City of Albany

NEW YORK

Fleet Electrification Study

December 2021

Project Sponsor:

NY Power Authority

Project Team:

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Executive Summary

Energetics and Clean Fuels Consulting evaluated the City of Albany's potential to electrify its vehicle fleet to reduce fuel consumption, maintenance costs, and greenhouse gas emissions. The project was structured to provide an evaluation and analysis of the current vehicle fleet, internal management practices, and vehicle trip data. The evaluation and analysis were informed by interviews with key staff responsible for maintaining and operating fleets in various City departments. The project team collected, reviewed, and analyzed information on current fleet practices, fuel management, preventive maintenance, routine service, vehicle allocation, procurement, infrastructure, and policies. The team also analyzed telematics data collected over a 14-month period using hardware installed on a subset of City-owned vehicles.

The City of Albany vehicle fleet consists of approximately 680 vehicles, 43% of which are classified as light-duty sedans, sport utility vehicles (SUVs), pickup trucks, vans, and motorcycles. The remaining assets are a mix of medium- and heavy-duty trucks, specialized vehicles, and related equipment. Fleet vehicles are owned and operated by individual departments who are responsible for all costs including purchasing, fueling, and maintenance. This decentralized structure results in a high degree of operational variability among City departments.

Telematics data can provide valuable insight that informs decisions on electrification. The City fleet data was analyzed using multiple parameters to provide quantifiable information pertaining to potential benefits from electrifying the City fleet, both financially and environmentally. There are two general report types generated by the telematics software and used in this study. The *Fuel Economy and Usage* report provides high-level summary data pertaining to the operational characteristics of each vehicle. Monthly reports were provided for 161 vehicles from the five Departments over a 14-month period, from February 2019 through March 2020. Additional reports provide more detailed data related to vehicle operation and emissions, but these were only collected for a smaller subset of vehicles. Although there is wide variability in the data, the analysis provides a cursory look at the fleets of individual departments and a variety of vehicle types. **Key findings from the telematics data analysis include:**

- Daily Utilization – although some vehicles make as many as eight or nine trips per day, the average per-vehicle trip distances are relatively short, ranging from 0.2 to 15 miles, with an average trip distance of four miles across all vehicles sampled.
- Operating Time – it is common for vehicles to operate up to eight hours or more on active days while reporting very few, or no, operating hours on other days. This variability has implications on electrification as it relates to vehicle charging.
- Idling Time – while some vehicles report a very low percentage of idle time, at the fleet level upwards of 35-40% of time is spent idling monthly. Electric vehicles (EVs) eliminate idling inefficiency and can lead to significant cost and emission savings just by addressing this problem.

Interviews with key City staff and a review of fleet management policies and practices identified several opportunities to better operate the fleet. An updated and modernized tracking system would allow the City to confidently identify cost-saving and emissions-reducing measures. **Recommendations related to fleet management include:**

- Fuel Management – the decentralized fueling operation should be replaced with an integrated, City-wide fuel and maintenance management system to accurately track and analyze utilization on a per-vehicle level. Department fleet managers should receive comprehensive training on this system to ensure consistent data collection and analysis across the entire City fleet.

- Vehicle Miles Traveled (VMT) – reducing VMT reduces operating and maintenance costs, as well as emissions. The fleet managers should start tracking annual VMT and departments should look to identify ways to eliminate wasted mileage.
- Preventive Maintenance and Routine Service – creating a centralized maintenance and service reporting system would allow for improved analysis to identify inefficiencies and support sustainability initiatives.
- Fleet Data Management – data collection and analysis are essential components of modern fleet management practices. The City should create a staff position responsible for assisting department staff in the collection, reporting, and analysis of vehicle data.
- Sharing of Vehicles – as more of the fleet is electrified, Departments should be encouraged to informally share vehicles as needed, particularly when there is occasional need for longer trips that don't lend themselves to EV use. For shorter trips or for staff who only need a vehicle occasionally, a small EV vehicle pool may be feasible.
- Fleet Right-Sizing and Vehicle Allocation – the fleet appears to be properly sized with most vehicles used regularly. A comprehensive tracking of VMT would be necessary to quantify use and identify any underused vehicles.

A review of vehicles in each departmental fleet was used to provide a priority EV replacement schedule of fleet vehicles. These recommendations are intended as a guide for fleet managers to evaluate vehicle replacement and purchasing plans to maximize capital investment while achieving the City's decarbonization goals, as outlined in the Albany 2030 Plan, Albany Climate Action Plan, and recent efforts by the City administration to reduce greenhouse gas emissions. **Recommendations related to vehicle electrification include:**

- Near-term transition of light-duty passenger vehicles – the light-duty sedans and SUVs present the best opportunity for near-term electrification. There are numerous commercially available EVs on the market that municipal fleets are successfully integrating. Departments should evaluate upcoming vehicle purchasing plans to identify opportunities to begin a complete transition of these vehicles to EVs.
- Pilot electrified pickup trucks and vans – pickup trucks and vans contribute more greenhouse gas emissions on a per-vehicle basis than the smaller vehicle classes, but the commercialization of electrified pickup trucks and vans is not as fully-developed as with smaller vehicles. The use of these vehicles in the fleet varies significantly and EV performance (both during operations and while charging) must be proven to meet the job requirements. A pilot study conducted with a small sample of vehicles should be implemented to gain insight as to how and when this segment of the fleet can be electrified.
- Consider gas-electric hybrid police vehicles – patrol vehicles in the Police Department fleet accrue much higher annual mileage and spend more time idling than all other vehicles. While the gas-electric hybrid drivetrain for pursuit-rated vehicles provides only modest gains in fuel efficiency, the use pattern of this subset of vehicles implies that substantial reductions in fuel cost and greenhouse gas emissions could be realized over time by phasing in hybrid electrics and eventually plug-in hybrids or fully electric models.
- Consider future transition of medium- and heavy-duty vehicles – electrification of medium- and heavy-duty vehicles is often a more complex process than with the smaller vehicle classes. Utilization and vehicle customization varies greatly while the development of electrified drivetrain technology has been slower. The departments operating medium- and heavy-duty vehicles should continue to monitor the development of electrified options for these vehicles and the peripheral equipment related to their use.

Electrification can result in cost savings and reduced greenhouse gas emissions. **The most immediate and tangible benefits realized by implementing a transition of the light-duty sedans and SUVs to EVs include**:

- Purchasing and Operating Cost – nearly $90,000 could be saved over a ten-year period from lower fueling and maintenance costs of EVs that offset the higher initial cost per vehicle.
- Greenhouse Gas Emissions – an incremental transition to electric sedans and SUVs will prove to have a considerable impact on greenhouse gas emissions, particularly carbon dioxide (CO_2), with benefits beginning to accrue immediately and increasing annually as more EVs are phased into the fleet. Over a ten-year period, the proposed vehicle replacement schedule analysis shows the annual reduction in CO_2 reaching nearly 900,000 pounds below current levels by FY2032.

Additional electrification recommendations are also expected to result in reduced cost and decreased greenhouse gas emissions, though there are limitations on quantifying the benefit due to the limited commercial availability of vehicles and data related to their cost of operation.

Introduction

The City of Albany is the Capital of New York State and the 6th largest city in the State with a population of 95,358. Five departments operate most of the City's fleet vehicles with a few vehicles operated by various other departments. The five departments are Department of General Services (DGS), Police Department, Department of Water and Water Supply, Fire Department, and Department of Recreation. Fleet management, including procurement, deployment, maintenance, repair, and replacement is decentralized and managed at the department level. City departments, except for the Fire Department, primarily utilize a central fueling station operated by DGS. The City fleet has approximately 697 vehicles, which can fluctuate as older vehicles are decommissioned and sold before or after the new replacement vehicles are added.

The City's Comprehensive Plan, the Albany 2030 Plan, contains the 2012 Albany Climate Action Plan which identifies electrified vehicles (EVs) as a strategy to reduce greenhouse gas emissions. The Office of Sustainability and Sustainability Advisory Committee oversees the City's environmental stewardship efforts. An EV Feasibility Study in 2012 identified actions necessary to make the City of Albany more hospitable to EVs. In 2016 and again in 2020, The Capital District Clean Communities Coalition and Capital District Transportation Committee (CDTC) released a Capital District Zero Emission Vehicle Plan. This plan goes into further detail on strategies to make communities in the region more "EV Ready," with a focus on private EV ownership and the installation of public charging infrastructure.

The goal of this project is to analyze the City's municipal fleet use patterns, develop recommendations on adopting more EVs, and evaluate fleet management practices among the various City departments. The study's scope outlined by the City of Albany and the New York Power Authority (NYPA) included:

- Data analysis of City-owned vehicles using Verizon NetworkFleet on-board telematics devices;
- Interviews with City employees who use personal vehicles for City business;
- Quantitative analysis of various vehicle usage parameters, such as
  - Average Daily Utilization,
  - Average Vehicle Fuel Economy,
  - Average Length of Engine Hours,
  - Average Duty Cycle Speed, and
  - Average Idling Time;
- Recommendations on electrification of the current fleet with a priority replacement schedule of fleet vehicles;
- A financial summary to determine the capital investment necessary to achieve suggested recommendations, along with monetary and energy savings estimations for electrifying the fleet; and
- Qualitative analysis of existing fleet management practices, addressing
  - Preventive maintenance schedules based on vehicle diagnostics and duty cycles,
  - Fleet right-sizing and motor pool opportunities, and
  - Optimal size of the fleet, based on vehicle count and vehicle types.

Report Structure

The overview section describes the City-wide fleet along with detailed descriptions of the fleet composition and management practices of the departments. The Vehicle Trip Data Analysis provides the quantitative analysis of fleet vehicle use patterns, derived from data captured by telematics devices. This provides a representative snapshot of fleet vehicle use since only a portion of the fleet vehicles had telematics devices and the available data was collected within a finite time period, from February 2019 through March 2020. The Fleet-wide Best Practices presents policies, procedures and practices used across the industry and adds recommendations on how these could be implemented by the City. The Electrification Recommendations outline relevant EV options and suggest a phased electrification of the City fleet over time and as technology and product offerings evolve. The Financial Analysis quantifies the anticipated costs to implement the electrification recommendations. This analysis combines the available fleet composition information with the vehicle usage data to estimate the initial costs and ongoing savings for electrification. The Environmental Analysis provides insight into the current and projected greenhouse gas emissions of the City fleet.

This report contains the project team's findings related to the study's scope. During the analysis, the project team discovered unique characteristics in (1) the data provided for analysis, and (2) the way that personal vehicles are used by some employees. The project team was planning to use both historic and current telematics data for the analysis, however, only a very limited timeframe of current data could be accessed which would not be representative of variable functions throughout a year and may still be impacted by COVID restrictions. Therefore, data analysis was only conducted using data from the original collection period (2019). The original project scope requested 15-20 City employees to be identified and interviewed about how they use their personal vehicles for conducting City business. In consultation with the various City department officials, the project team found very little reimbursable use of personal vehicles. The only significant amount of personal vehicle use is by the Department of Buildings and Regulatory Compliance inspectors who have a collective bargaining agreement that outlines this practice and cannot be changed. Thus, the project team modified the interviews to be with administrative and managerial staff in the departments that operate the larger fleets. This revised approach was very useful in gaining insight into the management of the various department fleets, given the highly decentralized nature of the City-wide fleet.

Site Visit and Interviews

Interviews were conducted with senior fleet management staff in the City departments that house significant vehicles; DGS, Water, Recreation, Police, Fire, and Codes. Initially, phone interviews were conducted, and in some cases follow up calls were made. Additional information was gathered during project meetings. A series of in-person discussions with senior fleet-related staff were conducted during a site visit on November 1st and 2nd. Vehicle staging facilities were visited, along with the main buildings for DGS (including the landfill maintenance shop) and Water. Police provided a tour of their vehicle parking and an interview was held with a patrol officer at their headquarters. The 200 Henry Johnson Boulevard parking lot was visited, to view the Level 2 charger and understand what City vehicles residing there might easily transition to electric. Recreation provided an excellent explanation of its mission and the vehicles while touring their facility at 7 Hoffman. During a City Hall visit, the Energy Manager and Acting Budget Director provided valuable insight into the City's overall vehicle management practices and the City's budget process for planning and conducting vehicle purchases. The Level 2 charger at City Hall was also visited and a member of the public who regularly uses it provided feedback on its ease of use and affordability.

The intent of the interview process was to determine how each department fleet operated, including purchasing and replacement cycles, duty cycles, preventative maintenance, routine repairs, and fueling. Discussing software systems used to track the vehicles was also an important aspect of the information gathering. Researchers also sought information on the City's experience with alternative fuels, hybrids, and EVs to date. Inquiries were made to see if staff were leveraging local resources such as Capital District Clean Communities, which supports the deployment of alternative fuel technologies for vehicles and fueling infrastructure. Finally, the level of experience in dealing with grants, both writing and administering them, was explored.

Fleet Overview and Departmental Assessment

Citywide Fleet Overview

The City of Albany has approximately 680 vehicles based on the master vehicle list provided for the project, of which 294 are classified by the City as light duty compact vehicles, sedans, SUVs, pickup trucks, vans, and motorcycles. Through attrition, the current vehicle total may vary as older units are removed and sold for auction, and replacements enter the fleet. The fleet management structure is highly decentralized, with large departments managing their respective fleets independently and having their own fleet managers who oversee their fleet and its repairs. The primary departments managing fleets include the Department of General Services (DGS), Albany Department of Water and Water Supply (AWD or Water), the Albany Police Department (APD or Police) and the Albany Fire Department (AFD or Fire).

Vehicles are phased out and replaced based on intra-departmental review and assessment, generally by the executive deputy commissioners working in conjunction with the fleet managers and operations managers. Approvals are provided by the commissioners and additions to the fleet must be justified. Replacements are based upon an evaluation of service life, mileage accrued on the vehicles, and their annual repair costs. Most departments acquire new vehicles via borrowing, though some departments such as the Police, bring forward direct capital. The vehicle acquisition budgets are set out in the City of Albany budget, outlined annually per department.

The internal fleets make use of a fleet management software program known as Fleet Maintenance Pro, which is developed and provided by Innovative Maintenance Systems[1]. Each large department uses this program independently, and due to the various versions of the program, the platform used in one department in some cases does not overlap with others to provide a unified picture of the total City fleet. The software is primarily used to track preventive maintenance and repairs. Mileage is inputted into the system when a unit comes in for service, to set a trigger for the next maintenance event but vehicle miles traveled is not tracked City-wide.

