- By 2030, reduce light- and medium-duty vehicle emissions by at least 45% from 2019 levels by transitioning to zero-emissions electric vehicles (EVs).
- Procure no new fossil-fuel consuming vehicles after 2030

2. Institute a Clean Fleet Procurement Policy

This procurement policy will support the above goals by establishing a vehicle procurement hierarchy that prioritizes battery electric vehicles (fairly strictly for light- and medium-duty vehicle classes) and discourages gas- and diesel-fueled vehicles (with some flexibility for heavy-duty classes). The policy would also aim to reduce the overall size of the fleet and the share of SUVs.

3. Limit procurement of medium and heavy-duty vehicles in the short term; pilot new fuels or procure CNG vehicles where feasible

This recommendation is meant to support achievement of the procurement targets listed as part of #1 above, and to move towards piloting new fossil-free fuels including electricity, hydrogen, and renewable diesel, and to scale them when effective.

4. Conduct an EV suitability assessment

Using fleet telematics and data analysis is a best practice for supporting data-driven fleet electrification on a mass scale. For example, an EV suitability assessment conducted for the City of Columbus, OH informed its deployment of over 300 electric vehicles between 2018 and 2020, along with the required charging infrastructure.

5. Establish a Clean Fleet Committee (CFC) to support infrastructure coordination and to track goals

This Committee will track progress and refine implementation of the Plan. It would meet at least semiannually and include representatives from Office of Fleet Management; Procurement Department; Office of Transportation, Infrastructure, and Sustainability; Department of Public Property; the Office of Sustainability / Energy Office; Fleet Liaisons from various departments. and other stakeholders as needed.

6. Develop funding programs to connect capital procurement and fuel cost/operational savings

Capturing and tracking data as the City fleet progresses towards electrification will be essential for demonstrating success. Accrued vehicle fuel and maintenance savings should be used to offset the price differential between an internal combustion engine (ICE) vehicle and its comparable EV equivalent in future procurements.

7. Optimize Alternative Fueling and EVSE Infrastructure

- Moderately expand compressed natural gas (CNG); focus on deploying renewable natural gas (RNG) – The City should explore ways to procure RNG for its current CNG-fueling facility, which should be expanded to its full capacity.

- Evaluate E85 or B20 Fueling Locations – Consolidate flex-fuel capable vehicle refueling to E85/B20 fueling locations.

- Consolidate Alternative Fuel infrastructure and EVSE management under a single department and expand staffing support appropriately – Currently, EVSE is installed and managed by the department owning the EV. There is no coordinated strategy for EVSE deployment or use. Given the cross-cutting nature of plan implementation, the Managing Director's Office should oversee the Clean Fleet Committee and designate that body to manage all aspects of EVSE with appropriate staffing. A full time staff position should be hired as soon as possible, but no later than FY23.

- Develop an EVSE deployment scenario; expand dual-port Level 2 charging availability at locations – The Clean Fleet Committee should use the EV Charging Infrastructure Analysis Tool to complete a 10-year EVSE deployment framework and begin expanding EVSE installation immediately. The City is encouraged to simplify and streamline its internal EV charging infrastructure permitting process to facilitate this rapid infrastructure buildout, and also to require new and renovated municipal facilities to be 'EV-ready' in order to minimize the costs of installing charging infrastructure at those sites in the future.

Emissions Impacts of Recommended Targets

In 2017, light and medium duty vehicles, which are the fleet's primary users of gasoline, emitted 26,441 Metric Tons CO2e, or slightly over half of the city fleet's greenhouse gas emissions (see Wilson Engineering Services/WES Report, Appendix B). If the City of Philadelphia achieves 100% procurement of clean energy for municipal operations by 2030 and adopts the recommended targets for light and medium-duty vehicle electrification, greenhouse gas (GHG) emissions for the light and medium duty fleet are estimated to decline by 47%.

Table 1. *Estimated Fuel Reduction and Emissions Impacts of Recommended Targets*

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gallons Gasoline Avoided Annually	20,000	49,000	53,000	87,000	147,000	218,000	376,000	687,000	1,068,000	1,429,000
Metric Tons CO2e Avoided Annually	148	369	409	670	1,146	1,707	2,955	5,416	8,424	11,281
% Reduction of CO2e from '17 Baseline for Gasoline Vehicles	0.5%	1.3%	1.5%	2.4%	4.2%	6.2%	10.9%	20.1%	31.6%	42.7%

Cost Impacts of Recommended Targets

Tables 11 and 12 highlight the projected total costs for the vehicle purchasing scenario illustrated between 2021 and 2030, with and without state incentives. Based on available vehicle model prices and projected cost trends, BEV sedans are projected to reach cost parity with conventional vehicles by 2025, whereas electric SUVs, pickup trucks, and vans are projected to remain more expensive than conventional vehicles through 2030. All cost assumptions are documented at the end of this section.

Based on the cost assumptions documented at the end of this section, it's estimated that the vehicle electrification scenario articulated in this Plan would incrementally cost the city \$7M between 2021 and 2030 in capital costs, and save the city \$2.5M in operating costs over that same time period. If the city could leverage available state incentives through the AFIG and Driving PA Forward programs, the city could potentially save on capital costs in the same time period.

EV Charging Considerations

The City's strategy around siting and deploying vehicle charging equipment should focus on 'future-proofing,' or meeting the needs of electric vehicles that will join the fleet not just imminently but in the longer term. It is recommended that the City consolidate and reduce installation costs as much as possible by installing the total required electrical capacity and conduit during the first set of installments.

The Infrastructure Analysis confirms that a 2:1 vehicle-to-plug equipment sharing would effectively cut project costs in half (as opposed to a 1:1 vehicle-to-charger ratio), but there still exist logistical challenges associated with sharing charge ports between vehicles, at least in the near term. To improve this type of analysis moving forward, it is recommended that the City collect parking location data from more fleet vehicles. Fleet telematics capture, as part of an EV Suitability Assessment, would satisfy this data need.

Introduction

The fundamental role of the City of Philadelphia is to provide essential services and amenities to Philadelphians. The City pumps clean drinking water to residents, collects garbage and recycling, maintains a system of parks, and much more. Yet, none of this would be possible without a highly diversified fleet of municipal vehicles or the tireless work of the Office of Fleet Management (OFM), which procures and services these vehicles across 43 City departments.

The municipal fleet deserves significant attention because it represents both an asset and liability. The vehicles are critical because they enable tasks that allow the City to successfully function. But the fleet also costs the City significant sums of money in terms of upfront procurement costs and ongoing maintenance and fueling. More critically, the current fleet, which runs almost exclusively on gasoline and diesel, is a significant emitter of carbon and other dangerous pollutants. Although low- and zero-emission vehicle technologies have been around for decades, they have not always been widely commercially available or viable. However, the future is set to be electric, with more and more auto-manufacturers debuting all-electric vehicle models and committing to phasing-out combustion-engine vehicle production within the next one or two decades. As these vehicles become more mainstream, and the impetus to improve air quality and reduce greenhouse gas (GHG) emissions from City operations becomes more pressing, it is essential that the City reassesses its procurement opportunities with the goal of keeping pace with industry-wide shifts by incorporating these low-emissions technologies into the City fleet.

This Municipal Clean Fleet Plan is based on the latest available data from OFM on the City's vehicle composition, and seeks to provide a more robust view of how OFM can procure vehicles which pollute less, have lower maintenance and fueling costs, and act as a beacon of sustainability for all of Philadelphia. This plan draws heavily from reports produced by two city consultants (Wilson Engineering Services/WES, see Appendix B; and ICF's Infrastructure Analysis, see Appendix C) which review the 2020 market for vehicles and fuels and make projections on charging infrastructure needs to support a zero-emissions fleet. ICF additionally developed a Charging Infrastructure Analysis Tool to support this Clean Fleet Plan, for which they conducted EV charging equipment location analysis based on parking location data available from the City. Using more current data to analyze immediate fleet electrification opportunities and associated carbon-emissions savings across all vehicle classes, the Dashboard for Rapid Vehicle Electrification (DRVE) Tool was also deployed — this report can be found in Appendix A.

Philadelphia's municipal fleet represents about 13% of the City's carbon footprint due to its reliance on fossil fuels. By transitioning away from fossil fuel-powered vehicles and being more thoughtful about efficient vehicle procurement and how this matches operational needs, the City will be one step closer to meeting its goal of becoming carbon neutral by 2050.

The City of Philadelphia Clean Fleet Plan recommends pursuing an electrification procurement schedule, which would allow the City to pursue a 100% EV procurement plan by 2030, generating up to $12,000,000 in total cost and operational savings; a 20% savings compared to a continued procurement plan of internal combustion engine-only vehicles.

Current Fleet and Procurement Process

Fleet Makeup

As of January 2020, the City of Philadelphia owned a fleet of approximately 5,500 vehicles which assist City workers in performing a variety of services. These vehicles are spread across 43 departments within the City and vary in terms of vehicle class and fuel type (Figure 1 and Figure 2).

Figure 1. *Vehicle Count by Department*

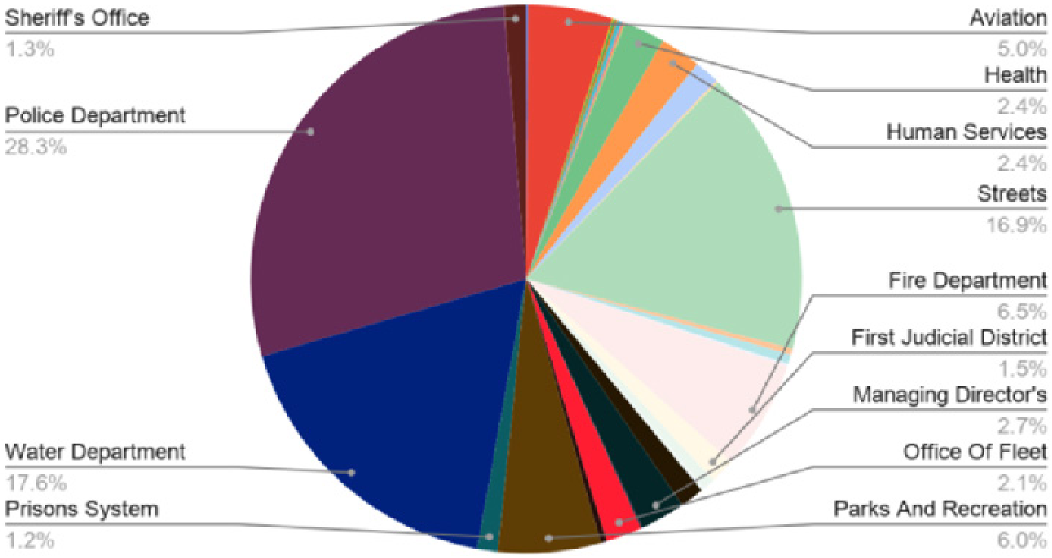
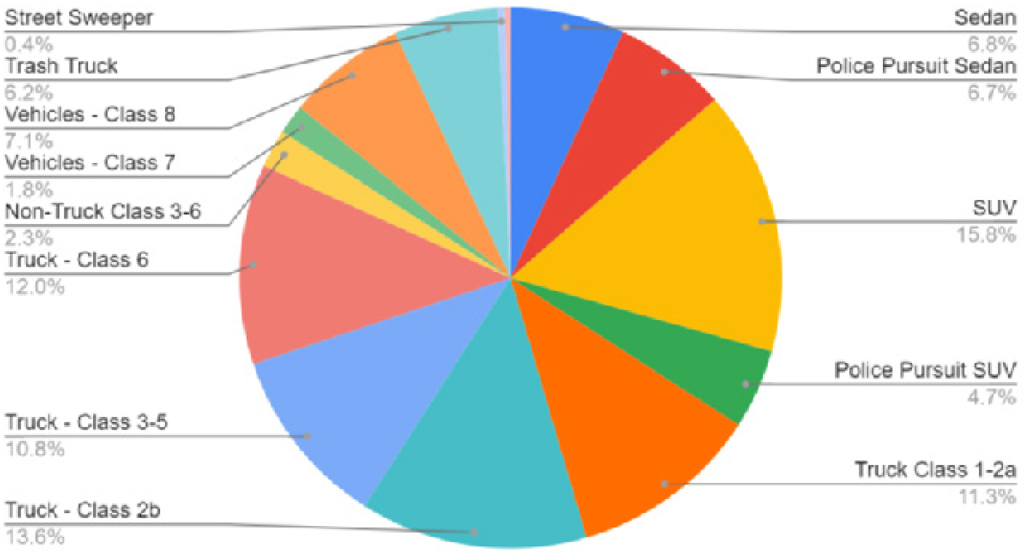


Figure 2. *Vehicle Count by Class Size*



Three key takeaways from these figures:

1. **Light-duty trucks comprise almost double the number of sedans, and many could be right-sized to allow for electrification.** While sedans present an immediate and easy opportunity to transition to electric vehicles, they are only 6.8% of the (non-Police) fleet. Over 11% of the City fleet consists of light-duty trucks (Class 1-2a), the smallest and lightest of trucks which are rarely used for towing and hauling. Pursuing vehicle right-sizing exercises with the light-duty trucks is an opportunity to further transition some of these to smaller vehicles more suited for electrification. Additionally, auto manufacturers are preparing to debut several electric truck models (light-duty and otherwise), which bodes well for electrification of this vehicle class in the next 3-5 years.

2. **SUVs may also benefit from vehicle right-sizing exercises.** The share of SUVs in the fleet has grown significantly in the past decade, from about 14% in 2010 to over 19% in 2020. SUVs are heavier vehicles and use more fuel per mile than a sedan, thereby reducing the average fuel efficiency of the fleet, even if transitioned to cleaner vehicles. Identifying opportunities to right-size these SUVs to lighter-duty, more fuel-efficient vehicles — without impacting service delivery — presents an opening to significantly decrease fuel consumption through electrification. Reducing the number of SUVs in the city fleet (transitioning these vehicles to sedans as possible) also provides an opportunity for Philadelphia to lead by example with respect to the Office of Transportation and Infrastructure Systems' (oTIS) Vision Zero goals. SUVs are more often involved in crash fatalities and injuries, and calls are growing to limit the size and scope of these larger vehicles on city streets.