The primary fueling facility is located at DGS's building at 1 Richard Conners Boulevard. This is an aged facility dispensing diesel and gasoline, with a canopy to shield users from precipitation. The fuel management system used is OPW Fuel Management Systems which records the fuel amount dispensed per fueling incident and linked with the vehicle via a fob which activates the pump. A vehicle odometer reading is entered by the driver before fueling, but there is no capacity within the aged system to determine if the reading is reasonably accurate. The OPW fuel management data system is not connected with the fleet management software Fleet Maintenance Pro. There are small satellite fueling locations at the Landfill and the Golf Course, which are not on the OPW system; thus the unique fueling incidents at these locations are not able to be recorded or tracked.

Most City departments refuel at the DGS facility on Richard Connors Boulevard, except for Fire which has its own fuel dispensing capacity at the firehouses. There is a shared services agreement with the Albany Housing Authority and the Albany Water Board, which allows them to also fuel at the DGS facility.

Vehicle maintenance within the departments is generally a mix of in-house routine and preventive maintenance activities, combined with dealer-based warranty work. Certain large repairs also take place at the dealers. The exception is the Police, which sends all its vehicles to an approved dealer for service.

[1] Innovative Maintenance Systems. https://www.mtcpro.com.

Departmental Assessment

The City of Albany has two primary oversight departments, the Department of Administrative Services (DAS), and DGS. Many municipalities have numerous vehicles operating out of City Hall, but Albany does not so DAS has very few vehicles. Besides DGS, Police, Fire, and the Water Board have a substantial number of vehicles. The remaining departments have few vehicles. The Department of Buildings and Regulatory Compliance, which provides code enforcement and other functions, has a contractual agreement that states inspectors are reimbursed for using their own vehicles upon an agreed reimbursement schedule. Again, vehicles are selected based upon age, budget outlook and internal senior staff review. The more aged assets reside in the small departments and include vans, sedans, and a few pickup trucks.

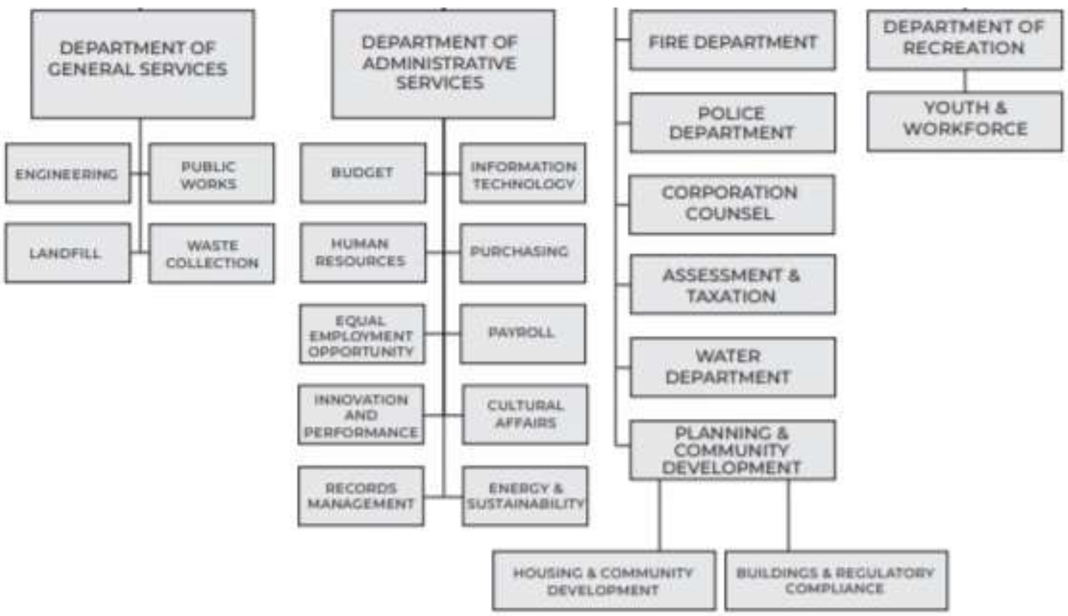

Figure 1. City of Albany Organizational Chart

Within the city-wide fleet, there are 22 assigned take home vehicles across various departments for those employees required to respond on a 24/7 basis, including staff at Water, DGS, and Fire. There are also eighteen (18) Police SUVs listed as take-home but did not include a specific assignment.

Department of General Services

The Department of General Services (DGS) has the largest fleet of any department. Staged out of main headquarters at 1 Richard Connors Boulevard, DGS has approximately 237 vehicular assets, plus a vast array of small equipment, of which the department keeps good track[2]. This includes the 29 units at the landfill, the two units at the Farm, two additional units noted “F1 and F3”, and various miscellaneous vehicles such as a bucket truck and an aged van. The DGS fleet includes six units assigned to Engineering, which are mostly Jeep SUVs, though one is listed as a 2011 “Ford hybrid”, likely an Escape. The original DGS fleet list noted 264 vehicles, which might have included some off-road assets or Gator type small carts. Golf carts maintained by DGS are included in the 237-vehicle fleet list.

DGS has two satellite locations, the City of Albany Landfill and the Capital Hills golf course. Both locations have small fueling facilities, which are not on the OPW system. Heavy-equipment repairs are performed at the landfill in

[2] Based on the list provided to researchers in November 2021 by DGS.

a modestly sized shop. As was noted, most DGS vehicle fueling occurs at the main 1 Richard Connors Boulevard facility. This facility's age could not be determined but appears aged and the dispensers appear to need replacement. An assessment of this facility should be performed to determine when the most cost-effective time for the City to consider investing in an integrated fuel management system that integrates with the City's existing Fleet Maintenance Pro software to allow more detailed tracking of vehicle mileage, fuel consumption (including electricity), and other metrics.

Figure 2. DGS Refuse Truck

DGS has a typical multi-tasking fleet composed of light-duty trucks, a few vans and sport utility vehicles (SUVs), many medium-duty trucks, and a variety of heavy-duty vehicles including numerous dump trucks, bucket trucks, and rack trucks. The City collects refuse, so they have large packers, smaller "flipper" packers, and innovatively, uses mini-packers which allows DGS to operate more flexibly in assigning staff. It has a fleet of street sweepers, which have been downsized, similarly to the waste packers.

DGS has purchased some best-in-class fuel economy models for its light-duty pickup trucks via acquisition of nine Ford F-150 hybrids which joined the fleet in 2021. These vehicles are still being evaluated but City staff reported seeing improved fuel economy over the standard pickup in use. Administrative vehicles include two Jeep SUVs and a Ford F-150 pickup truck. DGS uses the Onondaga County purchasing contract to order its vehicles and can also make use of state-wide contracts.

Police Department

With 198 vehicles, the Police Department has the second largest City fleet and is composed of patrol, administrative, and special operations vehicles. Vehicle types include sedans, SUVs, a few vans and pickup trucks, a bus, mobile home, and a recreational vehicle. The Dodge Durango is the current patrol vehicle of choice, purchased off state contract. Favorable attributes for Police include its larger size, good inclement weather performance, space for electronics/computer modules, and general performance. Fuel economy does not appear to be a criterion in its choice. Police has approximately 30 patrol vehicles. The department is aware of the recently available Ford Interceptor hybrid and will be ordering a few of these vehicles for non-patrol duty.

Figure 3. Police Cruiser and Animal Control Van

The Police recently performed an internal study on leasing rather than purchasing vehicles. Based on negotiations with potential leasing companies, the Department decided that 26 vehicles would be leased in the next replacement cycle, 20 of which will be the HEV Ford Interceptor SUV, though not slated for patrol. A primary factor noted for making this decision was that the leasing company offered a lease scenario that allows for more timely replacement of a greater number of older vehicles.

The Police Department sends its vehicles to a local dealership for service. Since most of the fleet is newer, service and repairs are primarily covered by their warranty. However, there are many older vehicles still in operation that are not covered.

Department of Water and Water Supply/Albany Water Board

The Department of Water and Water Supply and Albany Water Board share administrative functions and resources, including vehicles. Operationally, staff is employed by the City Water department, while the vehicles and equipment are owned by the Water Board. For the purposes of this report, the Department of Water and Water Supply and the Water Board are collectively referred to as the Water Department. The Water Department operates two reservoirs, one of which is far from the city and brings water via a long pipeline into the city limits. This pipeline has a dirt service road used for security and must be kept clear of snow in the winter. The department also maintains the sewers for wastewater conveyance but does not treat the sewage. It also performs flood risk assessment and mitigation.

The Water Department has the third largest City fleet. The most current available inventory includes 101 light-duty, medium-duty, and heavy-duty vehicles. The inventory indicates that some vehicles have been sold and/or replaced. Removing these from consideration as “active” vehicles leaves a total of 93. The fleet is comprised of specialized heavy-duty vehicles (e.g., vac trucks, dump trucks, special duty trucks, backhoes, and loaders), medium-duty utility work trucks (3500 series), light-duty pickups (2500 and 1500 series), SUVs, and larger work vans used by plumbers and special trades. There is one MY2012 Ford Fusion used as a mail car.

Figure 4. Chevrolet Bolt Charging at the Water Department

The fleet deployed two Chevrolet Bolt EV's in 2021, which are domiciled at its main headquarters at 10 N. Enterprise Drive. These are used for meter repair, are large enough to carry needed equipment, and have been well received by their drivers. They charge in the garage using a dual port Level 2 charging station. Water keeps the light-duty fleet vehicles inside the garage, with the larger heavy-duty vehicles in the exterior parking lot. Water has a maintenance facility for in-house preventive maintenance and repairs. It uses the Fleet Maintenance Pro software and has a good inventory spreadsheet of assets with replacement costs.

Fire Department

The Albany Fire Department has approximately 51 vehicles and a dozen pieces of equipment (trailers, boats, and an ATV). The large heavy-duty vehicles are primarily fire engines and pumpers, with some tillers. It has larger 3500 series medium-duty pickup trucks, a selection of SUVs (Explorers and Tahoes) and a sedan, as well as some older pickup trucks (Silverados and Fords). There is also a golf cart and one Polaris/Global Electric Motorcars (GEM) low-speed vehicle (LSV). Fire tends to have older light-duty vehicles which they purchase used from volunteer fire departments. These vehicles fuel at Fire facilities; the headquarters at 26 Broad Street and the eight firehouses. Fire primarily maintains its own equipment, with one master mechanic and two technicians.

Department of Recreation

The Recreation Department is responsible for recreation activities at several locations throughout the City. It oversees facilities at various City-owned parks and facilities such as pools, ballfields, and the skating rink. Grounds maintenance at City Parks is undertaken by DGS. Recreation has 14 vehicles, comprised of vans, pickup trucks, a rack truck, and dump trucks. Most vehicles domile at its main office on Hoffman Avenue. The heavy-duty dump and rack trucks are required to transport materials associated with events, facility upkeep (e.g., wood chips for the playgrounds), and plowing parking lots in the winter.

Recreation Department vehicles are maintained by DGS. DGS assists with additional vehicles for specific events, where they may assist in transporting items to a park, field, or event location. This sharing allows for greater flexibility and inter-departmental cooperation.

Department of Buildings and Regulatory Compliance

The Department of Buildings and Regulatory Compliance is under the Planning and Community Development Department. They are responsible for enforcing City building-related codes as well as administering and enforcing Code provisions pertaining to building applications and permits, as well as permits for plumbing, electrical, and other actions.

Figure 5. City Hall Charging Station

A significant portion of the work is performed by a group of inspectors. These inspectors receive their work orders daily by reporting to their office, located at 200 Henry Johnson Boulevard. The inspectors print a list of their appointments each morning. They plan their trips based upon the noted stops (no routing software is used), and generally return to the office at the end of the workday. Codes inspectors set appointment times within morning and afternoon windows. Construction inspectors set an hourly window for arrival. Currently there are eight code enforcement inspectors and seven construction inspectors. The department is expected to add one new construction inspector in January 2022. Currently, the inspectors use their personal vehicles to perform all their inspection duties. Inspectors record the starting and ending odometer readings each day and submit a monthly reimbursement request. They are paid an annual one-time stipend of $400 plus receive reimbursement for actual mileage at the prevailing IRS business rate (currently $0.56 per mile). This has been established through a relatively recent CSEA labor agreement so any recommendations for adopting alternative options or procedural changes for the group is not feasible at this time. Changing from the current personal vehicle system would necessitate adding at least 16) vehicles to the fleet as all the inspectors go out each day.

Vehicle Trip Data Analysis

The project team analyzed vehicle trip data from a subset of the City fleet to identify which vehicles may be suitable for electrification. Data was collected using Verizon NetworkFleet telematics devices installed by NYPA on vehicles from five City departments. Data reports covering a 14-month period, from February 2019 through March 2020, were provided for this analysis. Due to delays in obtaining and installing telematics units, the dataset is not consistent across the 14-month period for each department. However, the existing data does provide insight into vehicle use across several parameters.

Verizon NetworkFleet captured data on distance traveled and other various trip characteristics, fuel economy, and greenhouse gas emissions. NYPA and the City extracted data reports and provided them to the project team for analysis.

There are two general report types generated by the telematics software and used in this study. First, the *Fuel Economy and Usage* report provides high-level summary data pertaining to the operational characteristics of each vehicle. The report includes vehicle identification information (e.g. Vehicle ID, VIN, year, make, model), and monthly distance traveled, fuel consumption, and fuel economy data. Monthly reports were provided for 161 vehicles from the five major City Departments: DGS, Police, Water, Fire, and Recreation. The reports covered a 14-month period, from February 2019 through March 2020, although some monthly reports are missing and the number of vehicles reporting varied from month to month. Additional reports provided more detailed data, but these were only for a smaller subset of vehicles and included: *Begin/End of Day; Drive Time Summary; Fleet Utilization; Greenhouse Gas Emissions; Idle Time; and Stop Detail.* There is wide variability in which vehicles are included in these reports and the granularity of data is not consistent from one report type to the next (e.g. some reports return data on a monthly basis while others report daily or trip-level data). These idiosyncrasies in the data have an impact on the level of analysis presented and account for the variability in which departments' vehicles are reported in the charts and tables in this section. The project team has made every effort to merge these incongruent datasets to provide as detailed analysis as possible.

Daily Utilization

NetworkFleet usage reports were used to conduct a high-level analysis of distance traveled, fuel usage, and fuel economy. However, only the more detailed *Stop Detail* reports allows for further analysis of vehicles within the Fire, Police, and Recreation departments. Figure 6 shows the distribution of trips by department.

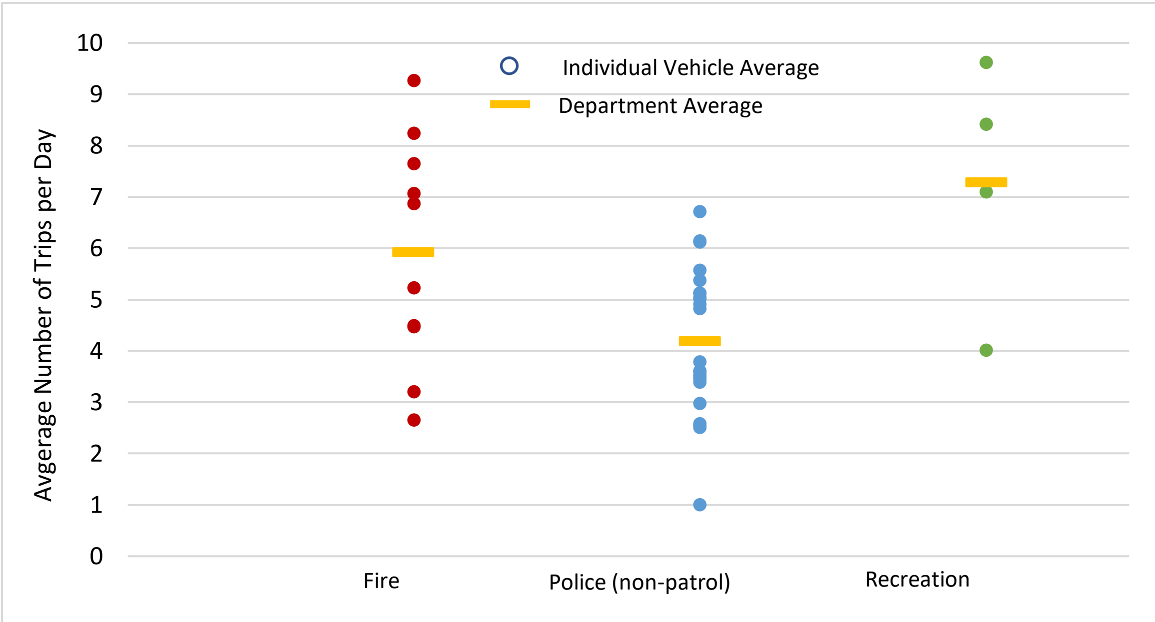

Figure 6. Distribution of Trips per Day by Department

Figure 7 shows the distribution of trip distance by department. The data show that Fire Department vehicles have a longer average trip distance (6.9 miles). Fire Department vehicles have the greatest range in trip distance (11.8 miles). Police Department vehicles have the lowest average trip distance (2.9 miles). Recreation Department vehicles have an average trip distance only slightly higher than Police (3.1 miles) but the range is smallest (1.8 miles) and the maximum average trip distance (4.5 miles) is lowest among all three departments.

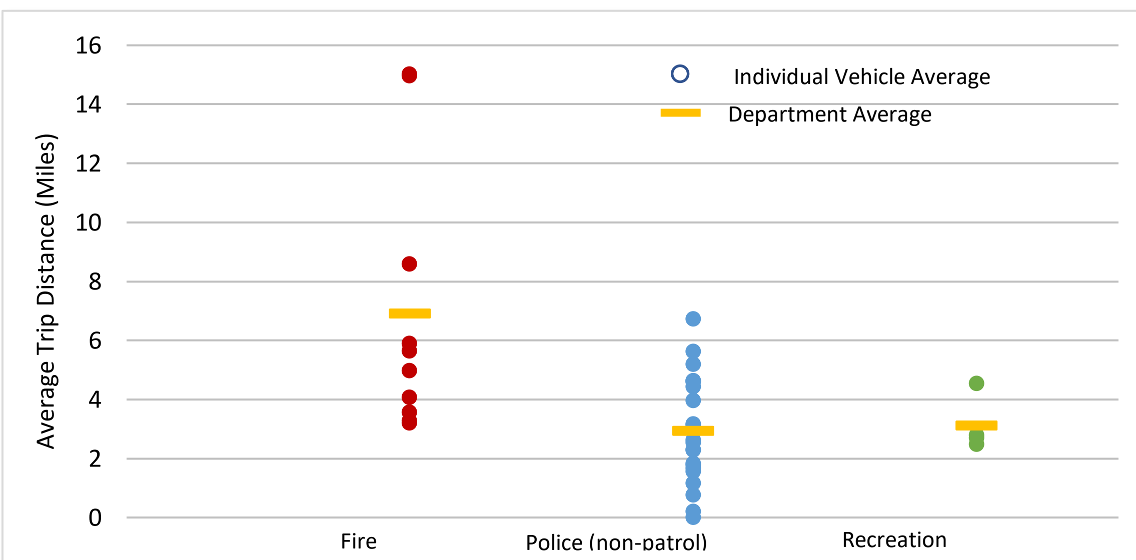

Figure 7. Distribution of Trip Distance per Vehicle by Department

Operating Time

A detailed look into the data reported by vehicles in the Police (non-patrol), Fire, and Recreation departments reveals trends in daily operating hours. The data shows that some light-duty Fire Department vehicles experience long operational times on some days and relatively little use on others. Hours of vehicle operation appear to be slightly steadier in the Police and Recreation departments, as shown in Figure 8.

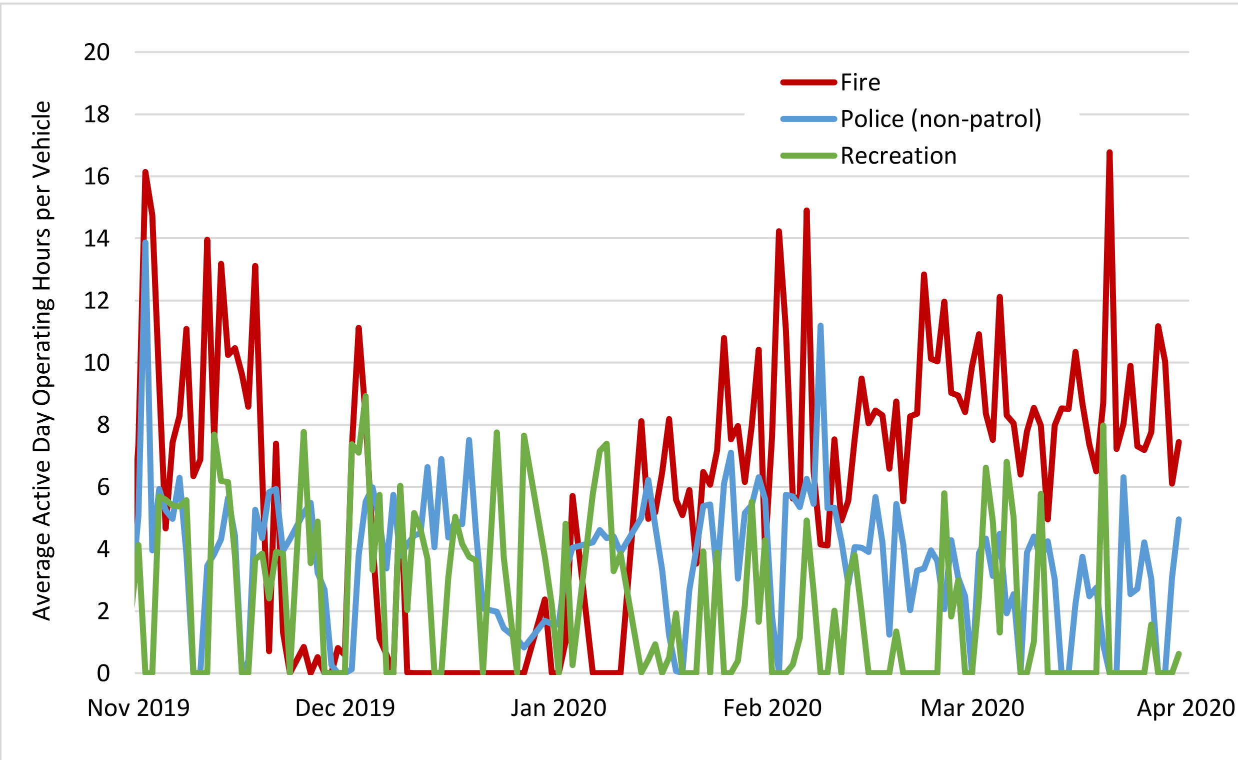

Figure 8. Average Active Day Operating Hours per Vehicle by Department

Duty Cycle Speed

The telematics reports available for this project does not provide data to evaluate this parameter.

Idle Time

Comparing vehicle driving and idle time helps fleet managers to quantify the importance of operational policy changes, driver education, and other internal practices to reduce wasted fuel due to excessive idling. Fire vehicles have the longest average drive time per vehicle and non-patrol Police vehicles have the shortest. Figure 9 shows that Recreation Department vehicle drive time fluctuates seasonally, with more activity in the summer than winter.

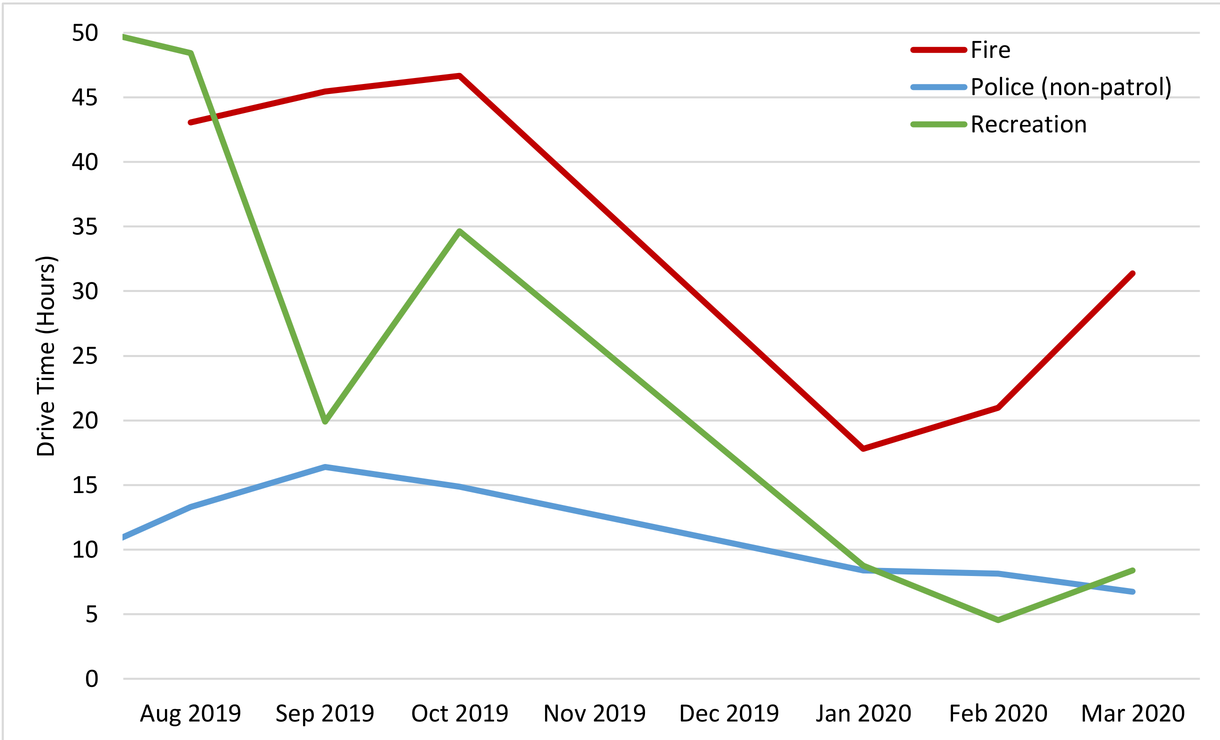

Figure 9. Average Drive Time per Vehicle per Month by Department

The analysis of total engine runtime data shown in Figure 10 reveals the percentage of running time spent in motion versus idling. Based on available data, non-patrol Police vehicles tend to idle more than Fire and Recreation vehicles.

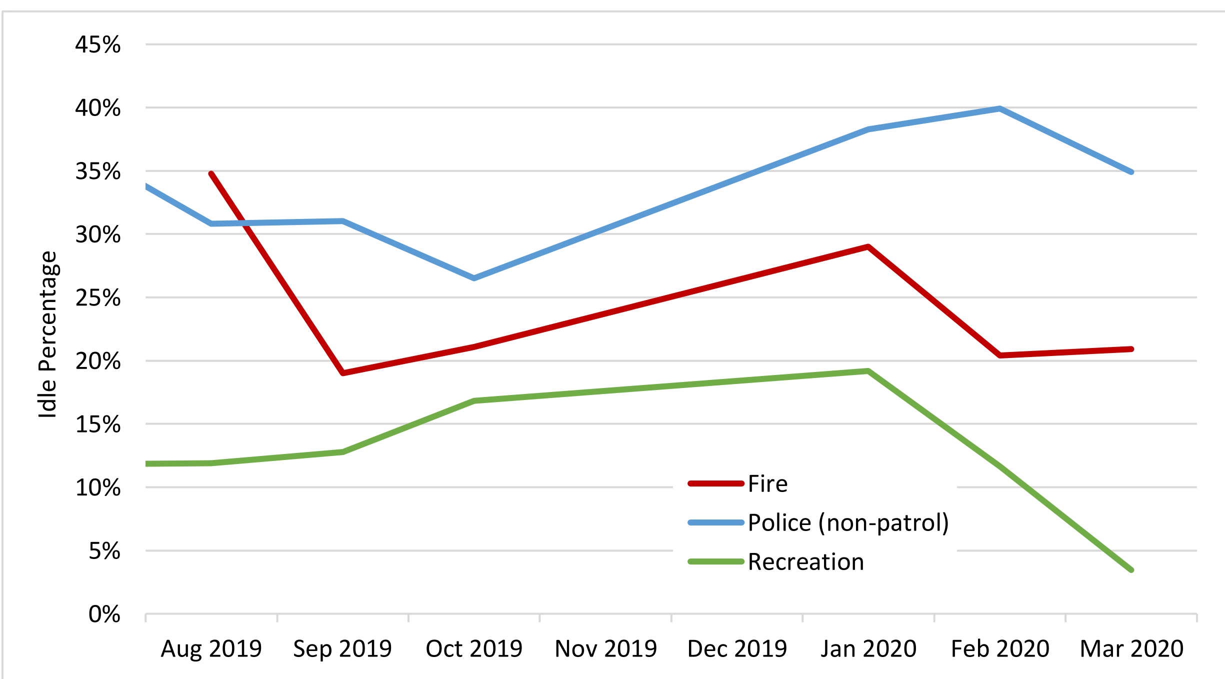

Figure 10. Average Idle Time Percentage per Month by Department

The distribution of average idle time percentage by vehicle provides additional insight. Figure 11 similarly shows the average idle time percentage is highest for non-patrol Police vehicles, but a few vehicles with very high idling may be skewing the average. Collecting and analyzing data from a larger set of vehicles could help to mitigate the impact of outliers.