3. **Police and other emergency vehicles are considered separately from other vehicles and are a significant share of the fleet.** These vehicles are considered in their own category, since compromising on performance or responsiveness may directly lead to public safety issues. They often have longer and more erratic duty cycles and may require special consideration when transitioning to alternative fuels. While their special operational needs must be considered, their large share of the fleet indicates that they too will eventually need to transition in order for the City to reach its climate goals.

Along with vehicle right-sizing exercises, efforts to downsize the fleet by leveraging alternative transport options for city staff — such as the city contract for car-sharing services or pre-tax transit benefits that staff may use in lieu of pool vehicles — can also help eliminate underutilized fleet assets. These strategies can provide an avenue to increase efficiency, as well as the number of electric miles travelled by staff (if the car-share service includes electric vehicles).

Overview of the Fleet Vehicle Lifecycle

This section describes the key steps in a City fleet vehicle's lifecycle, for both conventional internal combustion engine (ICE) vehicles and electric vehicles.

Table 2. *Fleet Vehicle Lifecycle Comparison*

	Internal Combustion Engine (ICE) Vehicles	Electric Vehicles (EVs)
Procurement	Departments have "fleet liaisons" which relay the needs of staff to OFM, which then uses capital funds from its budget to procure the vehicles requested by these liaisons.	The same as ICE Vehicles.
Use	Departments use vehicles — these are either assigned to a specific staff member or pooled across a department — to meet their operational needs. With funding from OFM's operating budget, drivers fill up their tanks at City-owned fueling sites.	The Department of Public Property (DPP) pays for electricity. EV charging stations are procured, and the department receiving the EV is responsible for installation of the charging equipment. The electricity supply for the vehicle is not sub-metered, it is included in the whole building mix.
Maintenance & Repairs	OFM employs in-house mechanics to ensure vehicles perform optimally and complete necessary repairs. OFM may also contract out for services.	The same as for ICE vehicles. OFM has specific shops and trained staff who can work on EVs.
Retirement	OFM "flags for retirement" vehicles based on age, mileage, parts availability problems and life-to-date maintenance cost. After a unit is flagged it still remains active, though it's closely examined when maintenance work is done. A flagged vehicle will only be relinquished if it requires a major repair, such as an engine failure, transmission failure, rear differential failure, or collision damage. These vehicles are then sold at auction.	The same outlet as for ICE vehicles (auction), though it is recommended that warranty coverage (currently at least 8 years/100,000 miles) be the primary driver for EV replacement cycles. This is a good way to protect against any battery defect, and vehicles that sill have 12 months or more of factory warranty left will fetch significantly more at auction than like models that are out of the warranty period.

Fleet Fuel Use and Emissions

Certain offices and departments use more fuel than others to provide their services, with fuel use intensity being highest in departments which utilize heavy duty vehicles, such as Streets and Fire. Table 3 shows fuel use consumption and associated emissions for each of the top 13 fuel-consuming City departments. These departments represent 98% of all fuel consumption by the City. Based on the corresponding 2017 City Government GHG Inventory (see Appendix B, Table 3), the municipal fleet represents about 13% of the City's carbon footprint due to its reliance on fossil fuels. See Appendix B for more information on vehicle ownership patterns among the 13 departments with the greatest vehicle use based on fuel consumption.

Table 3. Top Fuel Consuming Departments in Descending Order by Total Gallons (2017)

Department	Average Vehicle Age	Total Gallons (Gasoline & Diesel)	Number of Vehicles	Gallons Per Vehicle	MTCDE
Police	4	1,926,224	1,556	1,238	15,264
Streets	6	1,539,764	811	1,899	14,387
Water	6	768,358	896	858	6,693
Fire	8	638,514	354	1,804	5,952
Parks & Recreation	8	219,170	318	689	1,853
Commerce/ Division of Aviation	9	200,006	310	645	1,729
Fleet Management	11	109,342	116	943	913
Managing Director's Office	7	89,976	131	687	757
Human Services	6	69,989	105	667	553
Sheriff's Office	5	68,734	69	996	564
Prisons	6	62,978	67	940	508
Public Health	6	53,840	117	460	429
Public Property	6	51,374	82	627	421

Key Takeaways

- Data on annual vehicle miles driven was not available, which would shed more light on the level of vehicle utilization in each department. However, **this chart still provides a good indication of the range of fuel savings and GHG emissions reductions that could be achieved** by the replacement of a single vehicle with a more efficient vehicle.

- Excluding in total the Police/Fire/Sheriff's Departments, which have an outsized effect given their fuel intensity, 45% of the City's emissions are accounted for in the table. The Police and Sheriff Departments' fleets have the shortest average vehicle replacement times, and so these should be evaluated closely year-over-year for opportunities to transition to electric. Given the fuel intensity of the Police Department, and market developments which continue to maximize EV range and performance with respect to the operational needs for this department's vehicles, **electrification of the Police fleet is something that should be anticipated, not dismissed.** Other police departments have successfully introduced electric vehicles into their fleets, such as Holland, MI; Eden Prairie, MN; Windham County, VT; Logan, OH; Bargersville, IN; Westport, CT; Hyattsville, MD; Hastings-on-Hudson, NY; Spokane, WA; and Brookhaven, GA, to name a few.
- Both **the Water Department and Parks and Recreation Department present good opportunities for vehicle electrification**, given their fuel use intensity and average vehicle age. In other cities, these departments have traditionally been one of the first to adopt electric vehicles, given the associated applications, vehicle size, average vehicle age, and opportunity for leadership with zero-emission vehicle deployment given those departments' roles.
- Outside of the Sheriff's Office, the Police Department, and the Fire Department, **the Streets Department presents the largest fuel use intensity (gallons per vehicle per year)**, which translates to the biggest opportunity for GHG savings through fleet electrification. This department utilizes many heavy duty vehicles, so maximizing the electrification opportunities in this fleet stands to improve the Department's overall emissions and fuel intensity. The same rationale applies for departments with longer average vehicle ages, such as Commerce/Aviation, or the Office of Fleet Management. The Office of Fleet Management also deploys many SUVs, providing another good reason to explore aggressive electrification.

Additionally, the City's gasoline and diesel costs have risen by $2.3M dollars in the three years from 2017-2020, despite seeing a net decrease in consumption over that time. Between the years in question, the fleet added about 100 new vehicles while gasoline and diesel prices rose by an average of $0.60/gallon.

Table 4. *City of Philadelphia Gasoline and Diesel costs (2017, 2020)*

	2017		2020	
	Gallons	**Cost**	**Gallons**	**Cost**
Gasoline	4,064,843	$6,357,330	3,838,215	$7,537,575
Diesel	3,087,162	$4,919,464	2,758,168	$6,048,706
Total	7,152,005	$11,276,794	6,596,383	$13,586,280
		Total Change	- 555,622	$2,309,486
		% Change	- 7.8%	20.5%

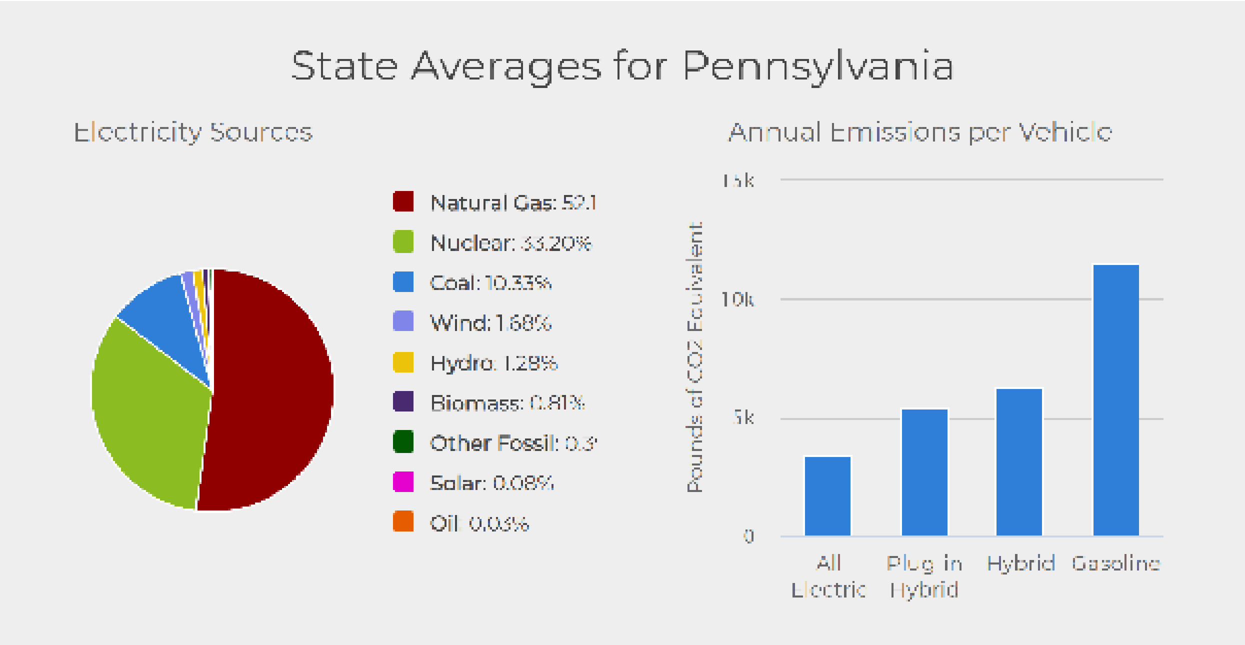
Efficiency is the hallmark of cost-savings, and this mantra must be prioritized by sizing vehicles appropriately for their duties, reducing the city's overall fleet size, and reducing the use of price-volatile fuels. Employing electricity as a widely-used transportation fuel is more efficient and supports domestically produced energy which is free from the national security risks posed by price-volatile international markets.

Alternative Fuel & Vehicles

Various fuels differ in terms of associated emissions, cost, energy density, supply, infrastructure needs, extraction and refinement methods, and geographic availability, amongst other factors. GHG emissions from transportation fuels were evaluated on the basis of Scope 1 and Scope 2 emissions, in accordance with the Climate Registry and the GHG Protocol Corporate Standard. Scope 1 is defined as carbon dioxide equivalents emitted due to direct combustion at the point of use. Scope 2 is defined as emissions due to purchase of grid electricity.

While electricity ranks among the lowest for net Scope 1 and Scope 2 GHG emissions (see Appendix B), it is critical to note that electric vehicles have Scope 2 emissions because EVs charge from the electricity generated in the immediate grid region, which contains natural gas and coal plants. Yet, when the City sources electricity solely from renewable energy — which is the City's goal by 2030 — electric vehicle Scope 2 emissions would essentially drop to zero. Despite currently having Scope 2 emissions, EVs are still found to produce at least 68% fewer GHG emissions than gasoline vehicles in Pennsylvania.

Figure 3. Electricity Sources and Emissions – Averages for Pennsylvania

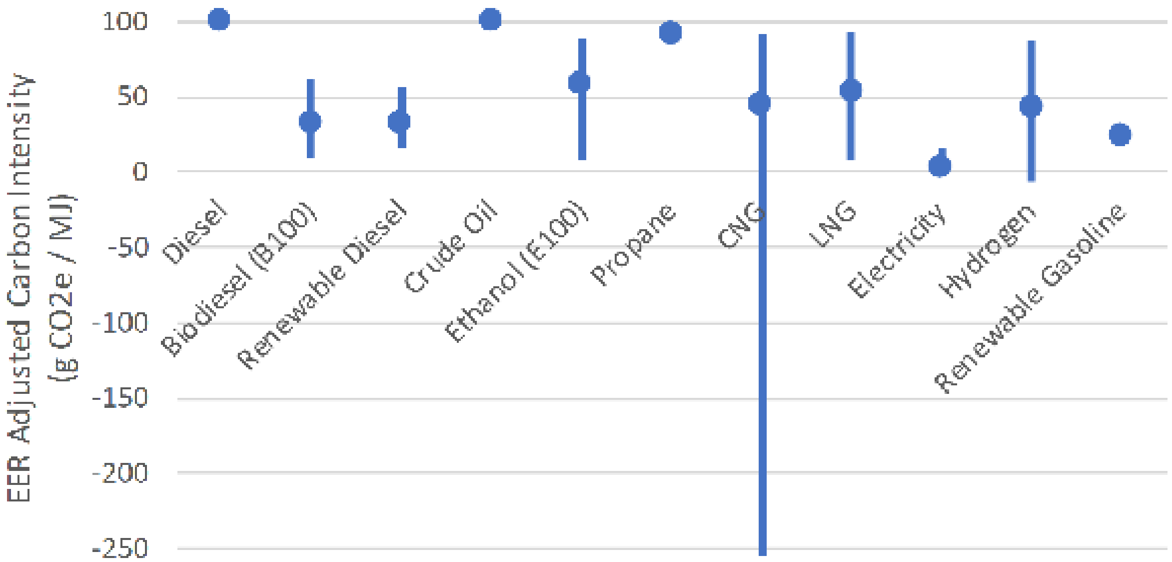


Source: Alternative Fuels Data Center

Clean transportation fuels are also evaluated on the basis of lifecycle emissions using pathways certified by the California Low Carbon Fuel Standard (LCFS). Figure 4 shows the GHG emissions for each fuel relative to the energy content of the fuel, adjusted for the energy efficiency ratio (EER) of the vehicle. In general, EER is an apples-to-apples comparison of emissions per energy unit. For liquid and gaseous fuel sources, total energy content (measured in British Thermal Units, BTUs) in each relative unit is converted.