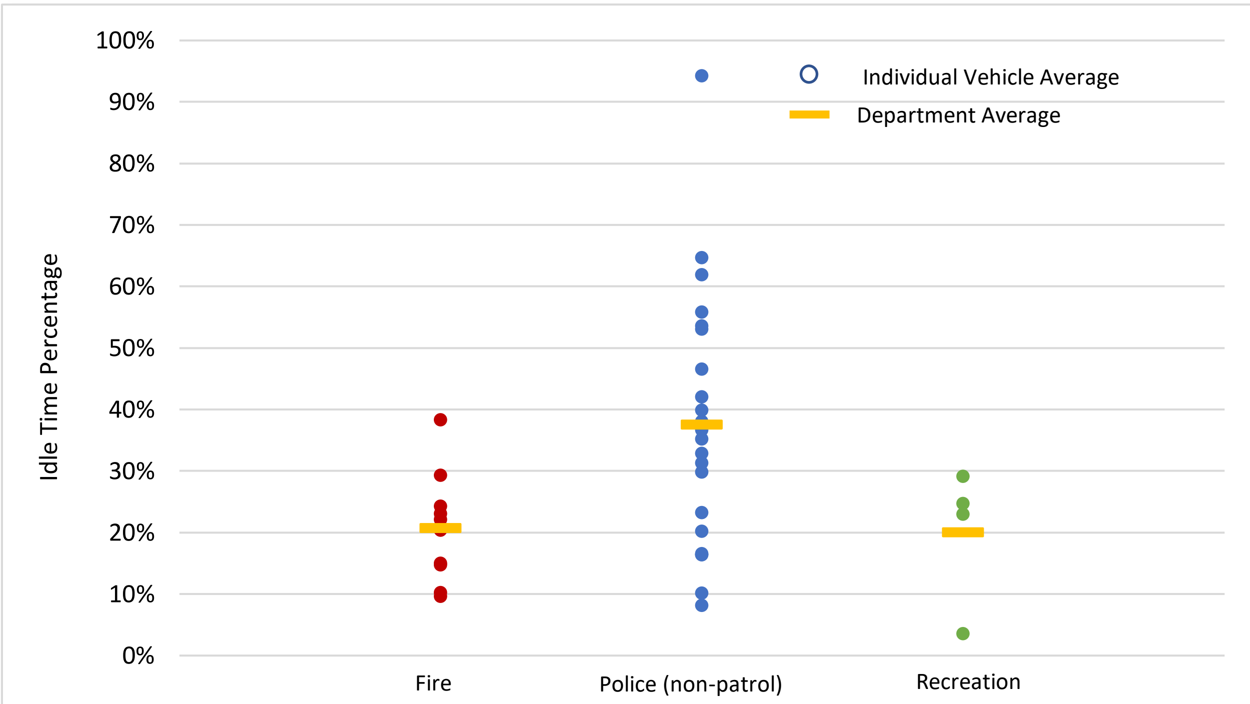

Figure 11. Distribution of Average Idle Time by Vehicle and Department

Fuel Economy

Fuel economy data analysis is limited by the availability of compatible data. However, Figure 12 provides a visual representation showing a decline in fuel economy with respect to engine size. This is to be expected and underscores the intuitive conclusion that transitioning the larger vehicles in the fleet provides greater GHG reduction benefit per vehicle. Although the data is not complete enough to perform more detailed analysis related to fuel economy, the project team reviewed the raw data values and found that this trend would likely carry through the entire fleet if more detail was available for further analysis.

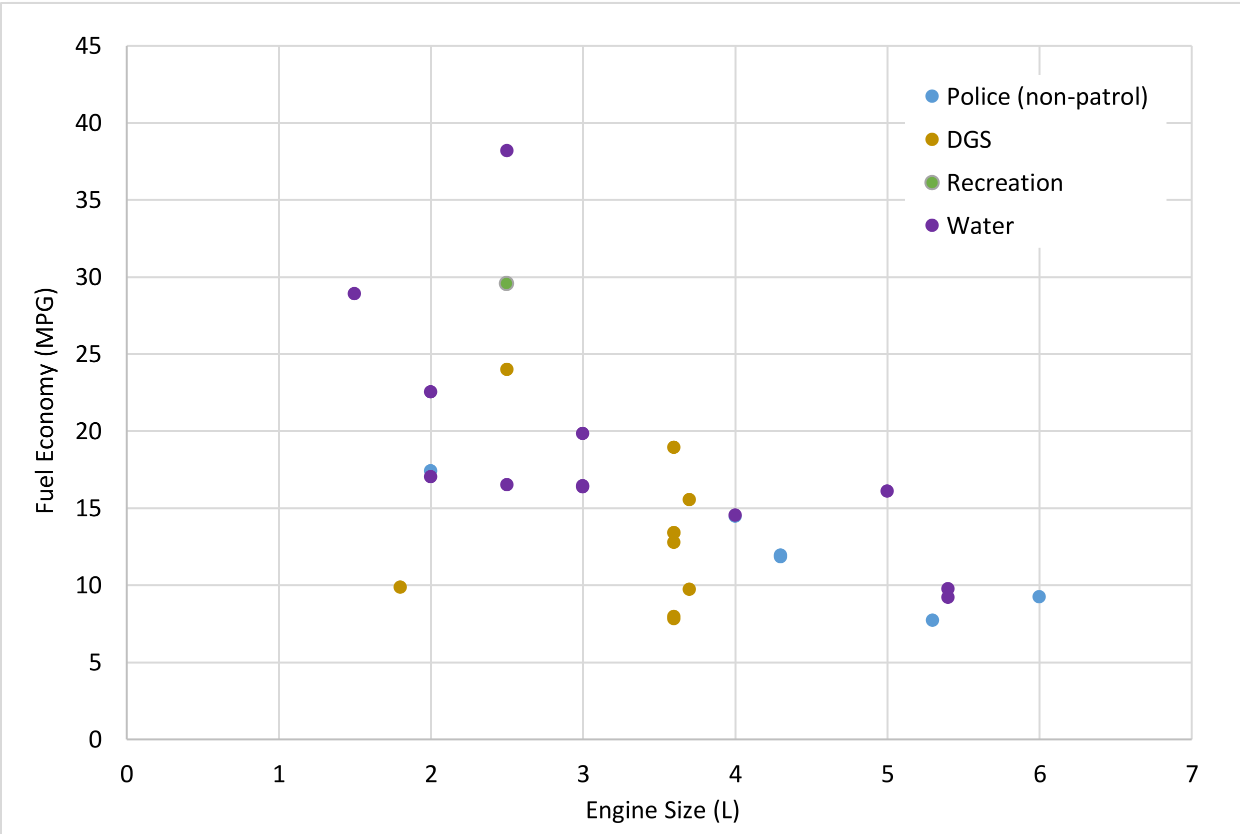

Figure 12. Fuel Economy vs. Engine Size by Department

Fleet-wide Best Practices

Fuel Management

The City has a decentralized fueling operation. While most department vehicles are fueled at the DGS operations fueling center, including DGS, Water, Police, and Recreation, there are also several remote fueling sites. These include the landfill, the golf course, and two firehouses.

The DGS site uses an older OPW fuel management system which uses a FOB to activate the pumps. The other sites do not use the OPW system and thus the transactions at the remote locations are not being captured by the fuel management system. Also, the OPW system asks for the vehicle's mileage to be manually entered, but it has no way to confirm accuracy, so proxy entries are often made, and accurate mileage data is not captured.

Best Practice Recommendation: The best fleets precisely track fuel use and ensure that all transactions at all fueling locations are captured (as well as integrating any transactions done at public stations using purchasing cards if applicable). These transactions are compiled into reports and reviewed on a regular basis, generally quarterly. Annual reports are prepared at the end of the fiscal year. Fuel use is tracked from year to year, and any significant changes are reviewed, and the causes evaluated. The overall imperative should be to reduce total fuel use over time, which can be accomplished through improved fuel-efficient vehicles, improved driver training, and staff awareness of sustainability and greenhouse gas reduction goals.

An integrated fuel management system should be phased in, which would include transactions from remote locations. Based on the size of the current fleet, a fueling system replacement using an 8,000-gallon gasoline tank and a 10,000-gallon diesel tank, with two dispensers, and canopy would cost approximately $680,000[3]. Dover Fueling Solutions, the parent company of OPW, offers a product known as DX Fleet that integrates with the fueling systems they offer. The DX Fleet software is a cloud-based fuel management solution that provides fleet managers with the ability to remotely monitor fleet fueling activity using proprietary fueling cards to track transactions, provide alerts, notifications and generate reports. Although pricing on this emerging software is not yet available, this could be a viable option for improving fuel management practices across the City-wide fleet if it is compatible with current fueling infrastructure. AssetWorks is an industry leader in providing fleet management solutions. The company's integrated fleet and fuel management software is used by municipal fleets across the country, including several large City and State-owned fleets[4]. Pricing is highly dependent on site- and fleet-specific parameters, but $50,000 in annual cost for the City of Albany's fleet is a fair approximation[5].

Vehicle Miles Traveled

The tracking of Vehicle Miles Traveled (VMT) is a key component of effective fleet management and should be done in conjunction with the tracking of fuel use. The VMT metric on a year-to-year basis can provide insight into fleet trends, routing efficiencies, and service delivery levels. It can also assist in helping to "right size" the fleet and conducting sustainability evaluations.

Any VMT analysis must consider factors that may influence variability. This could include extreme weather emergencies such as major weather events and storm response that would result in higher-than-normal mileage or a pandemic-like event that would reduce mileage amounts due to lockdowns or the temporary curtailing of certain City services.

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[3] Based on verbal estimate from New York State Office of General Services pump and tank contracting company.
[4] AssetWorks, https://www.assetworks.com/fleet.
[5] Based on verbal estimate form AssetWorks Northeast US sales representative.

Best Practice Recommendation: The best fleets carefully track VMT year to year. The overarching sustainability goal is to decrease VMT. Substantial increases in annual VMT warrant examination of how the fleet is being used. Unnecessary travel should be minimized, efficient routing and trip planning made use of, and an awareness raised with the staff on the City's sustainability and fuel reduction goals.

The entire City of Albany fleet should begin tracking and collecting VMT data on a fleet-wide basis starting on January 1, 2022, by having an odometer "start" reading for all its vehicles and then collected at the end of each quarter. If such a change is too great to start all at once, the light-duty vehicles should be tracked first. The annual mileage should be collected by department fleet managers, collated City-wide, and then used for annual fleet reporting.

Preventive Maintenance and Routine Vehicle Service

The City has a diverse approach to servicing its fleet. DGS and Water perform their own maintenance, while Police sends vehicles to a local car dealer for service and Fire has a hybrid approach with three in-house mechanics but also sends vehicles out for certain services. DGS, Water, and Police use Fleet Maintenance Pro, which assists in identifying which vehicles are due for preventive maintenance and routine service. When vehicles come in for service, the vehicles' odometer readings are put into the software, thus defining when the next service interval shall be due. This currently is the only way vehicle mileage is tracked.

Making use of the current fleet management software to track maintenance and repairs can be helpful. Fleet managers that closely track the preventive maintenance intervals have a good handle on managing their vehicles and can quickly generate system reports. The primary function of Fleet Maintenance Pro is to help track maintenance schedules and it is currently done very well by the departments examined.

Vehicle service and repairs are done at several locations. A review of the City of Albany budget documents found that the vehicle replacement tables in the Capital Plan section for DGS contained data on the average annual repair costs for the various vehicle types (packers, street sweepers, etc.) serviced by DGS. This data is used internally by DGS for fleet analysis and helps inform the City administration of why new vehicles are requested.

Best Practice Recommendation: Creating a centralized reporting location for fuel, mileage, and repair cost data will improve fleet analysis, identify opportunities to increase efficiency, and aid in supporting sustainability initiatives.

Preventive Maintenance Improvements and Cost Savings

With fewer moving parts, electric vehicles are expected to have lower preventative maintenance costs over the life of the vehicles, and this bears out in several studies and real-world scenarios. EVs do not require the most common preventive maintenance task, oil changes, which contributes to savings. EVs also don't require brake replacements as often since they utilize regenerative braking. There are no belts to change or transmissions to service. The New York City fleet released a short analysis of their EV fleet costs in 2019, which showed substantially reduced costs over internal combustion engine (ICE) vehicles, though the author noted the City's EVs were new and should be tracked over a ten-year life.[6]

Recently, the U.S. Department of Energy released an extensive study examining the costs of operating electric vehicles versus ICE vehicles[7]. For light-duty vehicles, the findings clearly show decreased costs per mile for hybrid electric vehicles (HEVs), plug in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs) over ICE

[6] Kerman, Keith, "NYC DCAS Newsletter", March 8, 2019, Issue #225.

[7] Burnham, Andrew, Gohlke, David, Rush, Luke, Stephens, Thomas, Zhou, Yan, Delucchi, Mark A., Birky, Alicia, Hunter, Chad, Lin, Zhenhong, Ou, Shiqi, Xie, Fei, Proctor, Camron, Wiryadinata, Steven, Liu, Nawei, and Boloor, Madhur. "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains", April 2021.

vehicles. The study examined light-duty vehicle maintenance costs using 24 parameters for standard maintenance tasks. It placed the comparative tasks into a cost per mile metric and found the costs of an EV per mile were $0.061/mile versus an ICE vehicle cost of $0.101 per mile. This 40 percent decrease is primarily due to the avoided costs for transmission service, belts, spark plugs, filters (oil, fuel, and air) and engine oil; while the brake costs were deferred until later in the vehicle's life and slightly less.[8]

Hybrids and plug-in hybrids were also less costly to maintain, though to a lesser degree. The cost per mile for hybrids was $0.0940 and for plug-in hybrids $0.091, representing seven and ten percent reductions, respectively.[9]

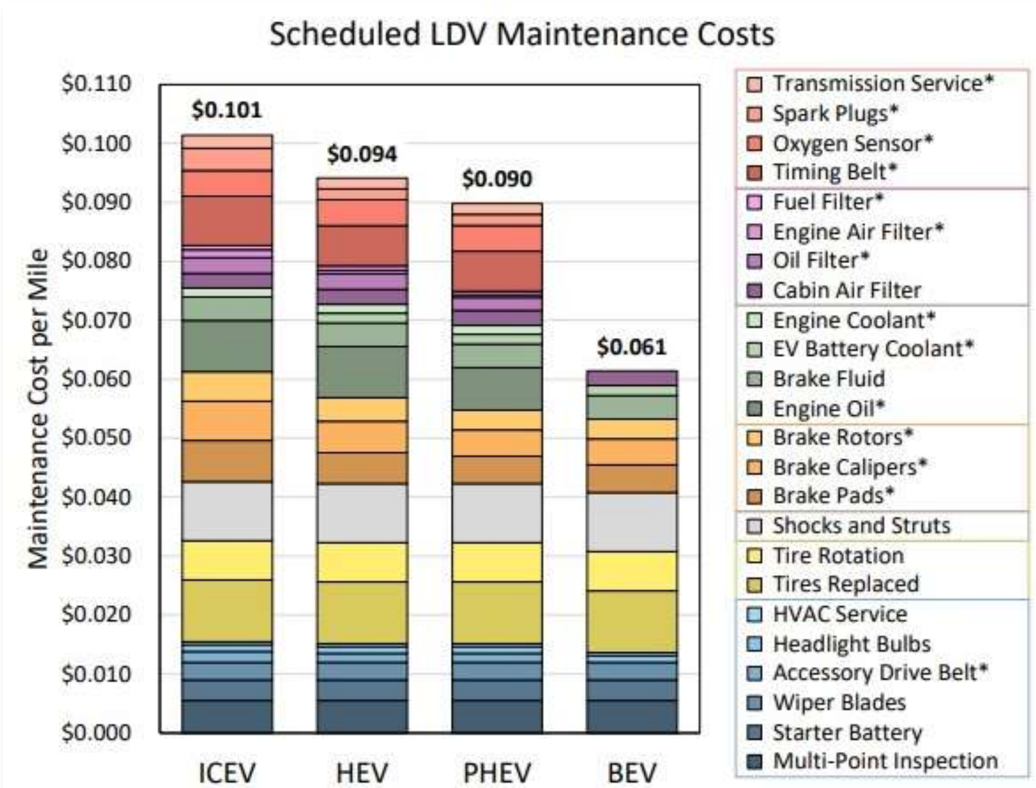

Figure 13. Scheduled Maintenances Costs for ICE, HEV, PHEV and BEV vehicles[10]

Best Practice Recommendation: The City of Albany can reasonably expect decreased preventive and routine maintenance costs, but it would be better to prove it. The maintenance costs for the two new Chevrolet Bolts in the Water Department should be closely tracked and compared against a newer vehicle that is used for similar tasks. Likewise, the conventional hybrid pickup trucks purchased by DGS this year should also be tracked for costs and compared against a newer ICE Ford F-150.

Fleet Data Management

Fleet data is an essential component of a modern fleet. Software and fuel management programs allow a municipality to track numerous fleet metrics in detail. The City of Albany's system concentrates primarily on preventive maintenance intervals and routine service events. With the Verizon telemetric system, as well as the

[8] Ibid., p. 83.
[9] Ibid.
[10] Ibid., p. *xi.*

fleet management software, there is a considerable amount of data collected, but it is not being fully leveraged to better optimize operations.

The departmental fleets make use of a fleet management software program called Fleet Maintenance Pro. Departmental fleet managers use the program independently, and due to the various versions of the program, the platform used in one department in some cases does not overlap with others to provide a unified picture of the total City fleet. For example, Police has a cloud-based version of Fleet Maintenance Pro which is different than the version used by DGS and Water. The software is primarily being used to track preventive maintenance and repairs. Mileage is entered into the software when a unit comes in for service, to set a trigger for the next maintenance event. Total vehicle miles traveled and other metrics are not tracked City-wide.

The City fleet does not lend itself to centralization under one fleet manager, however, the addition of a fleet data analyst, who could serve additionally as an electrification coordinator, would be warranted. The separate fleets are run by their respective Deputy Commissioners and Fleet Managers, who make vehicle replacement decisions based directly upon their understanding of their department's needs and the specific duty cycle of the vehicle categories. A centralized fleet under one manager would not likely add to the overall efficiency of each department. However, the addition of a fleet analyst position would allow valuable metrics to be calculated annually and changes and trends monitored over time. This person could collect and unify data from each department City-wide and share valuable information from department to department, acting as an inter-departmental fleet liaison. They could also coordinate and track where electric or hybrid vehicles are being deployed across the city, report back on successes and challenges.

City-wide fuel use should be calculated and tracked, for both budgetary and sustainability reasons. Total greenhouse gas emissions cannot be calculated if total vehicular fuel use is not tracked year to year. Likewise, total vehicle miles traveled is an important metric to track to determine trends over time. The fleet analyst could assist with metrics tracking.

Best Practice Recommendation: Create a position for an inter-departmental fleet data analyst, who could assist the sustainability staff in collecting essential metrics related to greenhouse gas tracking and reduction efforts.

Shared Vehicles/Communal Car Share Evaluation Findings

Fleet composition and management does not lend itself to creating City-wide vehicle sharing or motor pools. Informal vehicle sharing already takes place within departments such as the Police, Fire, Water, and DGS. For example, DGS assisted Recreation during special events, such as the recent pumpkin giveaway, by providing additional vehicles, delivering items, and providing support. Some sharing of heavy-duty vehicles takes place between DGS and Water. The detectives and patrol vehicles within Police are pool cars, though they may frequently be assigned to the same people from shift to shift.

Best Practice Recommendation: Departments should encourage and facilitate informal vehicle sharing where feasible. As EVs are integrated into the fleet, it will not make economic sense to only purchase longer range vehicles that are more expensive. Most daily driving needs can be met with an EV that has 100 or fewer miles of range, but there will be occasional need to make longer trips. For those occasions, having a shared longer-range EV or potentially just a plug-in hybrid may make sense. Vehicle sharing also allows a fleet to purchase fewer larger passenger vehicles because they are less often required and could be shared and used only when the need arises. One potential location where a pool vehicle is warranted would be at 200 Henry Johnson Boulevard. There is a new Level 2 EV charger there, and a small EV sedan or SUV could be used by any City staff at that building, including the Buildings and Regulatory Compliance staff (should they need an extra car on occasion or if their own vehicle was unavailable), or the Planning and Community Development staff, including Housing and Community Development.

Fleet Right-Sizing and Vehicle Allocation

The City fleet appears properly sized and regularly utilized. DGS and Water have newer vehicles, replaced on a defined and consistent basis. The Police Department fleet consists of a fluctuating number of excess vehicles that are rotated through the fleet to perform various duties and to avoid a limitation of services. For example, detectives will often make use of vehicles that have been repossessed. The Fire Department has been purchasing used vehicles from other volunteer fire departments, which saves on purchase costs but does result in a collection of older and less efficient vehicles. The department is moving away from this practice and will now be purchasing new vehicles off state contract.

DGS tracks how its vehicle service life compares with the recommended usage life set out by the New York State Comptroller's office. For many of its vehicles, DGS uses a ten-year service life, in comparison to the Comptroller's 8-year service life for pickups, passenger vehicles, and dump trucks. However, the vehicles are well maintained, and repair costs closely tracked, which allows them to exceed the Comptroller's guidance.

Best Practice Recommendation: Without per-vehicle mileage tracking for the entire fleet, it is not possible to definitively identify underused vehicles. The City should implement a strategy to track mileage per vehicle, which will help identify underused vehicles.

Vehicle Purchasing, Leasing, and Incentives

As is typical with many municipal governments, the City currently owns its fleet in its entirety. The plans for vehicle replacements are contained in the Capital Plan section of the Albany City budget[11].

The Capital Plan is a five-year plan that identifies the planned vehicle replacement schedule for each department by fiscal year. The plan also describes the type of funding that will be used. The two funding options include borrowing (debt financing) and the use of cash capital, which is an allocation from operating budget funds from the current fiscal year for capital purposes. For the 2021 fiscal year, the total amount budgeted for all vehicle purchases in the capital plan is $6,313,156. This is funded with a combination of cash capital and borrowing.

The Police Department recently performed an analysis of the benefits of leasing versus purchasing a portion of their vehicles slated for replacement. There are several old vehicles (greater than thirteen years old) that Police wishes to replace. The department determined that it would conduct a small pilot project to lease 26 vehicles from Enterprise for a five-year term. At the end of the term, it would have a choice of purchasing the vehicles for a nominal amount. Of those vehicles, 20 will be Ford Interceptor hybrids assigned to non-patrol duties.

Because municipalities can leverage larger volume vehicle purchasing contracts, over the lifetime of a vehicle it is typically less expensive for a municipality to purchase than lease. Leasing companies can show near-term cost savings from capturing any residual value in the already purchased vehicles and spreading lease costs over multiple years. They also commonly factor in fuel and maintenance savings from having newer vehicles being operated. For fleets that have a lot of older vehicles and are very cash-strapped, this might be their best and only option for upgrading their fleet quickly (which will result in some fuel and maintenance savings). However, if the fleet can find a way to accelerate those new vehicle purchases and hold tight to shorter replacement schedules, they will likely end up paying less per vehicle than the leases. Also, once a fleet starts to lease vehicles, it is very challenging to revert to purchases which would require a significant increase in funding because they need to go back to the large initial costs for new vehicles while still paying lease fees on vehicles already in the fleet. Leasing companies do have

[11] City of Albany Budget Office, https://www.albanyny.gov/653/Budget-Office.

some advantages in that they can take the Federal Tax Credit on EVs and might have better access to used vehicle markets to get a better price than the auctions which municipalities use.

The US Congress is currently reviewing and debating the Build Back Better Act. The Act, as written, would provide expanded incentives for EV purchases, technology development, and charging infrastructure expansion. While it is still too soon to speculate on the impact this bill could have on municipal fleet electrification, it is a clear sign that EVs are likely to emerge as the dominant type of alternative fuel. This Act may also include funding for larger EV deployments (entire fleet electrification pilots) or innovative demonstrations of EVs in unique applications. Municipalities ready to embrace such measures and can move quickly to collaborate on a proposed deployment could take advantage of public funding to significantly electrify their fleet.

Electrification Recommendations

Recent acceleration in EV development from nearly all major automobile manufacturers has created many electrification options for light-duty compact cars, sedans, and SUVs. Municipal fleets are successfully transitioning their light-duty fleets with data-supported transition plans and finding that anticipated reductions in fuel and maintenance costs are supported by real-world testing and evaluation. Fleet managers are also reporting that driver acceptance of EVs is high, given the proper planning of vehicle procurement and operational assignment. Medium- and heavy-duty vehicles present greater challenges to electrification in the near term based on technology limitations. The downsizing of units such as the waste packers and street sweepers (already adopted by the department) is a successful approach to reducing petroleum consumption and greenhouse gas emissions. The development of original equipment manufacturer (OEM) hybrid drive trains, particularly for medium-duty work trucks, should be monitored. If a proven system provider emerges, a pilot project of medium-duty plug in hybrid or fully electric vehicles can be conducted. This pilot project should have the vehicles' performance and benefits closely monitor to determine how to proceed in future years. In such a rapidly expanding segment of the automobile market, news of upcoming vehicle models can change quickly. While larger EV model releases were limited to a handful of start-up manufacturers just a few years ago, recent announcements have been coming from the more traditional automakers while some of the smaller start-up brands are starting to deliver vehicles. Table 1 provides a list of EVs that appear to meet the needs of the City's larger light-duty vehicle fleet that are expected within the next two to three years.

Table 1. Upcoming Larger Light-Duty Electric Vehicles, MY 2021-2024[12]

Type	Make	Model	Drive	Expected Year
CUV	Hyundai	Ioniq 5	BEV	2021
CUV	Mazda	MX-30	BEV	2021
CUV	Nissan	Ariya	BEV	2021
SUV	GMC	Hummer	BEV	2021
CUV	Kia	EV6	BEV	2022
CUV	Subaru	Solterra	BEV	2022
CUV	Toyota	bZ4X Concept	BEV	2022
CUV	Volvo	C40 Recharge	BEV	2022
SUV	Jeep	Wrangler Magneto	BEV	2022
SUV	Rivian	R1S	BEV	2022
SUV	Volkswagen	ID.Space Vizzion	BEV	2022
SUV	Volvo	XC90	BEV	2022
Pickup	Ford	F-150 Lightning	BEV	2022
Van	Volkswagen	ID.Buzz	BEV	2022
SUV	Ford	Explorer	BEV	2023
Pickup	Chevrolet	Silverado	BEV	2023
SUV	Honda	Prologue	BEV	2024
SUV	Volvo	XC60	BEV	2024
Pickup	Ram	1500	BEV	2024

[12] Car and Driver. https://www.caranddriver.com/news/g29994375/future-electric-cars-trucks/, September 7,2021.

Recommendation #1: Near-Term Transition of Light-duty Passenger Vehicles

Compact Vehicles

Compact vehicles are defined as light-duty (GVWR < 8,500 pounds) vehicles with interior passenger volume less than 100 ft^3. Compact vehicles are used for administrative purposes, typically by a single staff person traveling to worksites throughout the City. The **Toyota Prius, Toyota Corolla,** and **Honda Insight** are examples of HEVs that offer modest increases in fuel economy with minimal change in operational requirements. Several compact PHEV models are also available, including the **Toyota Prius Prime** and **Hyundai Ioniq SE Plug-In**. BMW and Mini offer compact PHEVs as well. While most compact PHEVs have limited electric range, the **BMW i3 with range extender** has similar range to BEVs plus a gasoline engine to extend that further but is also more expensive. The **Nissan LEAF, Chevrolet Bolt EV, Hyundai Ioniq, and Tesla Model 3** are the most widely available BEV options in this class. Due to the relatively high efficiency of conventional vehicles in this class and battery technology advancements, manufacturers are not expected to develop many new HEV or PHEV options for the compact vehicle class. Fully electric models serve almost all the needs for these vehicle types currently and most manufacturers have new BEV models coming to market. As more fleets continue to electrify, manufacturers are likely to develop innovative solutions to provide fleet-oriented trim lines and vehicle options. For example, General Motors offers a Rear Seat Delete Package for the **Chevrolet Bolt EV**. This is an option available through the GM Fleet program and reconfigured the rear cargo area of the vehicle to add approximately 10 ft^3 of cargo volume[13].

[13] GM Fleet Vehicle Order Guide. https://www.gmfleetorderguide.com, December, 2021.