The possible negative emissions from certain compressed natural gas (CNG) pathways are based on using renewable natural gas (RNG) produced by an anaerobic digester processing animal waste, which otherwise would have created uncontrolled methane emissions during decomposition. However, there exists a very limited supply of renewable natural gas (RNG) from waste — and when used in vehicles, natural gas provides limited climate benefits compared with diesel. Fueling heavy-duty trucks with RNG instead of diesel still involves the combustion of methane in the vehicle, emitting carbon dioxide, carbon monoxide, and nitrogen oxides. Anaerobic digesters also leak methane, at a rate of between 2 and 3 percent — a 2012 study by the National Academy of Sciences found that, if the leakage rate in natural gas pipelines exceeds 1.4%, the climate benefits of switching from diesel to RNG are negated. See Appendix B, for more information on the alternative fuel technologies evaluated for Philadelphia.

Figure 4. *EER Adjusted Carbon Intensity for Selected Transportation Technologies*



Note: Data from CA LCFS certified pathways as of 11/5/2019. EERs obtained from the CA LCFS Credit Price Calculator version 1.3. EER based on LCFS default values of 1 for gasoline, ethanol, and diesel, 0.9 for propane replacing diesel, 1 for CNG and LNG used in a heavy duty compression ignition engine, 5 for an electric heavy duty vehicle, and 1.9 for a hydrogen fuel cell heavy duty vehicle. Electricity emissions are based on usage in CA: the high value for electric represents the default CA grid while the lower values represent wind or solar derived electricity. Ethanol and biodiesel blends will have a blended carbon intensity.

Currently, only a small percent of the City's fleet runs on alternative fuels, including EVs, CNG, and 85% E85. Table 5 lists the alternative fuel vehicles in the City's fleet. Although the City has many flex fuel vehicles that can use E85, it is assumed these vehicles are fueled with conventional E10 gasoline.

Table 5. *Alternative Fuel Vehicles in Philadelphia Fleet*

Fuel Type	Count
E85	1,227
Hybrid EV (HEV)	394
Battery EV (BEV)	49
Plug-In Hybrid EV (PHEV)	33
CNG	16

In terms of individual vehicles, analysis revealed that the City's FY 2019 combined hybrid-electric (HEV) and battery-electric vehicles (BEV) purchases (103 vehicles total) reduced the City's annual GHG emissions by 305 MTCDE, approximately 0.6% of the City's total vehicle emissions as of 2017. This offset is an estimate based on the average GHG emissions of all gasoline vehicles in the fleet — including police cars — and it does not take into account the specific departments or use cases of these new vehicles. See Table 6 below, which provides an example of the amount of annual GHG emissions offset with the purchase (or retrofit) of a single light-duty gasoline vehicle using selected clean transportation technologies.

Table 6. *Annual GHG Reduction Potential for Light Duty Vehicles*

Measure	GHG Savings	MT CO2e Avoided Per Vehicle
BEV	70%	5.2
Anti-Idle	5%	0.4
E85	35%	2.6
HEV	37%	2.7

The City purchased its first hybrid-electric vehicle (HEV) in 2004 and has steadily increased annual purchases of this vehicle type. In FY19, the City purchased 93 HEVs, making it their highest annual HEV purchase year. In FY14, the City acquired its first Plug-in Hybrid Electric Vehicle (PHEV), and in FY18, the City acquired its first Battery-Electric Vehicle (BEV). Currently, the City has 394 HEVs, 49 BEVs, and 33 PHEVs in its fleet. The City also procured four CNG-fueled trash trucks and has another 21 being delivered by summer 2021.

EV Adoption Potential and Benefits

For the majority of City departments, the percent of vehicles which are hybrid or electric is between 3% and 8% — but the Department of Public Health (DPH) has 39% hybrid or electric vehicles, likely prompted by the opportunity to lead by example with low-emission vehicle deployment given the department's public health focus. Many departmental fleets are comprised of less than 4% PHEVs and BEVs, with the Department of Health and Department of Prisons at 12% and 8%, respectively.

EVs are a key solution to reducing both GHG emissions and operational costs associated with the City's fleet, most immediately for the light-duty sedans and trucks required by certain City staff. Beyond these benefits, EVs present other long-term advantages, including:

- **Cost competitiveness with comparable ICE vehicles over five-year time horizon:** EV prices have dropped significantly over the past decade. Looking at vehicle costs over the first five years of ownership, EVs are extremely competitive with ICEs. Although capital costs will still be a factor initially, EV technology for all light-duty classes is expected to reach price parity with comparable ICE vehicles in the next 5-10 years.

- **Reduced maintenance and upkeep:** The reduced cost of upkeep is factored into the five-year cost estimates. With fewer moving parts, EVs require less maintenance which allows these vehicles to stay in operational rotation longer, with fewer trips to the shop. The New York City Fleet, which has the most experience with electric vehicles on the East Coast, reported "dramatic" reductions in maintenance costs when compared with gas, hybrid, and hybrid plug-in models after a year-long review in 2018. Annual maintenance costs for the fleet's all-electric vehicles ranged from $204 with the Chevrolet Bolt to $386 with the Ford Focus Electric.

- **Less fuel price volatility:** Volatility and uncertainty in international oil markets lead to unstable and higher long-term costs for operating ICEs, which can pose an economic burden on the City in addition to a national security threat. Electricity is domestically produced (increasingly from renewable sources like solar and wind) with low, predictable rates, which provides for cost-stable fleet fueling free from volatile price swings to which petroleum-based fuels are especially subject. Electricity costs are also a fraction of petroleum fuel prices, leading to a minimum of 50-56% operational savings from fuel switching alone, in line with the Vehicle Cost Calculator from the Department of Energy's Alternative Fuels Data Center.

- **Improved local air quality:** Unlike fossil fuel vehicles, EVs have zero tailpipe emissions of air pollutants like nitrogen oxides (NOx) and carbon monoxide (CO), which can cause or exacerbate health-related issues, like asthma. Reduced emissions will improve local air quality and decrease related healthcare costs for Philadelphians.

Light and Medium Duty Fleet Electrification

Procurement Research and Emissions/Cost Analysis to Support 2030 Targets

This section analyzes ambitious yet feasible targets for light and medium duty fleet electrification for the city fleet between 2021 and 2030. Table 7 illustrates a recommended purchasing schedule that would include procuring 100% electric sedans, station wagons, and sport utility vehicles by 2025, and 75% electric radio patrol cars, unmarked police cars, pickup trucks, van cargo and passenger vehicles by 2030.

Table 7. Fleet EV Procurement Targets

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sedan and Station Wagon	75%	75%	75%	75%	100%	100%	100%	100%	100%	100%
Radio Patrol Car	25%	25%	25%	25%	50%	50%	75%	75%	75%	100%
Unmarked Police Car	25%	25%	25%	25%	50%	50%	75%	75%	75%	100%
Sport Utility Vehicle	25%	25%	50%	75%	100%	100%	100%	100%	100%	100%
Pickup Truck	0%	25%	25%	25%	50%	50%	75%	75%	75%	100%
Cargo and Passenger Van	0%	25%	25%	25%	50%	50%	75%	75%	75%	100%

The above analysis includes the 3,743 light and medium duty vehicles included in the ICF report (see Appendix C, Table 1), and utilizes ICF's analysis of when existing vehicles will need to be retired and replaced (Appendix C, Table 4). The analysis also utilizes ICF's EV eligibility criteria based on availability of EV alternatives, excluding for example large SUVs like Tahoes and Suburbans. **In total, 2,148 vehicles, or about 60% of the light and medium duty fleet, are included in the analysis as eligible to be replaced by an EV between 2021 and 2030.**

In total, about 60% of the light and medium duty fleet are included in the analysis as eligible to be replaced by an EV between 2021 and 2030

Table 8 summarizes the number of EVs that would be procured per year based on the estimated vehicles up for replacement that could be replaced by an EV, and the schedule of EV purchasing targets on page 20.

Table 8. *Fleet EV Procurement Estimates Per Year*

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sedan and Station Wagon	18	17	0	8	8	20	17	24	10	24
Radio Patrol Car	0	0	0	0	0	0	31	106	90	48
Unmarked Police Car	11	10	4	5	7	6	34	46	20	36
Sport Utility Vehicle	12	12	4	35	37	52	73	27	115	180
Pickup Truck	0	6	0	0	21	8	20	32	49	68
Cargo and Passenger Van	0	8	0	4	17	24	11	43	97	82
Total	41	53	8	52	90	110	186	278	381	438

Based on the procurement schedule outlined above, it is estimated that the light and medium duty in-service fleet would be **44% electric by 2030.** This is further illustrated in Table 9.

Table 9. *EV % of In-service Light and Medium Duty Fleet*

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sedan and Station Wagon	7%	13%	13%	15%	18%	25%	32%	40%	44%	52%
Radio Patrol Car	0%	0%	0%	0%	0%	0%	4%	19%	32%	39%
Unmarked Police Car	2%	4%	4%	6%	7%	8%	14%	22%	26%	32%
Sport Utility Vehicle	1%	2%	3%	6%	9%	14%	21%	23%	34%	51%
Pickup Truck	0%	1%	1%	1%	5%	7%	11%	17%	26%	40%
Cargo and Passenger Van	0%	1%	1%	2%	5%	9%	11%	18%	34%	47%
Total	1%	3%	3%	4%	7%	9%	14%	22%	32%	44%

By 2030, the recommended targets are estimated to reduce light and medium duty fleet GHG emissions by 47%

Emissions Impacts of Recommended Targets

In 2017, light and medium duty vehicles, which are the fleet's primary users of gasoline, emitted 26,441 metric tons of CO2e, or slightly over half of the city fleet's greenhouse gas emissions (see WES Report, Appendix B, Table 4). Based on the assumptions outlined in the upcoming sections, including the City's procurement of 100% clean energy for municipal operations by 2030, the following table summarizes the estimated emissions impacts of the recommended targets. By 2030, the recommended targets are estimated to **reduce light and medium duty fleet GHG emissions by 47%.**

Cost Impacts of Recommended Targets

Tables 11 and 12 highlight the projected total costs for the vehicle purchasing scenario illustrated on page 21. between 2021 and 2030, with and without state incentives. Based on available vehicle model prices and

Table 10. *Estimated Fuel Reduction and Emissions Impacts of Recommended Targets*

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gallons of Gasoline Avoided Annually	20,000	49,000	53,000	87,000	147,000	218,000	376,000	687,000	1,068,000	1,429,000
Metric Tons CO2e Avoided Annually	148	369	409	670	1,146	1,707	2,955	5,416	8,424	11,281
% Reduction of CO2e from '17 baseline for gasoline vehicles	0.5%	1.3%	1.5%	2.4%	4.2%	6.2%	10.9%	20.1%	31.6%	42.7%

projected cost trends, BEV sedans are projected to reach cost parity with conventional vehicles by 2025, whereas electric SUVs, pickup trucks, and vans are projected to remain more expensive than conventional vehicles through 2030. All cost assumptions are documented at the end of this section.

Based on these assumptions, it's estimated that the vehicle electrification scenario articulated above would incrementally cost the city $7M between 2021 and 2030 in capital costs and save the city $2.5M in operating costs over that same time period. If the city could leverage available state incentives through the AFIG and Driving PA Forward programs, the city could potentially save on capital costs in the same time period.

Table 11. *Total Fleet Transition Costs, 2021-2030 - Without Incentives*

	Capital costs		Operating costs		Total costs	
	Total - ICE	**Total - EV**	**Total - ICE**	**Total - EV**	**Total - ICE**	**Total - EV**
Sedan and Station Wagon	$4,120,000	$4,561,000	$447,000	$256,000	$4,567,000	$4,817,000
Radio Patrol Car*	-	-	$11,907,000	$10,498,000	$11,907,000	$10,498,000
Unmarked Police Car	$5,765,000	$5,518,000	$657,000	$362,000	$6,422,000	$5,880,000
Sport Utility Vehicle	$16,276,000	$19,537,000	$1,531,000	$783,000	$17,807,000	$20,320,000
Pickup Truck	$7,255,000	$10,349,000	$475,000	$251,000	$7,730,000	$10,600,000
Van Cargo and Passenger	$11,573,000	$12,708,000	$700,000	$390,000	$12,273,000	$13,098,000
Total	$44,989,000	$52,673,000	$15,717,000	$12,540,000	$60,706,000	$65,213,000
Difference (total)		$7,684,000		- $3,177,000		$4,507,000
Difference (%)		*17%*		*- 20%*		*7%*

**Because Radio Patrol Cars are not part of the Capital Budget, their cost of purchase is included within the Operating Costs.*

Table 12. *Total Fleet Transition Costs, 2021-2030 - With Incentives*

	Capital costs		Operating costs		Total costs	
	Total - ICE	**Total - EV**	**Total - ICE**	**Total - EV**	**Total - ICE**	**Total - EV**
Sedan and Station Wagon	$4,120,000	$3,135,000	$447,000	$256,000	$4,567,000	$3,391,000
Radio Patrol Car*	-	-	$11,907,000	$7,679,000	$11,907,000	$7,679,000
Unmarked Police Car	$5,765,000	$3,734,000	$657,000	$362,000	$6,422,000	$4,096,000
Sport Utility Vehicle	$16,276,000	$14,068,000	$1,531,000	$783,000	$17,807,000	$14,851,000
Pickup Truck	$7,255,000	$8,258,000	$475,000	$251,000	$7,730,000	$8,509,000
Van Cargo and Passenger	$11,573,000	$9,777,000	$700,000	$390,000	$12,273,000	$10,167,000
Total	$44,989,000	$38,972,000	$15,717,000	$9,721,000	$60,706,000	$48,693,000
Difference (total)		- $6,017,000		- $5,996,000		- $12,013,000
Difference (%)		*- 13%*		*- 38%*		*- 20%*

**Because Radio Patrol Cars are not part of the Capital Budget, their cost of purchase is included within the Operating Costs.*

Table 13 highlights key assumptions utilized to estimate the emissions and cost impacts of the proposed light and medium duty electric vehicle purchasing schedule detailed in Table 12.