Table 2. Compact Vehicle Options

   

	CONVENTIONAL: Toyota Corolla	HYBRID: Toyota Prius	HYBRID: Toyota Corolla Hybrid	HYBRID: Honda Insight
MSRP	$20,075	$24,525	$23,650	$25,210
Pass. / Cargo vol. (ft^3)	89 / 13	91 / 27	89 / 13	98 / 15
Drivetrain	FWD	FWD	FWD	FWD
MPG (city / hwy)	31 / 40	58 / 53	53 / 52	55 / 49
Annual Fuel Costs*	$327	$184	$199	$193

 

	PLUG-IN HYBRID: Toyota Prius Prime LE	PLUG-IN HYBRID: Hyundai Ioniq SE Plug-In
MSRP	$28,220	$26,800
Federal Tax Credit	$4,502	$4,543
New York State Rebate	$1,100	$1,100
Pass. / Cargo vol. (ft^3)	91 / 20	96 / 23
Drivetrain	FWD/AWD	FWD
EV Range	25	29
MPG (gas) / MPGe	55 / 141	52 / 122
Annual Fuel Costs**	$115	$115
240V Charge Time (hr)	2.0	2.3

 

	ALL ELECTRIC: Nissan LEAF	ALL ELECTRIC: Nissan LEAF S Plus
MSRP	$27,400	$32,400
Federal Tax Credit	$7,500	$7,500
New York State Rebate	$2,000	$2,000
Pass. / Cargo vol. (ft^3)	92 / 24	92 / 24
Drivetrain	FWD	FWD
EV Range	149	226
MPGe (city/hwy)	123 / 99	118 / 97
Annual Fuel Costs***	$90	$90
240V Charge Time (hr)	8.0	11.0

  

	ALL ELECTRIC: Chevrolet Bolt EV	ALL ELECTRIC: Hyundai Ioniq EV	ALL ELECTRIC: Tesla Model 3 Std Range
MSRP	$31,000	$33,245	$44,990
Federal Tax Credit	$7,500	$7,500	$0
New York State Rebate	$2,000	$2,000	$2,000
Pass. / Cargo vol. (ft^3)	94 / 17	96 / 23	97 / 15
Drivetrain	FWD	FWD	RWD
EV Range	273	170	271
MPGe (city / hwy)	131 / 109	145 / 121	150 / 133
Annual Fuel Costs***	$90	$90	$90
240V Charge Time (hr)	7.5	5.8	6.5

** Based on 85% city driving, 3,000 annual miles, and $3.50/gal gasoline*

*** Based on an average of 33 miles between charge events, 3,000 annual miles, $3.50/gal gasoline, and $0.10/kWh electricity.*

**** Based on 3,000 annual miles, an efficiency of 0.30 kWh/mile, and $0.10/kWh electricity*

Larger Sedans and Compact Utility Vehicles

Larger sedans have traditionally been used when additional space to transport passengers or equipment is needed. There are multiple hybrid options in this class that are comparable to ICE models currently in use, but the availability of PHEV and BEV options are limited. Several PHEV models have been discontinued after limited production (e.g., Chevrolet Volt), but the **Honda Clarity** is still being offered**.** Due to market trends towards utility vehicle models, manufacturers may not develop many new PHEV or BEV options for this larger sedan class. Most compact Sport Utility Vehicles on the market (conventional, HEV, PHEV, and BEV) offer passenger and cargo space equivalent to, or greater than, sedans and compete favorably in terms of initial cost. The advantages of a compact utility vehicle (CUV) are the more flexible cargo space, higher undercarriage clearance, and all-wheel drive (AWD) capability. There are numerous HEV, PHEV, and BEV models available. Passenger and cargo capacity vary within the CUV class, which can impact the suitability of different models based on the intended use. The **Toyota RAV4, Kia Niro, and Ford**

Escape are HEV options that offer modest improvements in fuel economy when compared to conventionally fueled CUVs. Many new CUV PHEV and BEV models have been released in recent years. The **Kia Niro, Toyota RAV4 Prime, Mitsubishi Outlander PHEV,** and **Ford Escape** are PHEV models to consider, some of which come with AWD capability. Initial cost, fuel economy (MPGe), and financial incentive eligibility can vary considerably among the PHEV CUVs. New fully-electric CUV models have also emerged. Federal and State financial incentives help lower the initial cost of these vehicles while increased battery range contributes to the viability of these EVs as fleet vehicles. The **Chevrolet Bolt EUV, Kia Niro EV, Hyundai Kona Electric, Volkswagen ID.4, Ford Mustang Mach-E**, and **Volvo XC40 Recharge Twin** are available options, with new models planned from most of the major manufacturers.

Table 3. Larger Sedan and Compact Utility Vehicle Options

CONVENTIONAL — Chevrolet Malibu

MSRP	$23,400
Pass. / Cargo vol. (ft^3)	103 / 16
Drivetrain	FWD
MPG (city / hwy)	29 / 36
Annual Fuel Costs*	$352

CONVENTIONAL — Ford Escape

MSRP	$25,555
Pass. / Cargo vol. (ft^3)	104 / 23
Drivetrain	FWD/AWD
MPG (city / hwy)	28 / 34
Annual Fuel Costs*	$365

HYBRID — Honda Accord Hybrid

MSRP	$26,670
Pass. / Cargo vol. (ft^3)	106 / 17
Drivetrain	FWD
MPG (city / hwy)	48 / 47
Annual Fuel Costs*	$219

HYBRID — Toyota Avalon Hybrid XLE

MSRP	$37,250
Pass. / Cargo vol. (ft^3)	103 / 16
Drivetrain	FWD
MPG (city / hwy)	43 / 43
Annual Fuel Costs*	$244

HYBRID — Toyota Camry Hybrid

MSRP	$27,380
Pass. / Cargo vol. (ft^3)	100 / 15
Drivetrain	FWD
MPG (city / hwy)	51 / 53
Annual Fuel Costs*	$205

HYBRID — Toyota RAV4 Hybrid

MSRP	$28,900
Pass. / Cargo vol. (ft^3)	99 / 38
Drivetrain	AWD
MPG (city / hwy)	41 / 38
Annual Fuel Costs*	$259

HYBRID — Kia Niro

MSRP	$24,690
Pass. / Cargo vol. (ft^3)	101 / 19
Drivetrain	FWD
MPG (city / hwy)	52 / 49
Annual Fuel Costs*	$204

HYBRID — Ford Escape SE Sport Hybrid

MSRP	$28,030
Pass. / Cargo vol. (ft^3)	104 / 34
Drivetrain	AWD
MPG (city / hwy)	43 / 37
Annual Fuel Costs*	$250

PLUG-IN HYBRID — Honda Clarity PHEV

MSRP	$33,400
Federal Tax Credit	$7,500
New York State Rebate	$1,000
Pass. / Cargo vol. (ft^3)	102 / 16
Drivetrain	FWD
EV Range	48
MPGe (city/hwy)	43 / 115
Annual Fuel Costs**	$124
240V Charge Time (hr)	2.3

PLUG-IN HYBRID — Kia Niro PHEV

MSRP	$29,590
Federal Tax Credit	$4,543
New York State Rebate	$500
Pass. / Cargo vol. (ft^3)	102 / 16
Drivetrain	FWD
EV Range	26
MPG (gas) / MPGe	46 / 105
Annual Fuel Costs**	$124
240V Charge Time (hr)	2.5

PLUG-IN HYBRID — Tovota RAV4 Prime

MSRP	$38,350
Federal Tax Credit	$4,502
New York State Rebate	$1,000
Pass. / Cargo vol. (ft^3)	101 / 16
Drivetrain	AWD
EV Range	17
MPG (gas) / MPGe	35 / 90
Annual Fuel Costs**	$124
240V Charge Time (hr)	2.0

PLUG-IN HYBRID — Misubishi Outlander PHEV

MSRP	$36,995
Federal Tax Credit	$5,836
New York State Rebate	$500
Pass. / Cargo vol. (ft^3)	102 / 30
Drivetrain	AWD
EV Range	22
MPG (gas) / MPGe	25 / 74
Annual Fuel Costs**	$124
240V Charge Time (hr)	3.5

PLUG-IN HYBRID — Ford Escape SE Plug-In Hybrid

MSRP	$33,075
Federal Tax Credit	$6,534
New York State Rebate	$500
Pass. / Cargo vol. (ft^3)	141 / 42
Drivetrain	AWD
EV Range	21
MPG (gas) / MPGe	23 / 56
Annual Fuel Costs**	$124
240V Charge Time (hr)	2.5

ALL ELECTRIC — Chevrolet Bolt EUV

MSRP	$33,000
Federal Tax Credit	$7,500
New York State Rebate	$2,000
Pass. / Cargo vol. (ft^3)	97 / 16
Drivetrain	FWD
EV Range	260
MPGe (city/hwy)	125 / 104
Annual Fuel Costs***	$99
240V Charge Time (hr)	7.5

ALL ELECTRIC — Kia Niro EV

MSRP	$39,990
Federal Tax Credit	$7,500
New York State Rebate	$2,000
Pass. / Cargo vol. (ft^3)	97 / 22
Drivetrain	FWD
EV Range	239
MPGe (city / hwy)	123 / 102
Annual Fuel Costs***	$99
240V Charge Time (hr)	9.5

ALL ELECTRIC — Hyundai Kona Electric

MSRP	$34,000
Federal Tax Credit	$7,500
New York State Rebate	$2,000
Pass. / Cargo vol. (ft^3)	92 / 19
Drivetrain	FWD
EV Range	258
MPGe (city / hwy)	132 / 108
Annual Fuel Costs***	$99
240V Charge Time (hr)	9.0

ALL ELECTRIC — Volkswagen ID.4

MSRP	$39,995
Federal Tax Credit	$7,500
New York State Rebate	$2,000
Pass. / Cargo vol. (ft^3)	N/A
Drivetrain	RWD/AWD
EV Range	261
MPGe (city / hwy)	104 / 89
Annual Fuel Costs***	$99
240V Charge Time (hr)	7.5

ALL ELECTRIC — Ford Mustang Mach-E AWD

MSRP	$42,895
Federal Tax Credit	$7,500
New York State Rebate	$500
Pass. / Cargo vol. (ft^3)	103 / 12
Drivetrain	AWD
EV Range	221
MPGe (city/hwy)	100 / 86
Annual Fuel Costs**	$99
240V Charge Time (hr)	8.5

ALL ELECTRIC — Volvo XC40 Recharge Twin

MSRP	$55,300
Federal Tax Credit	$7,500
New York State Rebate	$500
Pass. / Cargo vol. (ft^3)	N/A
Drivetrain	RWD/AWD
EV Range	261
MPGe (city / hwy)	104 / 89
Annual Fuel Costs***	$99
240V Charge Time (hr)	8.0

** Based on 85% city driving, 3,000 annual miles, and $3.50/gal gasoline*

*** Based on an average of 33 miles between charge events, 3,000 annual miles, $3.50/gal gasoline, and $0.10/kWh electricity*

**** Based on 3,000 annual miles, an efficiency of 0.33 kWh/mile, and $0.10/kWh electricity*

Sport-Utility Vehicles

When more passenger and/or cargo capacity is needed, there are both HEV and PHEV SUV options that provide greater capacity. Although generally designed, priced, and marketed for the luxury vehicle buyer, these larger electrified SUVs are options when additional space is required. The **Toyota Highlander Hybrid** is the lowest cost alternative option for the larger SUVs. While it is only an HEV, it provides a considerable increase in fuel economy compared to the conventionally fueled larger SUVs. The **Ford Explorer Limited AWD** (HEV) is a more expensive HEV option but would offer fuel savings compared to the non-patrol, conventionally fueled larger SUVs in the current fleet. The **Lincoln Aviator** and **Volvo XC60 T8** are PHEV options, but they are more expensive so a positive return on investment may be challenging.

Table 4. SUV Options

	CONVENTIONAL	CONVENTIONAL	HYBRID	HYBRID
	Dodge Durango	Chevrolet Tahoe	Toyota Highlander Hybrid LE	Ford Explorer Limited AWD
				
MSRP	$32,962	$49,700	$38,855	$45,495
Pass. / Cargo vol. (ft^3)	106 / 85	NA / 73	141 / 48	153 / 48
Drivetrain	RWD/AWD	4WD	AWD	RWD/AWD
MPG (city / hwy)	19 / 26	14 / 20	36 / 35	27 / 29
Annual Fuel Costs*	$1,061	$1,433	$586	$770

	PLUG-IN HYBRID	PLUG-IN HYBRID
	Lincoln Aviator Grand Touring	Volvo XC60 T8 AWD
		
MSRP	$51,465	$54,250
Federal Tax Credit	$6,534	$5,419
New York State Rebate	$500	$500
Pass. / Cargo vol. (ft^3)	N/A	103 / 30
Drivetrain	4WD	AWD
EV Range	21	22
MPG (gas) / MPGe	22 / 55	25 / 61
Annual Fuel Costs**	$528	$548
240V Charge Time (hr)	3.5	3.5

* *Based on 85% city driving, 6,000 annual miles, and $3.50/gal gasoline*

** *Based on an average of 33 miles between charge events, 6,000 annual miles, $3.50/gal gasoline (except Volvo XC60 = $4.50), and $0.10/kWh electricity.*

*** *Based on 6,000 annual miles, an efficiency of 0.33 kWh/mile, and $0.10/kWh electricity*

Recommendation #2: Pilot Electrified Pickup Trucks and Vans When Available

Pickup Trucks

Departments that have requirements to transport materials and equipment use trucks. There are currently only a few EV pickup truck options. The **Dodge RAM 1500** and **Ford F-150** offer hybrid (HEV) drivetrains intended to provide a modest increase in fuel economy without sacrificing payload, towing capacity and overall performance. There are aftermarket HEV and PHEV upfits which can be considered for pickup trucks. Several manufacturers offer these products, XL Fleet is used as an example because details for their products are available, and they offer electric drive systems compatible with a variety of makes and models. These systems claim to achieve a 25 - 50% increase in fuel economy in vehicles such as the **Ram 2500** (HEV), **Ford F-150** (PHEV), **Ford F-250** (HEV, PHEV), **Chevrolet Silverado 2500,** and **Chevrolet Silverado 3500** (HEV, PHEV). Unfortunately, the upfit costs for these systems can be prohibitive. There is considerable attention being given to the development of BEV pickup trucks. Several startup manufacturers, **Rivian R1T, Bollinger Motors,** and **Tesla** have plans to sell electric pickup trucks within the next few years. Rivian began delivering vehicles in the Fall of 2021, though priced at a substantial premium over an ICE equivalent. Ford has announced plans to release the **Electric F-150** in the Fall of 2022 and General Motors has an electric Hummer with an electric Silverado on the horizon. Early reports on performance of the trucks being developed have shown that it is possible to achieve the desired torque, payload, and seating capacity using a fully electric drive system, but initial vehicle costs may be prohibitively high, with the possible exception of the F-150.