Table 13. Cost and Emissions Inputs and Assumptions for Target Analysis

Description	Input and Source
Capital Costs	
Vehicle purchase cost projections	Lutsey, Nic, and Michael Nicholas. "Update on electric vehicle costs in the United States through 2030." ICCT (2019) (Cars, SUVs) *Analysis utilizes BEV200 and PHEV50 figures.* Energy Information Agency (EIA) Annual Energy Outlook (AEO) 2020 - New Light-Duty Vehicle Prices (Vans, pick-ups). *Analysis utilizes small pick-up and large van figures, for BEV200 and PHEV40 vehicles. Utilized to project cost changes over time from current MSRP.*
EV charging infrastructure costs	**Vehicles per port:** 2 (Atlas DRVE tool default assumption) **Type of equipment:** Assumes all non-networked Level 2 **Charging equipment cost per port:** $600 (cost for Clipper Creek non-networked station) **Make ready cost per port:** $4,900 (average from ICF report)
Incentives	**Vehicles:** $7500 BEV / $2000 PHEV from AFIG. **Charging infrastructure:** $3,500 or up to 50% of total project costs - Driving PA Forward.[BK2]
Operating Costs	
Estimated vehicle lifetime	12 years (City of Philadelphia fleet data)
Vehicle utilization	Average annual VMT by vehicle type (City of Philadelphia fleet data) – *Ranges from 4,624 for sedans and station wagons to 13,414 for radio patrol cars.*
Fuel economy	**Current:** fueleconomy.gov **Projections:** EIA AEO 2020 - New Light-Duty Vehicle Fuel Economy. *Analysis utilizes BEV200, PHEV40 figures for midsize car, small utility (SUV), small pick-up, and large van.*
Fuel - electricity [$/kWh]	$0.07 (City of Philadelphia)
Fuel - gasoline [$/gallon]	$2.35 (City of Philadelphia)
Vehicle maintenance	$0.09 — conventional vehicle $0.05 — BEV $0.08 — PHEV (Alameda County, 2017 (Passenger Vehicle) via U.S. DOE-funded Atlas Public Policy Fleet Procurement Analysis Tool)
Charging station maintenance [$/year/port]	3% of equipment cost (Atlas DRVE tool assumption)
Emissions	
Gasoline TTW emissions factors	Argonne National Labs' GREET tool via Atlas Public Policy fleet procurement tool
Electricity TTW emissions factors	EPA eGRID 2019 emissions factors by fuel type (coal, gas, etc.) by region (RFCE) utilized to project forward based on Ameren's projected grid mix. Also incorporates grid loss estimates.
Electricity emissions projections	City of Philadelphia's Municipal Energy Use Dashboard. Includes target to generate or purchase 100% of all electricity for the City's built environment from renewable resources by 2030.
Avoided fuel use and emissions from retiring vehicles	To estimate emissions reduction from retiring vehicles, utilizes implied fuel economy estimates based on average mileage and fuel use per vehicle type in the current fleet.

Table 14 highlights the sample vehicles modeled for each vehicle type in the light and medium duty fleet, and their base year MSRP.

Table 14. *Replacement Vehicle Base Year Purchase Costs*

	ICE		BEV		PHEV**	
	Make/ model	**Purchase price/ MSRP***	**Make/ model**	**Purchase price/ MSRP***	**Make/ model**	**Purchase price/ MSRP***
Sedan and Station Wagon	Ford Taurus	$27,800	Chevy Bolt	$36,620	Ford Fusion Energi	$37,000
Radio Patrol Car	Ford Interceptor	$37,500	Tesla Model Y Long Range AWD	$48,000	N/A	N/A
Unmarked Police Car	Chevrolet Impala (E85)	$31,620	Tesla Model 3 Standard Range Plus	$37,990	Ford Fusion Special Service PHEV	$37,000
Sport Utility Vehicle	Chevrolet Blazer	$28,800	Ford Mustang Mach-E AWD	$47,595	Ford Escape PHEV	$34,755
Pickup Truck	Ford F150 4WD	$33,390	Lordstown Endurance BEV	$52,500	N/A	N/A
Van Cargo and Passenger	Ford Transit T150	$37,470	Ford Transit (EV)	$45,000	N/A	N/A

**MSRP and fuel economy from fueleconomy.gov unless otherwise linked.*

***Assumes 25% of sedans and station wagons, unmarked police cars, and SUVs purchased through 2025 are PHEVs, and 0% of other vehicle types.*

DRVE Tool Fleet Analysis

Immediate opportunities for electrification savings across all vehicle classes

Analysis using the Dashboard for Rapid Vehicle Electrification (DRVE) Tool identified a **maximum** of 840 light-duty vehicles that offer Philadelphia lifetime savings today under current market conditions without including any federal or state level rebates, such as Pennsylvania's Alternative Fuels Incentives Grants (AFIG) Program. The competitiveness of light-duty EVs will of course increase if the City pursues state rebates and federal tax credits to offset the upfront costs. Table 15 provides a summary of these vehicle opportunities – see the DRVE Tool Report for additional details, assumptions, and analysis (Appendix A).

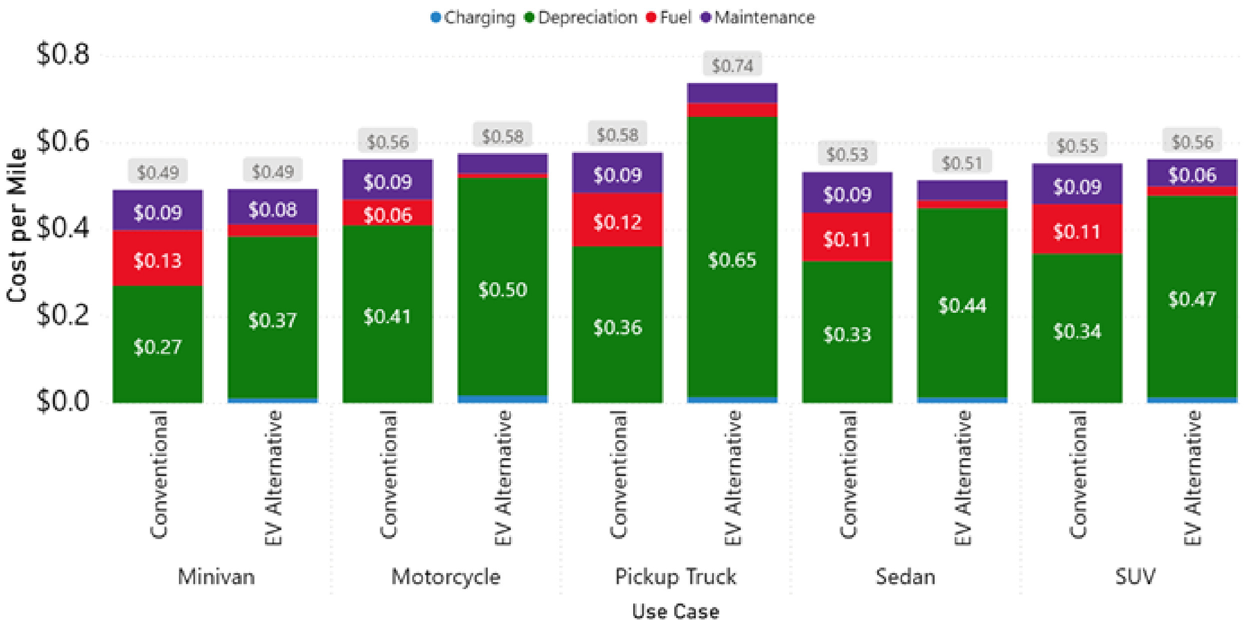
Table 15. *Near Term Light-Duty EV Procurement Options*

Conventional Vehicle Model	Use Case	Count	EV Alternative	Per Vehicle Savings Range	Average % Savings
Ford Taurus	Sedan	340	Chevy Bolt	$774-$19,535	12%
Chevy Impala	Sedan (Police)	66	Tesla Model 3	$24-$3,322	2%
Ford Fusion	Sedan	14	896	$83-$4,150	4%
Chevy Tahoe	SUV	116	354	$1,383-$13,575	12%
Chevy Equinox	SUV	56	318	$2-$1,212	1%
Dodge Durango	SUV	12	310	$33-$5,791	6%
Ford Explorer	SUV (Police)	194	116	$33-$15,044	7%
Ford Expedition	SUV	14	131	$2,442-$5,231	8%

When including AFIG rebates as a factor, the City could immediately cost effectively electrify 2,400 light-duty vehicles, or 83% of the total light-duty fleet. These calculations include state-level incentives/rebates ($3,500) for Level 2 charging infrastructure. Electric SUVs, which are the most common light-duty vehicle in the fleet, have an average cost per mile roughly equal to that of conventional vehicles. Figure 5 shows the cost per mile comparisons across different light-duty vehicle types — no federal or state incentives were applied to the calculations displayed in this figure.

The analysis depicted in Figure 5 (next page) considered the use of plug-in hybrid electric vehicles (PHEV), but not hybrid electric vehicles (HEV). Compared to the conventional ICE version, the Ford Escape PHEV has a similar cost per mile even without applying available incentives. The fuel cost for the plug-in Escape is four times lower than the conventional version.

Figure 5. *Cost Per Mile Breakdown Across Light-Duty Vehicle Types*



Across all plug-in hybrids, it is assumed that the vehicle will exhaust its electric-only range before turning to gasoline consumption — fuel cost savings are high because many vehicles do not have a daily driving range that is greater than the electric-only battery range. The Ford Escape plug-in, for example, has a battery range of roughly 30 miles which exceeds the average daily driving distance of SUVs in the Philadelphia fleet. The comparison depicted in Figure 6 ***does not include*** state or federal incentives, for which the Ford Escape PHEV is eligible. Adding these incentives would increase the lifetime savings potential of the applicable model.

While electric medium- and heavy-duty EVs are eligible for Pennsylvania purchase incentives (under the Alternative Fuels Incentives Grants (AFIG) Program, their high upfront cost and limited number of available models limit the savings potential of these vehicles, which offer significant fuel and maintenance cost savings. Fuel cost alone for electric trash trucks are more than 10 times lower than conventional trash trucks. In the near term, four (4) medium-duty EVs offer lifetime savings potential (about 5%) compared to conventional models on Philadelphia's fleet (the Chevrolet Express Van). See Appendix A for more details.

Figure 6. Cost Per Mile Comparison – Ford Escape ICE vs Ford Escape PHEV

Collaborative Procurement

Depending on their application, electric vehicles present a unique value proposition which may be best realized by pursuing alternative procurement, financing, and ownership options. Collaborative procurement — where multiple entities consolidate their procurements into a single process or bid request — saves staff time and effort during the procurement phase and eliminates the need to develop an RFP or evaluate its responses to secure competitive solicitations for electric vehicles and related equipment. Combined with the available Federal Tax Credit for plug-in vehicles — currently up to $7,500 off the vehicle purchase-price, subject to availability —procurement innovations and powerful financial incentives are available to support the adoption of (light-duty) electric vehicles on municipal fleets.

Municipalities, as public fleets with no tax burdens, are unable to take advantage of federal tax credit incentives. But under a lease financing arrangement, ownership resides with the lessor (a financing entity) until the lessee (the end-user, in this case the municipality) takes possession of the vehicle title at the end of the agreed-upon lease term. In this way, the lessor is able to monetize the tax credit directly as part of its annual tax return, and, in anticipation of this future tax credit, can presently agree to lease the vehicle in question to the lessee for a lower-than-normal monthly payment. In total, the lessee essentially takes advantage of the tax credit since the total purchase price of the vehicle is reduced (the original cost of the vehicle minus the available tax credit).

Solutions like the Climate Mayors EV Purchasing Collaborative provide flexible lease financing through a partnership with NCL Government Capital, under contract with collaborative procurement agent Sourcewell. The City of Philadelphia signed on to the EV Purchasing Collaborative but has not yet taken advantage of the program. This EV Purchasing Collaborative allows cities to save time and money during the procurement phase, while allowing cities to take advantage of the federal tax credit for plug-in vehicles. See Figure 7 below for more information. Other benefits include:

- **Predictable budgeting — terms never change over the life of the agreement**
- **Lease payments come out of the City's *operating* budget, not capital budget**
- **Lease payments billed monthly *OR* annually, as needed**
- **Lease agreements include non-appropriation clauses, providing room for cities to 'default' on payment and not be held responsible**

Such a financing arrangement also enables cities to explore different ownership options for its fleet vehicles – and decide whether or not to take on the depreciation risk of the asset. Closed-end leases are essentially long-term vehicle rentals, whereby the vehicle is returned to the lessor at the end of pre-arranged lease term. In this case, the lessor takes on the depreciation risk. Open-end leases (lease-to-own offerings) are more common for vehicles that record high vehicle miles travelled, and so the depreciation risk resides with the lessee who agrees to make a balloon payment at the end of the lease term to build equity in the asset/own the vehicle outright. In all cases, cities know up-front how much the monthly payments and the residual value will be – these never change over the term of the agreement. Different financing options may be employed for specific vehicles based on their applications, achieving enhanced fleet spending efficiency.

Figure 7. *2019 Nissan Leaf Procurement Comparison the Climate Mayors EV Purchasing Collaborative*

CLIMATE MAYORS EV
PURCHASING COLLABORATIVE
2019 Nissan Leaf

SAMPLE
Lease vs Buy Anaysis

Acquisition Price	**$26,528.00**
Federal Tax Credit	**$7,500.00**

Lease Term	**24 Month**	**36 Month**
Per Month Lease Payment	$599	$489.08
Full lease cost (Payment mulitplied by term)	$14,377	$17,606.88
Residual Value	30%	25%
Residual Value buy-out price	$7,958.40	$6,632.00
Total Cost to Own	$22,335.36	$24,238.88
Cash Price	$26,528.00	$26,528.00
Lease vs Buy Savings	**$4,192.64**	**$2,289.12**

**Maintenance, repairs, licensing/registration and insurance costs NOT included. Sales Tax will be charged on the monthly lease payment and the appropriate rate.*

Opportunities for Non-EV Alternative Fuel Vehicles

See Appendix B for a more detailed review of Alternative Fuel Technologies

Electric Vehicles should be prioritized for procurement in the light duty vehicle classes, especially fleet sedans. All-electric options for SUVs, light-duty pickup trucks, and transit vans are on the horizon for 2022, with wide market penetration and at more competitive prices by 2025. While electric options exist for heavy-duty fleet vehicles such as sanitation haulers and fire trucks (of specific interest to this plan given those Departments' fuel intensity), barriers to these vehicles' widespread and near-term adoption by the City fleet include price, size, and service abilities. To add further complexity, Philadelphia's sanitation vehicles have dual duty cycles in the winter when they are deployed as snow plows.

Regulatory pressures may also shift the medium- to heavy-duty market in the next decade, unlocking more widespread EV availability in Pennsylvania. On July 14, 2020, the Commonwealth of Pennsylvania entered into a Memorandum of Understanding (MOU)[1] with 14 other states and the District of Columbia committing to work collaboratively to accelerate the market for electric medium- and heavy-duty vehicles. The goal is that by 2030, at least 30% of new medium- and heavy-duty vehicle sales in the MOU states will be zero emission vehicles, and 100% by 2050.

With this state-level goal in place and efforts to transform the market underway, Philadelphia can expect more options to replace its medium- and heavy-duty vehicles in the next decade. The Biden Administration has also been very vocal in support of vehicle electrification, which might include federal support for increased or expanded EV purchase incentives (especially for government fleets); public transit electrification (including school buses); manufacturing incentives and support; EV charging infrastructure development; and EV Charging workforce development.

Other alternative fuel opportunities exist that may allow for reduced emissions from heavy-duty vehicles in the near term. The City has been developing a CNG trash truck pilot which presents an opportunity for the expanded use of this fuel on the City fleet, especially with fueling infrastructure already in place. In the short term, the City should review strategies for obtaining a reliable, local/regional, ethical, and cost-effective supply of renewable natural gas (RNG) as feasible, and focus the expansion of its CNG trash truck pilot project on using RNG as a fuel source.

Renewable diesel is an attractive, though currently unattainable, fuel for the City's heavy-duty vehicles. While the Port Authority of New York and New Jersey (PANYNJ) recently conducted a trial of renewable diesel in its fleet, this fuel is not available on a commercial basis outside of California. There is not enough demand on the East Coast to support the necessary barge terminal and rack facilities that would need to be allocated for the provision of renewable diesel. However, the City's 2.6 million gallons of annual diesel use (FY17), when aggregated with several other large customers, could be enough to support an East Coast market for this fuel. The City could potentially consult with large commercial customers and fleets in the area (such as PANYNJ) to help develop the availability of this fuel. Furthermore, if New York State votes to implement a Low Carbon Fuel Standard (LCFS) program, which may happen within five years, renewable diesel will likely become available in the region. The price point of renewable diesel may exceed conventional diesel in Pennsylvania when it's available, but it does offer potential cost savings in terms of reduction in maintenance of fuel filters and diesel emissions control systems.

1. https://www.nescaum.org/documents/multistate-truck-zev-governors-mou-20200714.pdf

Department Perspectives on Fleet Electrification

OFM captures a significant amount of data related to fleet operations, such as fuel usage and the vehicle owner. This data allows staff to better understand how vehicles are used across departments and what future changes may be most appropriate. To supplement this data, OOS interviewed City staff and circulated a survey to understand individual vehicle usage as well as departmental needs and concerns related to fuel switching. Representatives from 15 departments responded concerning their departments' vehicle driving, refueling, idling, and parking patterns:

Table 16. *Staff Survey Highlights*

Question	Response Highlights
Average distance for individual trips taken by employees in your department?	66% travel less than 30 miles (roundtrip) 26% travel 30-60 miles (roundtrip) Prison Department travels >60 miles (roundtrip)
What time of day are trips most likely to occur?	Two-thirds of all departments drive during normal business hours (9am-5pm) One-third of all departments drive within and outside normal business hours
Where do drivers in your department most frequently park vehicles? *Note: departments park vehicles in more than one location; for this reason, total vehicle percentages exceed 100%.*	*Portion of departmental vehicles which are parked:* On street — 46% Building-adjacent parking lots — 20% In a garage — 46%
Average vehicle downtime?	< 4 hours — 20% of vehicles 4-8 hours — 40% of vehicles > 8 hours — 20% **Department of Human Services – Never*
Average vehicle idle time?	< 15 mins — 46% of vehicles 15 – 60 mins — 20% Never — 33% *Note: Despite the demonstrated operational necessity, idling for these lengths of time is prohibited by both Philadelphia and Pennsylvania law*
Vehicle assignment?	86% of vehicles are pooled/shared
Process for deciding to request a vehicle and determining what type to request?	Overwhelming majority of departments make their own decision on the type of vehicle and when to procure
What factor(s) represent the most significant barriers to each department's adoption of EVs?	*Concerns about:* Availability of EV infrastructure — 60% Ability to meet operational needs — 33% EV range — 33% EV costs and knowledge of EVs — 13%

Through these discussions with City staff, OOS also gleaned information related to the current benefits of EVs, and challenges they foresee in expanded adoption.

Benefits

- **Departments find EVs are easy to maintain and generally reliable.**
- **Hybrids are especially advantageous for departments with respect to fuel efficiency, resulting in a significant reduction in fueling frequency.**
- **Departments are proud of EVs and what they represent, and feel it shows residents their commitment to climate action.**

Challenges

- **Accessing EV charging infrastructure is a major barrier, with lingering questions about installation, accessing and using/sharing EV charging equipment**
- **EV size constraints, as electric SUVs and trucks are either not yet available or too costly to justify**
- **Educating employees about EV refueling patterns and normalizing plugging-in the vehicles**
- **EV battery capacity and driving range (“range anxiety”)**
- **Upfront costs of EVs being higher than their gasoline-fueled counterparts**

Certainly, the most challenging aspects were concerns with building out EV infrastructure given the problems identified with the EV chargers the City already operates. These problems include the disconnected nature of electric vehicle supply equipment (EVSE) procurement, use, and management by departments; aging parking infrastructure; inefficient charger utilization by seldom-used vehicles; and the absence of EV charging data to inform fuel efficiency comparisons. Solutions identified during internal City discussions include centralized management of stations, the development of strategic City-fleet charging hubs and adding EVSE requirements to requests for proposals (RFPs) for leased parking spaces.

OOS interviewed City staff and circulated a survey to understand individual vehicle usage as well as departmental needs and concerns related to fuel switching

Vehicle and Fueling Recommendations

1) Adopt goals for the fleet that will provide a pathway to zero emissions

The City should adopt the following goals related to its fleet:

1. **By 2030, reduce light- and medium-duty vehicle emissions by at least 45% from 2019 levels by transitioning to zero-emissions electric vehicles (EVs).** A comprehensive review of the City's 3,743 light- and medium-duty vehicle inventory was completed, and was compared to scheduled vehicle replacements and available zero-emission vehicle options. The results of this review and comparison indicate that the City can successfully electrify over 1,600 vehicles by 2030 (over 44% of the light and medium duty fleet). This would eliminate over 11,000 metric tons of CO_2e emissions annually, or 43% of associated gasoline vehicle emissions. Across all vehicle classes today, electrifying a Philadelphia fleet vehicle is estimated to reduce CO_2 emissions by 70% on average compared to existing conventional vehicles on a per mile basis. By 2030 when the city aims to procure 100% renewable electricity for city operations, this figure would reach 100% reduction on a per mile basis.

2. **By 2025, lay out a procurement strategy to achieve 100% procurement of EVs for sedans, sport utility vehicles (SUVs), vans, and light duty pickup trucks by 2030.** The passenger sedan vehicle class presents the most immediate opportunity for electrification, to be followed by light-duty pickup trucks and vans by 2023/2024. With the federal tax credit available and procurement options that allow the City to take advantage of tax credits, fleets are encouraged to transition as many sedans and SUVs to plug-in versions as feasible.

   The procurement strategy should include planning for the electrification of vehicles in these classes (sedans, SUVs, Vans, and Light Duty pickup trucks) in the Police Department fleet. It should also include, specific to the Police fleet, a plan for installation of charging infrastructure to complement EV procurement, and a deployment strategy to meet the fleet's operational needs; this includes planning specifically for deployment of EVs compatible with fast-charging infrastructure. The Police Department EV procurement strategy should include motorcycles, radio patrol cars, and "chase vehicles". Exceptions may be considered for unmarked vehicles used primarily for covert operations — their identification as City vehicles may incapacitate them from performing their normal duties. However, this should not be used as a barrier to the electrification of the Police Fleet.

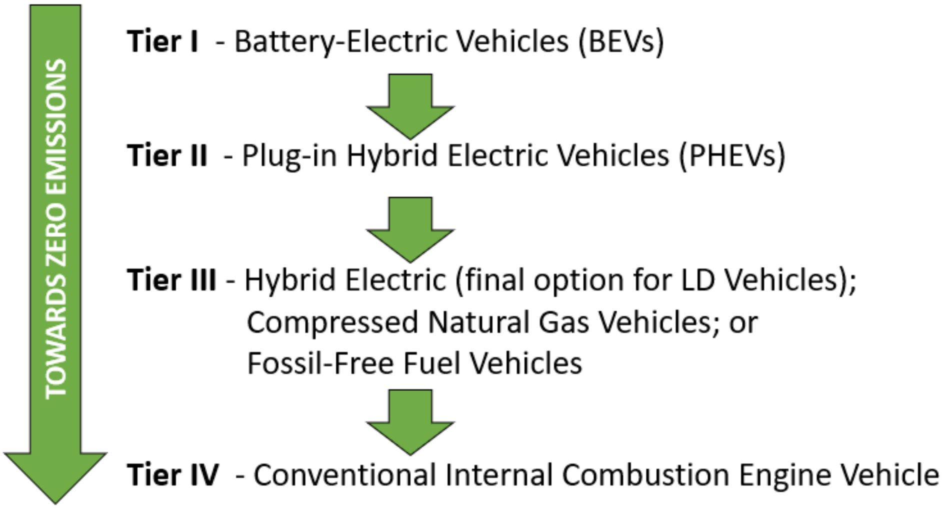
3. **Procure No New Fossil-Fuel Consuming Vehicles after 2030.** By effectively halting the procurement of fossil-fuel consuming vehicles by 2030, the City's fleet will be well on its way to becoming fossil-fuel free by 2050. By 2030, there is expected to be full market penetration of medium- and heavy-duty electric vehicle options, and the next decade will allow the City to fully prepare its infrastructure and budgeting to support the fueling and financial implications of a transition away from fossil-fuel based vehicles. The Clean Fleet Committee (CFC, see #5) must play a critical role by helping to develop intermediate milestones to reach these targets; establishing and tracking costs, savings, and progress metrics; and convening and supporting staff with research on available funding opportunities, alternative fueling opportunities, and the market outlook for vehicle availability. The CFC may also make exemptions to this policy as they deem appropriate.

2) Institute a Clean Fleet Procurement Policy

Goals of the clean fleet procurement policy are to reduce the overall size of the fleet, right-sizing SUVs and larger vehicles as feasible, deploying managed idle technologies to reduce fuel consumption of legacy vehicles, and requiring departments to prioritize electric or zero-emission vehicles in the procurement process. Strategies to help reduce the size of the fleet include leveraging alternative transport options for city staff, such as the city contract for car-sharing services or pre-tax transit benefits that staff may use in lieu of pool vehicles. Both strategies can be used to help eliminate underutilized fleet assets, as well as provide an avenue to increase efficiency and the number of electric miles travelled by staff (if the car-share service includes electric vehicles).

Requests for new vehicle purchases/upgrades would be evaluated and authorized by OFM, first determining that a new vehicle procurement is warranted; that the vehicle request is the follows rightsizing principles; and that a pool vehicle/resource (such as a city-staff carshare), bikeshare, or transit benefits cannot meet the need. OFM would then follow the highest-to-lowest decision-hierarchy (Figure 8) to ensure that fleet procurement goals align with the City's carbon neutrality and cost management targets. This decision-hierarchy should be updated with the consensus of the Clean Fleet Committee (CFC) by the Transportation Electrification Manager (see EVSE Recommendations, below) as new fossil-fuel free technologies emerge, and the tiers may be revised to more accurately account for GHG emissions potential.

Figure 8. *Proposed Vehicle Procurement Hierarchy*



3) Limit procurement of medium- and heavy-duty vehicles in the short term; Pilot new fuels or procure CNG vehicles where feasible

While there are currently limited electric options for replacing medium- and heavy-duty vehicles, several models are actively being developed and will be more widely available and viable within the next decade. Due to market forces, as well as the multi-state MOU related to vehicle electrification, this is an area that should be revisited **at least every five years** to ensure that Philadelphia is procuring the latest in zero-emission vehicles and supporting infrastructure.

Given the market trajectory of medium- and heavy-duty electric vehicles, the City should try as much as possible to limit procurement of fossil-fuel vehicles in these classes over the next 5 years, instead 'piloting' EV or other low-emission vehicle options where possible. For any unavoidable procurement, the City should first consider alternative fuel vehicles, including the expansion of CNG-fueled vehicles given the sanitation vehicle pilot (the City should try to use RNG whenever possible to fuel its CNG fleet). If electric- or CNG-fueled vehicles are not feasible, the City should consider whether piloting other low-emission fuels, such as renewable diesel or hydrogen, may provide long-term benefits.

City of Philadelphia's CNG-powered Trash Compactor Fueling Station

The Office of Fleet Management (OFM) has started to convert Streets Department trash trucks to compressed natural gas (CNG). Due to the size of the city, there is no central trash truck facility. Instead, the approximately 341 City trash trucks are based out of numerous facilities that are local to the areas that they serve. The City selected the Southwest Sanitation Convenience Center as the CNG fueling location and, in partnership with Clean Energy Fuels Corp, completed the retrofit in 2021. The City selected the location due to the availability of natural gas and its proximity to a publicly accessible fast-fill CNG station at the Philadelphia International Airport. The fast-fill station could serve as a backup fueling source if the City's station is unavailable due to maintenance or malfunction. The City's CNG fueling station configuration can accommodate 44 trash compactors and an additional 40 trash trucks (70 total). Currently, OFM has 16 CNG compactors in active service and 11 will be on line by September of 2021.