Table 5. Truck Options

CONVENTIONAL — Chevrolet Colorado

MSRP	$25,200
Drivetrain	RWD/4WD
MPG (city / hwy)	19 / 24
Annual Fuel Costs*	$892

CONVENTIONAL — Ford F-150

MSRP	$28,677
Drivetrain	RWD/4WD
MPG (city / hwy)	19 / 24
Annual Fuel Costs*	$892

CONVENTIONAL — Ford F-250

MSRP	$32,574
Drivetrain	RWD/4WD
MPG (city / hwy)	15 / 16
Annual Fuel Costs*	$1,156

HYBRID — Dodge Ram 1500 HFE V-6

MSRP	$28,931
Drivetrain	RWD/4WD
MPG (city / hwy)	20 / 26
Annual Fuel Costs*	$845

HYBRID — Ford Maverick

MSRP	$19,995
Drivetrain	FWD/AWD
MPG (city / hwy)***	42 / 33
Annual Fuel Costs*	$434

HYBRID — Ford F-250 HEV Upfit (XL Fleet)

MSRP	$32,574
Estimated Upfit Cost	$16,000
Drivetrain	RWD/4WD
Li-ion Battery	1.8kWh
MPG (city / hwy)***	16 / 20
Annual Fuel Costs*	$1,061

PLUG-IN HYBRID — Ford F-150 PHEV Upfit (XL Fleet)

MSRP	$29,290
Estimated Upfit Cost**	$26,500
Drivetrain	RWD/4WD
Li-ion Battery	15 kWh
MPG (city / hwy)***	29 / 36
Annual Fuel Costs*	$636
240V Charge Time (hr)	5.0

PLUG-IN HYBRID — Ford F-250 PHEV Upfit (XL Fleet)

MSRP	$32,574
Estimated Upfit Cost**	$29,000
Drivetrain	RWD/4WD
Li-ion Battery	15 kWh
MPG (city / hwy)***	21 / 24
Annual Fuel Costs*	$868
240V Charge Time (hr)	5.0

ALL ELECTRIC — Ford F-150 Lightning

MSRP	$39,947
Federal Tax Credit	$7,500
New York State Rebate	NA
Pass. / Cargo vol. (ft^3)	NA
Drivetrain	4WD
EV Range	230
MPGe (city / hwy)	NA
Annual Fuel Costs***	$250
240V Charge Time (hr)	NA

ALL ELECTRIC — Rivain R1T

MSRP	$67,500
Federal Tax Credit	$7,500
New York State Rebate	NA
Pass. / Cargo vol. (ft^3)	NA
Drivetrain	4WD
EV Range	326
MPGe (city / hwy)	74 / 66
Annual Fuel Costs***	$250
240V Charge Time (hr)	13.0

* *Based on 85% city driving, 5,000 annual miles, $3.50/gal gasoline.*

** *Based on an average of 33 miles between charge events, 5,000 annual miles, $3.50/gal gasoline, and $0.10/kWh electricity.*

*** *Based on 5,000 annual miles, an efficiency of 0.50 kWh/mile, and $0.10/kWh electricity*

Vans

There are currently very limited EV van options. The **Toyota Sienna** comes equipped standard with an HEV drivetrain, but the **Chrysler Pacifica PHEV** is the only currently available PHEV passenger minivan from an OEM. The **Ford E-Transit** is the only BEV cargo van currently available. There are aftermarket HEV and PHEV upfits which can be considered for passenger and cargo vans. XLFleet, as one example, claims to achieve a 25% increase in fuel economy in vehicles such as the **Ford Transit**, **Chevrolet Express**, and **GMC Savanna** with their system. Production of electric cargo vans has been growing in Europe but has been slow to take hold in the U.S. market. **Rivian** has a commitment from Amazon to purchase 100,000 BEV van units. **Mercedes-Benz** has started producing the eSprinter electric cargo van, but it is not clear when this might be available in the U.S. market. The Ford E-Transit appears to present the best option for electrification of the passenger and work vans in the near-term.

Table 6. Van Options

CONVENTIONAL – Chevrolet Express 2500

MSRP (2017)	$34,000
Pass. / Cargo vol. (ft³)	– / 240
Drivetrain	RWD
MPG (city / hwy)	11 / 16
Annual Fuel Costs *	$1,213

CONVENTIONAL – Ford Transit (350 Series)

MSRP	$35,270
Pass. / Cargo vol. (ft³)	– / 247
Drivetrain	RWD
MPG (city / hwy)	15 / 19
Annual Fuel Costs *	$904

CONVENTIONAL – Ford Transit Connect

MSRP	$27,920
Pass. / Cargo vol. (ft³)	– / 106
Drivetrain	FWD
MPG (city / hwy)	19 / 27
Annual Fuel Costs *	$704

HYBRID – Chevrolet Express HEV Upfit

MSRP (2017)	$34,000
Estimated Upfit Cost**	$15,000
Drivetrain	RWD
Li-ion Battery	1.8 kWh
est. MPG ***	14 / 20
Annual Fuel Costs *	$955

HYBRID – Ford Transit HEV Upfit

MSRP	$31,596
Estimated Upfit Cost**	$15,000
Drivetrain	RWD
Li-ion Battery	1.8 kWh
est. MPG ***	19 / 24
Annual Fuel Costs *	$714

PLUG-IN HYBRID – Chrysler Pacifica PHEV

MSRP	$35,996
Federal Tax Credit	$7,500
New York State Rebate	$1,100
Pass. / Cargo vol. (ft³)	165 / 88
Drivetrain	FWD
EV Range	32
MPG (gas) / MPGe	30 / 82
Annual Fuel Costs^	$235
240V Charge Time (hr)	2.0

ALL ELECTRIC – Ford E-Transit

MSRP	$47,185
Federal Tax Credit	$7,500
New York State Rebate	TBD
Pass. / Cargo vol. (ft³)	Varies
Drivetrain	RWD
EV Range	NA
MPGe (city / hwy)	NA
Annual Fuel Costs^	$200
240V Charge Time (hr)	11.0

* *Based on 85% city driving, 4,000 annual miles, $3.50/gal gasoline.*

** *Parts and labor estimates. Actual system installation cost varies based on location.*

*** *Based on manufacturer's fuel efficiency improvement claims of 25% for HEVs*

^ *Based on 4,000 annual miles, an efficiency of 0.50 kWh/mile, and $0.10/kWh electricity*

Recommendation #3: Consider Gasoline-Electric Hybrid Vehicles for Police Use

Ford has led the way in developing electrified options that meet the specifications of pursuit and special service vehicles available to law enforcement agencies. The **Police Interceptor SUV** is based on the popular **Ford Explorer** and has been in use around the country since 2015. The model year 2022 Interceptor SUV is now offered standard with a hybrid (HEV) drivetrain and all-wheel-drive, boosting the EPA-estimated combined fuel economy rating to 24 mpg. In September 2021, Ford announced that the **Mustang Mach-E** had passed Michigan State Police testing that included top speed, braking, and handling characteristics. The New York City Police Department deployed a Tesla Model 3 marked police patrol vehicle in mid-2021. While this is just the first step in developing an all-electric pursuit vehicle for use by law enforcement agencies and there is no definitive timeline for widespread development, it should be noted that automakers and law enforcement agencies are actively working to develop these vehicles.

Table 7. Law Enforcement Options

CONVENTIONAL — **Chevrolet Tahoe PPV**

Purchase Price	–
Pass. / Cargo vol. (ft^3)	123 / 70
Drivetrain	4WD
MPG (city / hwy)	14 / 18
Annual Fuel Costs*	$6,042

CONVENTIONAL — **Dodge Durango Pursuit**

Purchase Price	–
Pass. / Cargo vol. (ft^3)	100 / 43
Drivetrain	AWD
V-6 MPG (city / hwy)	18 / 25
Annual Fuel Costs*	$4,657

CONVENTIONAL — **Dodge Charger Pursuit**

Purchase Price	–
Pass. / Cargo vol. (ft^3)	104 / 17
Drivetrain	RWD/AWD
MPG (city / hwy)	18 / 27
Annual Fuel Costs*	$4,618

CONVENTIONAL — **Chevrolet Impala Pursuit**

Purchase Price	–
Pass. / Cargo vol. (ft^3)	105 / 19
Drivetrain	FWD
MPG (city / hwy)	14 / 22
Annual Fuel Costs*	$5,909

HYBRID — **Ford Interceptor 3.3L HEV**

Purchase Price	–
Pass. / Cargo vol. (ft^3)	118 / 52
Drivetrain	AWD
MPG (city / hwy)	23 / 24
Annual Fuel Costs*	$3,781

ALL ELECTRIC (FUTURE) — **Mustang Mach-E (Extended Range)**

MSRP	$42,895
Federal Tax Credit	$7,500
New York State Rebate	$500
Pass. / Cargo vol. (ft^3)	103 / 12
Drivetrain	RWD/AWD
EV Range	221
MPGe (city / hwy)	100 / 86
Annual Fuel Costs**	$825
240V Charge Time (hr)	8.5

** Based on 85% city driving, 25,000 annual miles, and $3.50/gal gasoline*

*** Based on 25,000 annual miles, an efficiency of 0.33 kWh/mile, and $0.10/kWh electricity*

Recommendation #4: Consider Future Transition of Medium and Heavy-Duty Vehicles

There are limited options for electrifying this portion of the fleet. The most readily available electrification solution for medium- and heavy-duty pickup trucks, flat trucks, straight trucks and large vans is through upfitting of ICE trucks and large vans with aftermarket hybrid and plug-in hybrid drivetrains. There are some promising hybrid-electric systems being developed by heavy-duty manufacturers and upfitters that can run aerial devices, tools and exportable power, and provide cab comfort without relying on an idling internal combustion engine. While these systems do not power the vehicle itself, they could provide quantifiable greenhouse gas emissions reduction by reducing vehicle idle time[14]. There are a limited number of manufacturers producing cab-and-chassis and specialty vehicles that run on fully-electric drivetrains. The flexibility of these vehicles and similarity to conventionally-fueled models make them potential electrified replacements for many vehicle types, including refuse trucks, tankers, and others. However, these are currently being used only in limited numbers under pilot efforts. For example, the New York City Department of Sanitation (DSNY) deployed a fully-electric street sweeper in May 2021. The deployment was made as part of a project supported by the New York State Energy Research and Development Authority. The DSNY street sweeper fleet, with approximately 450 units, also has 27 hybrid-electric drive models[15]. New York City also pilot tested an electric equivalent of its standard refuse truck in 2021. The pilot vehicle was a Mack LR Class 8 vehicle used for waste collection. The pilot proved successful, and the unit has now been equipped with a snowplow. The pilot will soon enter a second year to determine performance with plowing. DSNY has ordered seven of these units which will be deployed across each of the departments seven zones.

[14] Altec Industries, Inc., Altec Green Fleet. https://www.altec.com/products/green-fleet.

[15] New York City Department of Sanitation. Clean Streets, Clean Air: New York City Department of Sanitation Unveils First-Of-Its-Kind All-Electric Street Sweeper, May 6, 2021.

Figure 14. Bucket truck with Altec Industries JEMS system and Global Environmental Products electric sweeper.

Given the current state of development of these vehicles and technologies and the current composition of the City's fleet, it is advisable to focus electrification efforts on the light-duty vehicles while continuing to plan for a transition to electrification of the medium- and heavy-duty vehicles and equipment in the medium-term (five to ten years).

Financial and Environmental Analysis of Fleet Electrification

Electric vehicles have a higher initial capital cost than their ICE vehicle equivalents. However, the higher inception costs may be ameliorated over the course of time due to the lower maintenance and operations costs of EVs. The U.S. Department of Energy's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool was used to compare these values for common light-duty vehicle types in the fleet.

Analyses were run for some common platforms used by the City of Albany, including passenger sedans/small SUVs, light-duty (F-150 type) pickup trucks, utility cargo work vans (250 series), and SUV police vehicles. AFLEET's modeling tool is populated with numerous pre-set input values which drive the calculations; for these analyses, where possible, real City fleet metrics were put into the model, including average annual mileage, vehicles' replacement costs, expected MPG for the vehicles used by the City based on fueleconomy.gov values, and updated electric vehicle pricing for emerging vehicles such as the E-Transit vans and F-150 Lightning BEV. In the case of the police SUV, it was compared against the price for a Tesla Model 3, the only current option for a fully electric police patrol vehicle. The Ford Mustang Mach-E pilot police vehicle, while rated for pursuit by the Michigan State Police in 2021, is not yet available for upfitting as a police or special service vehicle. Monitoring for the availability of this vehicle should be conducted going forward.

The findings, presented in the following table, show that total cost of ownership is lower for the EV models versus the internal combustion versions. The delta between a small passenger sedan/small SUV versus a Chevrolet Bolt is $9,318 over a ten-year vehicle life, a 14 percent reduction over the ICE option, based upon an annual average mileage of 13,000 miles (mileage taken from the most recent Capital Improvement Plan, based on average mileage of vehicles at replacement). For a light-duty pickup truck, the delta is $12,159, or 14 percent based on the same parameters for service life and annual mileage. For the utility cargo van, an E-350 series was used for comparison based on the limitations of the model, which bumped a van up to a larger version; the model could not compare a small van such as a Transit Connect as that was not contained in the data selection options. However, the City does have many mid-size work vans used in DGS and Water, for workmen such as plumbers and carpenters. These could be electrified via substitution with the Ford E-Transit. The delta in this case was $9,807, or nine percent, for the vans for the noted mileage and service life as prior. Likely, had the model been able to compare a smaller van platform, the total cost of ownership savings would be greater.

In the case of the police patrol vehicle of choice, the Dodge Durango, specific usage metrics were applied to the model. These vehicles have substantially higher mileage, between 25,000 and 30,000 miles per year, so the latter value was used for the model. The analysis for this unit did not count the cost of "add on" features selected by Police, which were assumed to be relatively equivalent in terms of customization for all powertrains; it used the base cost of the vehicles for comparison. Since the value of EVs is leveraged when annual mileage increases, this vehicle category reflected a greater total cost of ownership delta of $67,340, or a 32 percent reduction. The model did not allow for inclusion of an EV SUV for a police vehicle, another reason the Tesla sedan was chosen for comparison. Table 8 includes the results of the AFLEET analysis.

Table 8. Total Cost of Ownership (TCO) for Various Vehicle Categories[16]

Vehicle Type	ICE	EV	Delta	EV Lower TCO (Y/N)	Vehicle Lifespan (YR)	TCO Reduction	Notes
Sedan	$68,114	$58,796	$9,318	Y	10	14%	Chevrolet Bolt EV; Chevrolet Malibu ICE
Light-Duty Pickup	$87,558	$75,399	$12,159	Y	10	14%	Ford F-150 Lightning EV; Ford F-150 ICE
Cargo Van	$109,169	$99,362	$9,807	Y	10	9%	Ford E-Transit EV; Ford E-350 ICE
Police SUV vs. Tesla EV	$210,754	$143,414	$67,340	Y	10	32%	Tesla Model 3 Extended Range EV; Dodge Durango ICE

Based on $3.50/gal gasoline; vehicle pricing from City of Albany FY2022 budget; fuel economy based on USEPA estimates

Recommendation #1: Near-Term Transition of Light-duty Passenger Vehicles

There are several light-duty passenger vehicle models on the market that meet the necessary specifications of the sedans and SUVs currently deployed in the City fleet. Near-term replacement of sedans and SUVs will provide an immediate fuel reduction and some cost savings with relatively low risk. The project team evaluated the use of sedans and SUVs to provide an estimate of monetary and energy savings by transitioning these vehicles to EVs.