4) Conduct an EV Suitability Assessment

Given the size of the City's fleet and the need to achieve deep electrification quickly, a third-party telematics assessment (specifically, a months-long EV Suitability Assessment) is highly recommended. This data-capturing exercise provides a high level of detail into vehicle duty cycles (hours driven per day, per week and total miles per measurement cycle) as well as vehicle drive cycles (average speed, number and frequency of vehicle stops and starts, idle time, and engine-off time). This data can then be used to calculate fleet greenhouse gas emissions and assess which vehicles are the best candidates for electrification. For PHEVs, telematics can track how many miles are driven using the internal combustion engine versus the battery.

An inherent benefit of telematics is the collection of location data, which is not only useful to understand where a vehicle travels (to potentially identify optimum sites for installation of on-route charging) but also to better understand where vehicles regularly park, especially overnight. This real-world data will support Philadelphia's informed decision-making about the number of Level 2 charging stations that need to be installed in support of the planned EV deployment. By indicating best sites for strategic and consolidated charging infrastructure installation, and then validating that these plans are sufficient to meet the driving needs of the planned EV procurements, infrastructure and overall project costs can be reduced. Fleet telematics and data analysis were specifically identified by city consultant Wilson Engineering Services (WES) as an exercise with the potential to provide benefits to fleet maintenance departments (see Appendix B). For example, an EV Suitability Assessment conducted for the City of Columbus, OH informed its deployment of over 300 electric vehicles between 2018 and 2020.

5) Establish a Clean Fleet Committee (CFC) to oversee plan implementation and track goals

The Clean Fleet Committee (CFC) should be an intragovernmental body that meets at least biannually to support the transition to a carbon-free fleet and to meet the goals listed in this plan. While OFM will manage vehicle procurement requests and ensure they follow the decision hierarchy, the CFC must play a leadership role in coordinating the infrastructure needed to support electrification. The CFC can provide support to OFM in ensuring that all departments are adhering to the procurement policy. **All requests for non-electric vehicle procurements (especially SUVs and light-duty cars/trucks) must include an operational and/or cost justification. Any plans to upsize a department's fleet must be supported by a reasonable strategy to offset any incremental fuel consumption or emissions impacts that would result.**

The CFC will serve as a general clearinghouse for questions on alternative fuel vehicles; as a reviewer of market conditions and vehicle availability; as a coordinator for EVSE and infrastructure planning and implementation; and will develop metrics to track fleet composition changes towards zero-emissions (vehicle number and type, emissions, and operational performance and costs including EV charging, etc.). It is envisioned that this Committee will prepare a report for relevant stakeholders — including the City Fleet Liaisons — after each meeting, which will inform the next iteration of the Clean Fleet Plan.

At each meeting, the Clean Fleet Committee will:

- **Review key performance indicators (KPIs)**
    - > **Ongoing fleet maintenance costs, by vehicle category:** Consider tracking maintenance for new EVs compared to maintenance costs of comparable ICE vehicles (or the vehicles they replaced), and adding indicators to the City's sustainability dashboard (see Recommendation #6 below)
    - > **Vehicles procured and retired during the timeline, including:** Number of EVs or AFVs procured; Number of vehicles permanently retired/not replaced
    - > Fuel usage and year-over-year comparison, by department
    - > EV charging station installations, utilization, and operational EV supply costs (see EVSE Recommendations)
- **Review issues encountered during implementation of the Clean Fleet Plan, not limited to:**
    - > Vehicle and EVSE costs, meeting needs of end users, technical issues, workforce issues, and EVSE planning and deployment
- **Provide resources to staff to support the familiarize them with Electric/Alternative Fuel Vehicles and Best Practices:**
    - > Familiarize City staff with the benefits of (and industry-wide shift to) vehicle electrification
    - > Identify upcoming availability of EVs and AFVs, including procurement and grant-funding opportunities
- **Review fleet management techniques and ensure alignment with documented Best Practices:**
    - > Vehicle assignment/'take-out'/parking efficiency
    - > Promote 'eco-driving' to improve fuel efficiency of drivers through better operational practices
- **Collect, streamline, and analyze data such as electricity rates and EV operational costs to faciliate the streamlined development of program baselines and compoarisons to other fleet fuels**
- **Spearhead EVSE installation processes and coordinating stakeholder roles across departments**

The facilitator and lead convener of the Clean Fleet Committee would be the Transportation Electrification Manager (see EVSE Recommendation #1. The Committee would additionally be composed of at least four (4) departmental fleet liaisons, as well as indicated staff from City departments, outlined in Table 17.

Table 17. Proposed Clean Fleet Committee Personnel

Department	Function	Representative
Office of Fleet Management (OFM)	Purchases vehicles on behalf of departments	Houses Transportation Electrification Manager to coordinate EV infrastrucure; Senior automotive engineers
Procurement Department	Manages contracts for vehicle procurement	Department Buyer; Procurement Representative; or as assigned by department leadership
Office of Transportation, Infrastructure, and Sustainability (oTIS)	Oversees critical municipal infrastructure such as right of way and street paving	Deputy Managing Director; or as assigned by department leadership
Department of Public Property (DPP)	Manages a majority of the City's built environment and also provides capital project management for various departments	Deputy Commissioner of Operations; Deputy Commissioner of Capital; or as assigned by department leadership
Office Of Sustainability (OOS)	Manages the citywide GHG inventory and has established goals in order to mitigate the impact of climate change	Director of Sustainability; or as assigned by department leadership
Energy Office (EO)	EO manages vehicle fuel procurement in addition to electricity for all municipal government	City Energy Manager or as assigned by department leadership
Office of Innovation and Technology (OIT)	OIT manages major technology projects for the City and encourages municipal employees to engage with technology in useful ways.	SmartCityPHL Director

6) Develop funding programs to connect Capital Procurement and Fuel Cost/ Operational Savings

Currently, the City's EV and clean fleet procurement goals are disconnected from the funding allocated for new capital and vehicle procurement. Given the current price premiums for EVs and the impetus to reduce fleet emissions, there is a need for specific budget allocations to support fleet electrification. Fuel switching – from price-volatile petroleum-based liquid fuels to domestically-produced and relatively price-stable electricity – is a widely accepted operational-savings factor indicating the economic benefits of EVs over conventional vehicles.

Since the City already collects information on metrics like fuel expenditures and vehicle miles traveled by vehicle category, a relatively simple comparison can be made with electricity rates and electricity dispensed from fleet-dedicated charging stations to account for fuel cost savings post-transition. These accrued fuel savings should be used to offset the price differential between an ICE vehicle and its comparable EV equivalent in future procurements.

Additionally, since EVs demonstrate lower maintenance costs compared to ICE vehicles, the City should establish a method of quantifying and tracking maintenance savings per vehicle/class to develop a complete profile of the financial impact of the fleet's breakdown as it progresses towards full electrification (see #4 above, Clean Fleet Committee). It is recommended that indicators like annual maintenance costs and time spent in the shop/out of duty be tracked and reported on the City's sustainability dashboard, with avoided maintenance costs similarly used to support an internal fund to help offset the higher price premiums for electric vehicles. Combined with available federal funding opportunities or state-based initiatives, like Pennsylvania's Alternative Fuels Incentives Grants (AFIG) Program or Driving PA Forward from the Pennsylvania Department of Environmental Protection, this internal fund would be well poised to support a sustainable funding pathway for fleet electrification.

7) Optimize Alternative Fueling and Infrastructure

- **Moderately expand compressed natural gas (CNG); focus on deploying renewable gas (RNG):** RNG presents the best short-term opportunity for transitioning medium- and heavy-duty vehicles to lower emission alternatives. The City should explore ways to procure RNG for its current CNG-fueling facility, which should be expanded to its full capacity.

- **Evaluate E85 or B20 Fueling Locations:** The City currently has 1,227 flex fuel (E85 capable) vehicles in the fleet, although the extent to which E85 fuel is used is unknown. Since many City fueling depots may only provide two dispensers, for E10 gasoline or diesel, availability of E85 for City vehicles may be sparse or nonexistent. However, it may be worth looking at where vehicles are fueled to see if there are specific fuel depots which serve primarily flex fuel vehicles, and then it may be possible to convert the E10 dispensers to E85, if the non-flex fuel vehicles can be moved to other fuel stations. In this way, a GHG offset can be used with existing vehicles, and at very little cost, since E85 is priced similarly to E10 on an energy cost basis.

  The same type of evaluation could be conducted for diesel vehicles, to determine which vehicles are supported to run on B20 by their manufacturers. Although moving to B20 from the current B2 does not provide as significant of a GHG offset as the difference between E10 and E85, the transition could be worthwhile it if it requires minimal effort.

- **Consolidate Alternative Fuel infrastructure and EVSE management under a single department and expand staffing support appropriately:** Currently, EVSE is installed and managed by the department owning the EV. There is no coordinated strategy for EVSE deployment or use. Given the cross-cutting nature of plan implementation, the Managing Director's Office should oversee the Clean Fleet Committee and designate that body to manage all aspects of EVSE with appropriate staffing. A full time staff position should be hired as soon as possible, but no later than FY23.

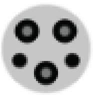
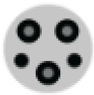
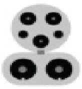
- **Develop an EVSE deployment scenario; expand dual-port Level 2 charging availability at locations:** The Office of Fleet Management should use the EV Charging Infrastructure Analysis Tool to complete a 10-year EVSE deployment framework and begin expanding EVSE installation immediately. The City is encouraged to simplify and streamline its internal EV charging infrastructure permitting process to facilitate this rapid infrastructure buildout, and also to require new and renovated municipal facilities to be 'EV-ready' in order to minimize the costs of installing charging infrastructure at those sites in the future.

Electric Vehicle Supply Equipment (EVSE)

Technology Overview

Electric Vehicle Supply Equipment (EVSE) is typically differentiated by the maximum amount of power that can be delivered to the vehicle's battery. Table 18 presents an overview of different charging types as well as a comparison of estimated equipment/installation costs – see Appendix B for more information.

Table 18. *Comparison of EV Charging Levels*

	Level 1 Alternating Current	**Level 2** Alternating Current	**Level 2 & 3** Direct Current (aka DC Fast Charging)
Description	Uses a standard plug – 120 volt (V), single phase service with a three-prong electrical outlet at 15-20 amperage (A)	Used for PHEV and BEV charging 208/240 V AC split phase service that is less than or equal to 80 A	Used specifically for BEV charging Typically requires a dedicated circuit of 20-100 A, with a 480 V service connection
Connector type(s)	 J1772 charge port	 J1772 charge port	 J1772 combo  CHAdeMO  Tesla combo
Use	Residential or workplace charging	Residential, workplace, or opportunity/public charging	Rapid charging for transportation depots, vehicle fleets, public corridor
Limitations	Low power delivery lengthens charging time	Requires additional infrastructure and wiring	Can only be used by BEVs currently. Higher upfront and operational costs
Time to Charge	2 to 5-mi range/1-hr charging Depending on the vehicle battery size, PHEVs can be fully charged in 2-7 hours and BEVs in 14-20+ hours	10 to 25-miles range/1-hr charging Depending on the vehicle battery size, PHEVs can be fully charged in 1-3 hours and BEVs in 4-8 hours	50 to 70-mi range/20-min charging Depending on the vehicle battery size, BEVs can be fully charged in 30-60 minutes.
Estimated Installation Cost	Minimal	1-5 chargers per site: $2,800-$3,100 6+ chargers per site: up to $2,300	1 charger per site: $45,500* 3-5 chargers per site: $27,000*
Estimated Equipment Cost	$600 to $820 per non-networked charger per pedestal	$940 to $1,200 per non-networked charger, per pedestal $2,800 to $3,200 per networked charger, per pedestal	50 kW: up to $28,400 per pedestal networked charger* 150 kW: up to $75,000 per pedestal networked charger*

**Note that these cost estimates include estimated charges for upgrading of switchgear and distribution lines - consult with your utility about how these charges can be managed. Equipment and installation costs are based on average manufacturer hardware quotes, surveyed in 2019 by the International Council on Clean Energy*

Current Municipal EVSE Deployment

To meet the current charging needs of its fleet, the City has installed 47 single-port, non-networked, Level 2 EV charging stations at 28 locations throughout the City of Philadelphia (Figure 9, below). The largest concentration of charging stations is in North Philadelphia, with ten charging locations that offer access to 16 charging stations. Fifteen locations citywide have one charging station; and the remaining 13 locations have more than one charger. OFM procures and provides EV charging infrastructure to the department procuring EVs. The procuring department is then responsible for the installation and maintenance of the stations (see recommended changes to this process in EVSE Recommendations #1). There is currently no coordination between EV drivers or departments on EVSE deployment.

Figure 9. City of Philadelphia Charging Stations Locations

With the required growth in the City's EV fleet over the next decade, thoughtful EVSE deployment and management will be critical to provide adequate charging options to drivers. The following sections provide a review of resources currently available to effectively meet Philadelphia's increased need for EV charging. A more detailed report, including equipment, installation, and operational cost comparisons, can be found in Appendix B.

Networked vs. Non-Networked Charging

Electric Vehicle Supply Equipment (EVSE) is typically differentiated by the maximum amount of power that can be delivered to the vehicle's battery. Table 18 presents an overview of different charging types as well as a comparison of estimated equipment/installation costs — see Appendix B for more information.

Networked charging stations

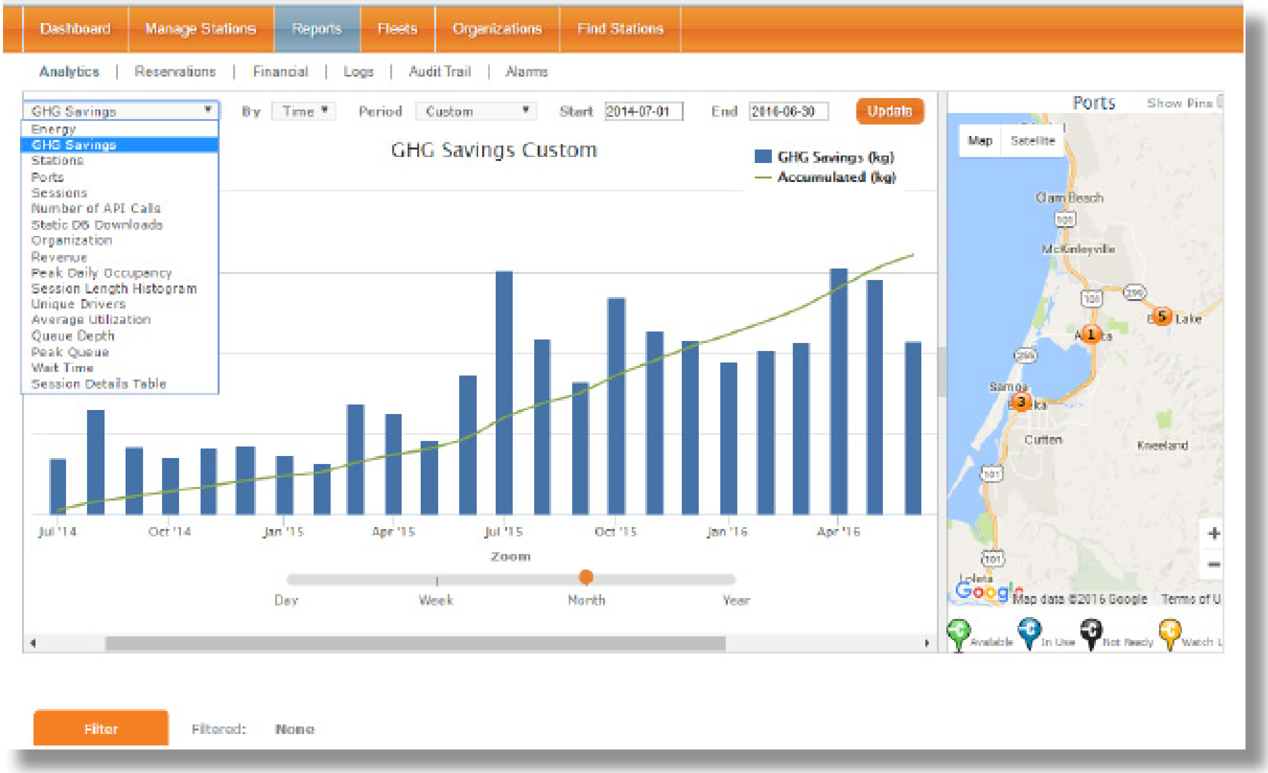
Also called "smart" chargers, networked chargers incorporate the hardware, software, and communications capabilities necessary to connect it with a network service provider's charging station management software, and commonly access a network "dashboard" for ease of monitoring and enhanced user experience (Figure 10, below). This facilitates the automated delivery of detailed, customizable reports on energy use, costs and avoided emissions, providing enhanced visibility on fleet operations. This dashboard also makes it easy for remote infrastructure management in the case of hardware/network failures. Networked chargers can also restrict access to certain users via RFID access cards, while enabling payment facilities for public use. Networked chargers can also support the City's building energy efficiency work as well, since they allow the differentiation between electricity used to charge vehicles and building electricity use.

Non-networked charging stations

Non-networked charging stations are stand-alone (Level 1 or Level 2) EVSE which allow users to simply access electrical power to charge vehicles. This equipment lacks the hardware and software to inherently connect to the internet or other communications networks, and therefore cannot be accessed or managed remotely. Non-networked EVSE collect very limited data on energy dispensed, meaning that station owners will only be able to see the total electricity consumed by the unit over a given period of time. For this reason, non-networked EVSEs are the least expensive and simplest option to meet charging needs. Non-networked EVSEs are best suited for residential and small workplaces, where a limited number of charging stations are necessary.

In addition to the costs for the physical charging equipment, networked charging station owners (i.e., the City) pay a fee that covers the cost for cellular/Wi-Fi network communications and back-end support, which would provide access to the dashboard (see Appendix B for more information on these costs). While networked chargers are more expensive, networked charger management software allows for real-time monitoring of the charging equipment including maintenance needs, up-time, energy usage, and charging station status. These additional features make networked chargers an attractive complement to EV-fleet management and for fleets seeking enhanced energy and operational data tracking.

Figure 10. *Example of an EVSE Network Dashboard*



Source: California Energy Commission (CEC). 2018. Electric Vehicle Charger Selection Guide.

EVSE Maintenance

Maintenance and repair costs vary, depending on the type and features of charging equipment deployed. Basic, non-networked Level 1 and Level 2 chargers do not require regular maintenance unless physical damage occurs. The equipment is typically modular in design, and any malfunctioning components can be replaced separately rather than replacing an entire unit.

Networked chargers with advanced features or communications systems may require periodic maintenance. Depending on the station ownership structure, maintenance and extended warranties may be included in agreements or provided as a fixed annual fee.

Charging as a Service (CaaS)

EV charging-as-a-service (CaaS) is a relatively new option offered by EVSE network companies. CaaS minimizes the financial burden on hosts by reducing the upfront cost of chargers to essentially zero. Theoretically, the only expenses for which a host would be responsible are the network fees and the operating fees. EVSE providers which offer this service cover the purchasing and installation of charging equipment, as well as an equipment warranty.

One important difference between CaaS and a standard equipment leasing arrangement is that at the end of the fixed term, CaaS customers do not have the option to buy the EV charging equipment. The advantage to the City would be zero upfront cost for the charger, zero maintenance fees, and for some providers that offer fixed pricing, a clear understanding of future costs.

However, a review of other public entities' experience with this option reveals that **it is not as simple as it appears.** For example, during installation the EVSE provider does not cover any infrastructure upgrades (electricity panel upgrade, transformer replacement, etc.), nor will it cover the cost for any required trenching. As stated, charging equipment cannot be purchased at the end of the fixed term, so in light of the high infrastructure costs this may not be the most cost-effective option for the City. Please refer to Appendix B for more information on companies offering a charging-as-a -service option, including companies who offer this option in in the Philadelphia area.

Advanced Fleet Management Opportunities

One concern when managing a large EV fleet is the logistical challenge of maintaining sufficient charge across a large number of operational vehicles when the ratio of available charging infrastructure to plug-in vehicles is less than 1:1 (i.e., when multiple EVs must share access to 1 charge port). **Queuing opportunities,** facilitated by the network service provider through a platform or dashboard add-on, may allow for the enhanced coordination of fleet charging by aggregating data related to EV driving patterns and EV battery state of charge. This data would be analyzed to prioritize the charging of vehicles that:

1. **are due for a vehicle trip, *and/or***
2. **are insufficiently charged to carry out a pending vehicle trip.**

Although no companies currently offer this 'queuing' option, ChargePoint does currently offer a 'waitlist' feature which allows EVs to 'get in line' when all charging spots are being used and receive a notification when there is an opening. 'Auto-Queueing' is another available feature which automatically adds a car to the waitlist, obviating the need for drivers to add themselves to the queue.

Location Considerations

The Charging Infrastructure Analysis Tool, created by ICF for the City, provides a range of estimated costs related to the charging infrastructure necessary to support the City fleet's transition to electric. The Tool combines information on the fleet's EV adoption projections (over the next 10 years, based on currently deployed vehicles) with location analysis based on existing parking location data. From this identification of potential 'hot spots' for future EV charging needs, Table 19 presents the **Top 15** City parking locations. Note that over the next decade, **641 EV chargers** are anticipated for City-vehicle parking spots for which no accurate or consistent location data could be found; additionally, this Top 15 list includes several Police Department sites (highlighted in blue). See Appendix B for full citywide results and an overview of the assumptions used in the analysis.

Table 19. *Expected EVSE Demand at Various City Parking Locations*

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total 5 Year	Total 10 Year
NO DATA	63	45	10	28	73	52	44	48	154	124	219	641
POLICE TRAFFIC DIV.	0	2	0	0	3	5	13	11	10	6	5	50
SW WATER POLLUTION CONTROL PLANT	1	1	0	4	6	6	5	8	7	10	12	48
NE WATER POLLUTION CONTROL PLANT	1	4	0	5	0	1	2	12	9	9	10	43
POLICE NARCOTICS	5	1	1	0	2	3	12	10	1	7	9	42
AUTO SERVICES	2	2	4	3	4	1	3	5	7	0	15	31
HOMICIDE DETECTIVE DIV.	1	7	4	0	2	1	1	6	3	1	14	26
35TH POLICE DIST.	1	0	0	1	2	2	10	4	5	1	4	26
39TH POLICE DIST.	0	2	0	1	1	1	9	3	8	1	4	26
HOMELAND SEC/ DIG PROTECT/ CRIM INTELL	4	2	1	3	2	0	2	6	1	4	12	25
INTERNAL AFFAIRS BUREAU IAB	3	5	1	1	0	1	4	4	0	4	10	23
CONSTRUCTION UNIT	2	0	0	6	0	11	1	0	0	3	8	23
DISTRIBUTION PWD	1	2	0	1	0	0	1	6	7	5	4	23
9TH POLICE DIST.	0	1	2	1	0	1	6	4	5	2	4	22
OFM INTERAGENCY POOL	3	4	0	4	5	1	1	0	3	0	16	21
FIRE ADMIN BLDG	0	2	0	3	0	1	1	7	2	5	5	21

EV Charging Costs and Considerations

See also 'Charging as a Service,' page 44.

Total charging infrastructure costs are primarily composed of:

- **Permitting fees,** which account for City administrative staff time as the municipality enforces the applicable electrical code to protect both the public and property. EVSE permitting fees vary widely (from $0 to $624 nationally), adding great variability to total charging infrastructure costs. For example, near Philadelphia, permitting fees are calculated as a percentage of the total job cost, meaning that permitting fees would increase along with EVSE labor and capital costs. Permitting processes also vary widely, and it is recommended that the City streamline this internal process and minimize fees to complement the planned municipal EVSE deployment and support increased equipment installations throughout Philadelphia.

- **Hardware costs** include the level and number of chargers deployed, and available features such as networking. While non-networked Level 1 or Level 2 chargers are the least expensive, they are not expected to serve the City well in the long term. As EV range and battery size increase, these vehicles will quickly outpace Level 1 charging's ability to provide them sufficient charge. There is also value in having more sophisticated Level 2 charging infrastructure as more EVs are deployed. This will allow the City to track and manage electricity consumption remotely, reducing potential impacts to building energy costs. More sophisticated Level 2 equipment may also increase utilization potential at the stations through advanced features such as queueing capabilities and other notifications.

- **Installation costs** are based largely on site-specific concerns, such as the charger distance from the electrical panel and the associated need for boring/trenching through any hardscaping; or if the equipment will be wall- or pedestal-mounted. Installation costs are the most widely variable cost factor – a 2013 EPRI study found that L2 sites that required special work such as trenching or boring were about 25% more costly.

The City's strategy around siting and deploying vehicle charging equipment should focus on 'future-proofing,' or meeting the needs of electric vehicles that will join the fleet not just imminently but in the longer term. This means maximizing the utility of instances of boring/trenching activities during an infrastructure upgrade and installing excess electrical panel/conduit capacity at that time. Such measures reduce long-term project costs by delaying the need to modify the site at a later date to accommodate additional equipment installation.

...over the next decade, thoughtful EVSE deployment and management will be critical to provide adequate charging options to drivers

For example, based on the findings from the EV Infrastructure Analysis Tool and shown in Table 19, the OFM interagency pool parking location will need an estimated 16 EV charge ports over the next five years, and 21 charge ports total in the next 10 years. Therefore, instead of installing seven charge ports in 2021 and 2022 at this site, it is recommended that the City consolidate installation costs as much as possible by installing the total required electrical/conduit capacity during the first set of installments. To improve this type of analysis moving forward, it is recommended that the City collect parking location data from more fleet vehicles. Fleet telematics capture, as part of an EV Suitability Assessment, would satisfy this data need — see Vehicle and Fueling Recommendations, #4, as well as Appendix C for the full list of analyzed City parking locations and their requisite expected EVSE demand.

Vehicle-to-Plug Ratio

It is also important to note that the City currently uses a 1:1 vehicle-to-plug ratio when procuring/installing charging equipment to support new fleet EVs. Moving forward, the City should move to a vehicle-to-plug ratio of at least 2:1 in order to reduce infrastructure capital costs. The following tables provide more information on projected EV Infrastructure costs per year (both a low- and high-cost scenario), and a comparison of total costs over the same period.

The Infrastructure Analysis confirms that 2:1 vehicle-to-plug equipment sharing would effectively cut project costs in half (as opposed to a 1:1 vehicle-to-charger ratio), but there still exist logistical challenges associated with sharing charge ports between vehicles, at least into the near term. In order to accomplish this successfully, vehicles with complimentary daily trips and uses must be paired together at charging locations in order to achieve an overall adequate state of operational charge. Other strategies to manage equipment include scheduling charging sessions by using a charging platform (see EV Fleet Management Opportunities, above), or by pairing staff EV users who easily and effectively communicate with each other.

Projected City EVSE Deployment Needs and Estimated Costs

Adapted from the ICF Report in Appendix C, the following table illustrates Philadelphia-specific estimated costs for the recommended City EVSE deployment scenario each year through 2030 – networked or non-networked Level 2 charging stations, where each charge port is shared by 2 electric vehicles. See Appendix C for additional cost scenarios, including if all chargers were Level 1 and if a 1:1 Vehicle-to-Charger Ratio was employed instead. Again, while basic Level 1 or Level 2 charging is most economical, that approach not recommended to support the City's long-term electrification plans.

Table 20. *EV Infrastructure Costs by Year, Assuming 2:1 Vehicle to Charger Ratio per year*

		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
If all chargers were L2 *non-networked*											
Capital Costs	Low	$34,850	$22,500	$3,000	$17,000	$20,500	$25,000	$53,500	$117,000	$137,000	$123,000
	High	$221,339	$242,933	$32,391	$183,549	$221,339	$269,925	$577,640	$1,263,249	$1,479,189	$1,328,031
Operational Costs	Low	$3,075	$6,450	$6,900	$9,450	$12,525	$16,275	$24,300	$41,850	$62,400	$80,850
	High	$4,100	$8,600	$9,200	$12,600	$16,700	$21,700	$32,400	$55,800	$83,200	$107,800
Total Costs	Low	$37,925	$28,950	$9,900	$26,450	$33,025	$41,275	$77,800	$158,850	$199,400	$203,850
	High	$225,439	$251,533	$41,591	$196,149	$238,039	$291,625	$610,040	$1,319,049	$1,562,389	$1,435,831
If all chargers were L2 *networked*											
Capital Costs	Low	$52,275	$57,375	$7,650	$43,350	$52,275	$63,750	$136,425	$298,350	$349,350	$313,650
	High	$324,864	$356,558	$47,541	$269,399	$324,864	$396,175	$847,815	$1,854,099	$2,171,039	$1,949,181
Operational Costs	Low	$7,790	$16,340	$17,480	$23,940	$31,730	$41,230	$61,560	$106,020	$158,080	$204,820
	High	$13,325	$27,950	$29,900	$40,950	$54,275	$70,525	$105,300	$181,350	$270,400	$350,350
Total Costs	Low	$60,065	$73,715	$25,130	$67,290	$84,005	$104,980	$197,985	$404,370	$507,430	$518,470
	High	$338,189	$384,508	$77,441	$310,349	$379,139	$466,700	$953,115	$2,035,449	$2,441,439	$2,299,531

Table 20 Summary. *Cumulative EV Infrastructure Costs by Year, Assuming 2:1 Vehicle to Charger Ratio*

		Cumulative 10-year costs
If all chargers were L2 *non-networked*		
Capital Costs	Low	$553,350
	High	$5,819,583
Operational Costs	Low	$264,075
	High	$352,100
Total Costs	Low	**$817,425**
	High	**$6,171,683**
If all chargers were L2 *networked*		
Capital Costs	Low	$1,374,450
	High	$8,541,533
Operational Costs	Low	$668,990
	High	$1,144,325
Total Costs	Low	**$2,043,440**
	High	**$9,685,858**

In summary, the cumulative costs for infrastructure over the next ten years can range considerably based on the type of equipment selected and varying installation costs across different types of sites. Table 21 presents a summary comparison of the cumulative 10-year costs.

Table 21. *Cumulative 10-Year EV Infrastructure Costs (2020 undiscounted)*

Scenario	Charger Types	Vehicles per Charger	Low	High
If all chargers were L2 non-networked and **each vehicle had its own chargeport**	L2 non-networked	1	$ 1,634,850	$ 12,343,366
If all chargers were L2 networked and **each vehicle had its own chargeport**	L2 networked	1	$ 4,086,880	$ 19,371,716
If all chargers were L2 networked and **two vehicles shared a chargeport**	L2 networked	2	$ 2,043,440	$ 9,685,858

Power Management Considerations

All large fleets undergoing electrification must find ways to balance their charging load while making sure that all vehicle operational needs are met. This can be a daunting task for fleet staff, as they must still consider remaining ICEs in their fleet while onboarding EVs and accounting for energy considerations — which are typically outside of their area of expertise. Luckily, networked chargers and third party vendors offer solutions to manage challenges like ***demand charges***, which are determined by the highest level of electricity demand in kilowatts (kW — not kWh, which measures the amount of electricity consumed) during a billing period, known as the 'peak demand.' By remotely managing power draw, networked chargers can split or reduce load drawn from the grid by co-located Level 2 chargers, in order to avoid demand charge impacts which can be substantial. Charging stations located at facilities that are a part of the Energy Office's demand response program could also be managed during events, helping to further reduce demand and generate additional program revenue.

For the City, these types of charge management regime offerings — especially the possibility of splitting power among vehicles and shifting EV charging to off-peak electricity periods — may prove invaluable to managing charging costs as fleet electrification gains further momentum. There are also documented examples of entities which operate multiple EVSE stations and are utilizing creative solutions to reduce and or spread out the electricity demand in order to reduce demand charge costs. See Appendix C for a brief review of these examples.

EVSE Recommendations

1) Consolidate EVSE management under a single department and expand staffing support appropriately

Committing to electrifying a fleet is more than just procuring vehicles — it requires the installation and ongoing management of charging infrastructure to service the growing complement of plug-in vehicles in a cost-effective way.

To date, the department procuring and using the EV has also been responsible for the installation and maintenance of the associated EVSE, while OFM arranges the procurement. Meeting the goals of this plan warrants a more strategic approach to efficiently and cost-effectively building out the charging network. The fueling, maintenance, and procurement logistics will require increased levels of coordination compared to the management of a conventional vehicle fleet. Therefore, **centralizing duties under one unit to take ownership of the EV charging equipment management is critical.**

- **The Managing Director's Office (MDO) has been identified as the department best suited to be the centralized overseer of all municipal EVSE:** Concentrating the skills, knowledge, and experience of charging station procurement, installation and management under one department is a recognized best-practice for achieving maximum cost-effectiveness and easing the City's future efforts to deploy charging equipment at a wide scale. Having the Managing Director's Office oversee the CFC to take ownership of all EV infrastructure-related needs would streamline data collection and analysis, the tracking of program costs, and the identification and rapid response to maintenance needs in order to ensure reliability. Centralized EVSE program management under MDO would create a uniform point of contact for other city departments and external stakeholders seeking information and updates on the City's EV deployment and its impacts.

  For optimum efficacy, a centralized oversight structure would still necessitate coordination with, at least, oTIS, OOS, the Energy Office, and DPP — as well as other departmental building owners whose sites will house charging equipment. OFM will continue to identify and respond quickly to maintenance needs to ensure reliability, and report electricity use data to the Energy Office so the utilities management database can incorporate chargebacks to build energy use as needed.
- **The City should hire a Transportation Electrification Manager:** To support the implementation of the Clean Fleet Plan and spearhead the electrification of Philadelphia's fleet, the City should allocate funds to hire a Transportation Electrification Manager as the go-to person for all electrification and alternative fuel issues. Among other duties, this Manager would compile resources, track operational metrics, and lead activities related to the Clean Fleet Committee (see Vehicle and Fueling Recommendations, #5 above), which include accounting for EVSE planning and installation to support City EV deployment. Importantly, the Manager's execution of City EV and EVSE deployment must be actively managed to ensure that the city's real-world procurement, installation, and deployment timelines are meeting expectations and projections

(such as those provided in this plan and the attending consultant reports). Another important responsibility for this role is to coordinate with City grant researchers and writers, and to facilitate mutual support in the pursuit of incentives and grant financing to help fund Philadelphia's fleet transition. It is recommended that the Transportation Electrification Manager be located in the Managing Director's Office.

- **The City should define a streamlined process for the uniform procurement, permitting, installation, and utilization-tracking of City EV charging equipment:** A defined process for the procurement and installation of EV charging equipment to service Philadelphia's growing plug-in vehicle fleet must be established. Currently, the procurement of the charging equipment (done by OFM) is disconnected from the installation and maintenance of said equipment (which is managed by the department to which the EVSE is provided) and there is no coordination between EV drivers or departments on charging station deployment. This results in a situation that fails to capture implementation efficiencies and advanced planning opportunities to support broad fleet electrification, all of which would substantially reduce installation costs to the city.

  The City should establish a defined process across all agencies to unify activities related to charging equipment procurement and installation at City facilities/sites, in line with the planned procurement of EVs. Especially when trenching, curb cuts and drilling through hardscaping or structures will be required to make infrastructure upgrades and/or complete equipment installation, it is most cost-effective to plan for future electrification by installing more capacity than is needed in the moment. This installation factor is the source of greatest variability in installation costs, with other factors being the need of electrical panel upgrades (if required) and distance from EV charger to electrical panel.

  It is also recommended that City EVSE permitting processes be simplified and streamlined to support the rapid EVSE deployment and fleet transition presented in this Plan. Uncertainty, process redundancies, and burdensome or unnecessary requirements cause delays during the permitting process which can then delay or outright deter EVSE installation and EV procurement. For the purposes of achieving rapid EVSE deployment at City facilities, it is worthwhile for the City to subject fleet electrification EVSE installations to the least burdensome (and therefore most economical) permitting processes. In several jurisdictions, this means defining Level 2 charging equipment as appliances and allowing their installation to fall under 'minor' electrical work. On the other hand, the need in many cases to create excess electrical capacity or conduit/panels at City facilities may complicate EVSE installation scenarios, necessitating increased inspection stringency.

  However, efficiencies in EVSE permitting can be achieved, the City is encouraged to make these changes in support the Clean Fleet Plan. This would make EVSE installation faster, easier and more cost-effective. Streamlining and simplifying the EVSE permitting process and providing clarity of applicable fees will assist vendors, service providers and City liaisons to plan and execute EVSE installations in a timely manner, mitigating project costs and meeting project timelines.

2) Develop an EVSE Deployment Scenario

To support the Clean Fleet Plan, consultant ICF developed a Charging Infrastructure Analysis Tool to provide the City with EV projections and the range of expected costs associated with the charging infrastructure anticipated over the next 10 years. This Tool is valuable for appreciating the long-term EVSE program scale and its estimated fiscal impacts. Overall, the objective of the Tool is to help the City understand the quantity of infrastructure needed and what a program at scale would look like and cost over the next ten years. **OFM should use this Charging Infrastructure Analysis Tool as the basis to develop a 10-year EV Charging Station Deployment Plan to present to the Clean Fleet Committee, based on the recommendations provided in this Clean Fleet Plan and attending Appendices. OFM should then begin pursuing the procurement and deployment scenario immediately.**

- **Expand dual-port L2 charging availability at locations included in deployment scenario:** To meet the current and future needs of the fleet, it is recommended that the City pursue a mix of **non-networked Level 2 charging stations in the short-term** and **networked Level 2 charging stations in the mid- and long-term**.
  - In the short-term, given the relatively low number of plug-in vehicles on the fleet, the benefit of networked Level 2 charging stations may not exceed the higher capital costs and ongoing networking fees. The City should review the operational status of existing City EV charging equipment and replace/upgrade equipment as necessary.
  - In the mid- and long-term, especially as queueing technology and other management services develop, it will be important for the City to begin procuring networked Level 2 equipment and leveraging the connected capabilities to coordinate and manage increased EV charging and maintenance schedules.
  - The City should prioritize purchasing (owning outright) EV charging equipment at sites that require significant infrastructure upgrades. Charging-as-a-Service (see page 42 above) may be a beneficial approach in cases where infrastructure upgrades remain low.
- **Require new and retrofitted municipal buildings to be 'EV-ready'**: The installation of EV charging infrastructure is four to six times less expensive when included during the construction phase as opposed to a building retrofit, an activity with typically includes costs such as labor expenses for demolition, trenching and boring, balancing the circuits, and new permitting costs.

  The City should develop and implement an EV Infrastructure Ordinance for municipal buildings, sties, and facilities which capitalizes on the construction phase (new construction, extensive facility alterations/additions, or upgrades to surface parking or facility electrical systems). This ordinance would define EV-Ready Parking Spaces and mandate the installation of full circuits (electrical panel capacity + branch circuit + constructed raceway + 240-volt outlet accessible to parking space) for a certain percentage of existing parking spaces, making these spaces ready for the 'plug and play' installation of Level 2 EV Charging Station equipment. Strategic alignment with municipal capital improvement timelines and the EVSE Deployment Scenario (above) can further minimize total costs and barriers.

Building or facility retrofitting activities will trigger EV-readiness requirements if they:

1. **Involve 50% or more of building property**
2. **Include the parking area (repaving or lighting)**
3. **Include upgrades to electrical infrastructure**

3) Provide Adequate Signage and Accessibility

It is recommended to utilize signage and accessibility guidance to ensure proper wayfinding and usability of chargers. This includes two core elements:

- **Signage and Wayfinding Guidance:** the Federal Highway Administration (FHWA) has issued interim signage guidance for EV charging stations, which can be used for signage of local EVSE in turn.
- **ADA Accessibility Guidance:** There is currently no regulation with respect to EV charging and the Americans with Disabilities Act (ADA). Guidance has been issued however for illustrating how accessibility can be planned into EVSE spaces. Incorporating accessibility into charger design will ensure safety and ease-of-use and access to EV owners and users of all capabilities.

Conclusion

Identified as a key component of the city's Climate Action Playbook, the transition to a municipal fleet of clean and electric vehicles will see the City lead by example on reducing carbon pollution, achieve cost savings, support local job creation, and enhance Philadelphia's competitiveness in the state and among peer cities. While there has been some penetration of zero-emission electric vehicles among the municipal fleet of approximately 5,500 vehicles, most fleet vehicles are still internal combustion engine (ICE) vehicles which produce carbon emissions and other tailpipe air pollutants during operation.

This City of Philadelphia Clean Fleet Plan is intended to provide guidance and recommendations on concrete actions that the City can take to significantly reduce fleet-related emissions by transitioning its vehicles to electric options. Focusing specifically on the next ten years, the plan identifies opportunities to accelerate electrification of the light, medium, and heavy duty fleet, and makes recommendations to set clear procurement targets, institutionalize procurement policies and procedures that prioritize clean vehicles, and build out charging infrastructure in an efficient and cost-effective manner.

If the City of Philadelphia achieves 100% procurement of clean energy for municipal operations by 2030 and adopts the recommended targets for light and medium-duty vehicle electrification, GHG emissions for the light and medium duty fleet are estimated to decline by 47%. Based on available vehicle model prices and projected cost trends, BEV sedans are projected to reach cost parity with conventional vehicles by 2025, whereas electric SUVs, pickup trucks, and vans are projected to remain more expensive than conventional vehicles through 2030. It's estimated that the vehicle electrification scenario articulated in this plan would incrementally cost the city $7M between 2021 and 2030 in capital costs, and save the city $2.5M in operating costs over that same time period. If the city could leverage available state incentives for vehicles and EVSE, the city could potentially also save on capital costs in the same time period.

Appendices

Find appendix documents A through C referenced throughout the Plan linked below.

Appendix A: City of Philadelphia - DRVE Tool Analysis Report

Appendix B: WES 2020 Vehicle & Fuels Report

Appendix C: ICF EV Charging Infrastructure Report

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