There are 215 vehicles in the Master Inventory that have been designated as sedans (122) and SUVs (93). These vehicle types are grouped together in this section as they are primarily used for passenger and small equipment transport. Representative vehicles from each type are used to demonstrate the potential cost and energy savings for a transition to EVs over a ten-year period. The representative purchase price for a sedan is $20,000, the approximate manufacturer suggested retail price (MSRP) of the Ford Focus and Toyota Corolla. The representative purchase price of an SUV is $26,600, the approximate MSRP of a Ford Escape. There are several EV types and models that could meet the operational needs of the vehicles in this category. These options range from the sedan EVs, such as the Chevrolet Bolt and Nissan LEAF (approximate MSRP of $26,600), to SUVs such as the Hyundai Kona EV and Kia Niro EV (approximate MSRP of $34,000). Conventional sedans in the fleet travel an average of 3,100 miles annually with a fuel economy of 32.9 miles per gallon (mpg). Overall, all sedans in the City Fleet are consuming 11,600 gallons of fuel annually, adding 297,000 pounds of carbon dioxide (CO_2) to the atmosphere. Conventional SUVs in the fleet travel an average of 6,300 miles annually with a fuel economy of 18.5 mpg. Overall, all SUVs are consuming 31,700 gallons of fuel annually, adding 814,000 pounds of CO_2 to the atmosphere. Transitioning this category of vehicles includes an incremental cost increase that is mitigated by fuel and maintenance cost savings over time. Transitioning the sedan and SUVs to EVs provides a significant reduction in greenhouse gas emissions. Table 9 shows an initial cost and emissions comparison between conventionally fueled vehicles and EVs for both vehicle types.

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[16] USDOE AFLEET, v. 2020

Table 9. Cost and Emissions Comparison of ICE and EV Vehicles

	Sedan/Compact	SUV
ICE Purchase Price	$20,000	$26,600
ICE Annual Fuel Use (gal)	95	341
ICE Annual Fuel Cost ($3.50/gal)	$332	$1,192
ICE Annual Maintenance ($)[17]	$316	$636
ICE Annual GHG emissions (lb.)[18]	2,445	8,767
EV Purchase Price	$27,000	$34,000
EV Annual Fuel Use (kWh)	938	2,205
EV Fuel Cost ($0.10/kWh)	$94	$221
EV Annual Maintenance ($)	$191	$384
EV GHG (lb.)	698	1,641

Although the initial purchase price of EVs can be considerably higher than conventionally fueled sedans and SUVs, analysis of the incremental savings due to lower fuel and maintenance costs shows that EVs provide savings over their lifetime. An incremental replacement of the ICE sedans and SUVs will result in nearly $90,000 in savings over a ten-year period (initially there is higher costs to acquire the vehicles, but over time the savings from all the EVs in the fleet are greater than the higher incremental costs to purchase EVs). Table 10 provides a uniform replacement schedule with associated cost savings indicated.

Table 10. Total Investment and Savings of Transitioning Sedans and SUVs

	New Sedans	New SUVs	Cumulative Sedans	Cumulative SUVs	Net Cost/Savings[19]
FY23	12	9	12	9	$135,225.11
FY24	12	9	24	18	$120,947.93
FY25	12	9	36	27	$104,616.62
FY26	12	9	48	36	$86,011.39
FY27	12	9	60	45	$64,889.41
FY28	12	9	72	54	$40,982.21
FY29	12	9	84	63	$13,992.98
FY30	12	9	96	72	-$16,406.53
FY31	12	9	108	81	-$50,579.43
FY32	12	9	120	90	-$88,927.47

[17] Burnham, Andrew, Gohlke, David, Rush, Luke, Stephens, Thomas, Zhou, Yan, Delucchi, Mark A., Birky, Alicia, Hunter, Chad, Lin, Zhenhong, Ou, Shiqi, Xie, Fei, Proctor, Camron, Wiryadinata, Steven, Liu, Nawei, and Boloor, Madhur. "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains", April 2021.
[18] California Air Resources Board. Low Carbon Fuel Standard (LCFS), https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard, November 2021.
[19] Annual vehicle purchase price, fuel expenditure, and maintenance cost projected to rise by 2%, 5%, and 10%, respectively.

As shown in Figure 15, replacing ICE sedans and SUVs with EVs will result in a reduction of greenhouse gas (GHG) emissions. While there are more sedans in the fleet, the difference in fuel economy and annual usage between the two vehicle types indicates results in a disproportionate contribution of CO_2 emissions from the SUVs.

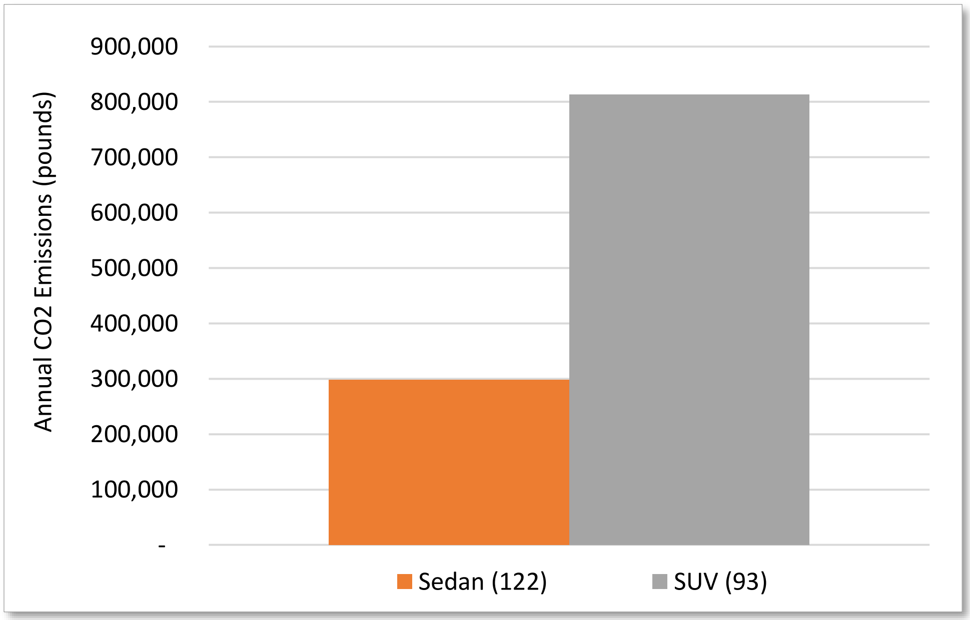

Figure 15. Baseline Emissions of Sedans and SUVs

Based on the disparity between the two vehicle types, transitioning the SUVs has a greater per vehicle reduction in GHG over time. Figure 16 demonstrates the relationship between the two vehicle types.

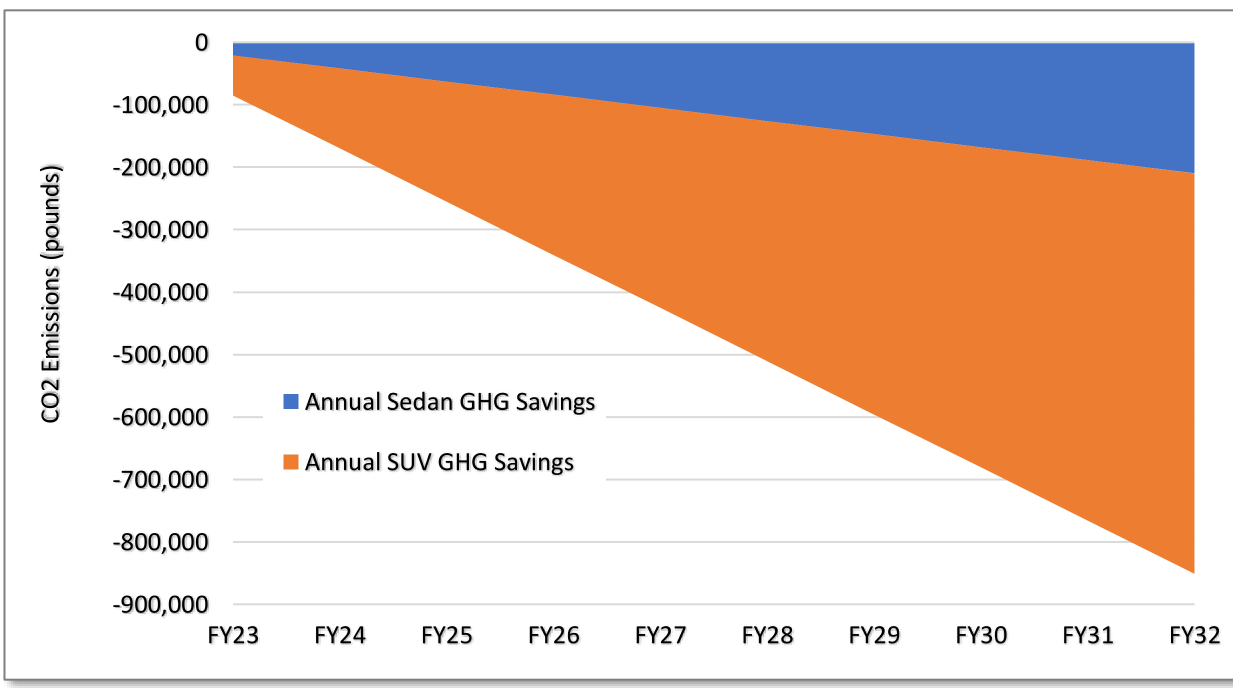

Figure 16. Ten-Year CO_2 Emissions Savings

Recommendation #2: Pilot Electrified Vans and Pickup Trucks When Available

Light-duty pickup truck and cargo van electrification presents a great opportunity for the City fleet as the technology develops. Although the development of electric trucks and vans has been in the news recently, the availability of vehicle models and examples of successful deployments still lags behind the passenger vehicle types (compact, sedan, SUV). As the vehicle technology continues to develop, the City fleet can start to plan for a phased transition away from ICE pickup trucks and vans in two ways: (1) by evaluating the use of these vehicles within the fleet to determine if a different vehicle type will meet the needs as a replacement, and (2) by selectively replacing ICE pickup trucks and vans with EVs to evaluate suitability for future, more widespread deployment.

Electric Pickup Truck and Van Pilot – Water Department

With a small number of EV pickup trucks and vans coming to the market in 2022 as more US manufacturers ramp up investment and production, now is an optimal time for fleets to begin testing these vehicles on a limited basis. A limited deployment of emerging vehicle technology gives the fleet manager an opportunity to perform real-world testing on the electric vehicles and simultaneously compare performance to existing vehicles of similar type and operational characteristics.

Pickup trucks are perhaps the most versatile vehicles throughout the City fleet. They are used by field staff and administrative staff alike and offer flexibility of use that is difficult to match with any other vehicle type. Due to this versatility, it is easy for pickup trucks to become a *de facto* vehicle of choice. However, pickup trucks are also the least fuel-efficient and often most expensive vehicles to purchase and operate. To date, there have been very few options to effectively electrify fleet pickup trucks but as vehicle manufacturers continue to develop and produce electrified pickup trucks the opportunity to dramatically reduce cost and greenhouse gas emissions by phasing in electrified pickup trucks will accelerate. There are eight light-duty pickup trucks (Ford F-150 and Chevrolet Silverado), ranging in age from MY2010 to MY2020 and traveling an average of approximately 7,000 annual miles, in the Water Department fleet. Some of these trucks are assigned to specific staff while others are assigned to specific divisions. These vehicles could be some of the first to test EV options, then provide feedback and guidance to other departments over time. Based on the Water Department's fleet inventory, the average purchase price of these vehicles is $34,876.

Based on the Department's NetworkFleet platform, only two of these vehicles (Vehicle ID 326 and 372) are currently reporting usage data. The remaining vehicles should be equipped with telematics devices, if they are not already installed, allowing for a usage baseline to be established. The NetworkFleet software allows for groups of vehicles to be created. Adding these vehicles to a separate group within the software platform will aid in the collection of data for future analysis. The Fleet Maintenance Pro software that the department is currently using is adequate for tracking cost and other maintenance related metrics on these vehicles. The maintenance data will be an important element of the baseline data.

It appears as if the Ford F-150 Lightning, with delivery expected to begin in late 2022, is going to be the first fully-electric pickup truck available from a major US manufacturer. Initial specifications on these vehicles indicate that the entry-level model of this truck, with an anticipated MSRP of approximately $40,000, will adequately meet the needs of the vehicles recommended for this pilot study[20]. Information on fleet purchasing and state contract availability of this specific vehicle is not currently available and should be evaluated by the department early in the process.

[20] https://www.ford.com/trucks/f150/f150-lightning/2022.

Cargo vans are another versatile vehicle type used throughout the fleet. The cargo capacity of a van allows staff to transport a wide variety of materials and supplies. There are three vans in the Water Department fleet, one MY2010 GMC Savanna, one MY2015 Ford Transit Connect, and one MY2017 350 series Ford Transit. The GMC van is a special use vehicle and despite its age has only traveled 15,000 total miles. The Ford Transit and Transit Connect vans would be good candidates for an internal pilot study. The amount of use and initial cost of these two vehicles is significantly different. The initial cost of the 350 series van was $41,820 and it has traveled an average of 3,678 miles per year while the smaller, older Transit Connect van was initially purchased for $23,465 and has traveled an average of 10,067 annual miles.

Only one of these vehicles (the MY2015) appears to currently be reporting data through the Verizon NetworkFleet platform. The MY2017 vehicle should be equipped with a telematics device, if not already installed, to establish a baseline of use. The two vans could then be added to the pilot group within the NetworkFleet software to aid in future analysis.

Upon equipping the ten vehicles in the pilot with telematics devices, the Water Department Operations Manager will be able to monitor use over the initial phase of the pilot, data collection on existing ICE vehicles. This data collection and monitoring period can continue up until the time when the pilot vehicles are able to be replaced with the EV equivalent, preferably after at least one full calendar year. Upon replacement, the EVs should be equipped with telematics devices and monitored in the same way as the ICE vehicles were monitored in phase 1. The City should also select similarly operated new pick-up trucks in other departments that are acquired at the same time as these EVs for further comparison purposes (maintenance in particular). Table 11 shows an initial cost and emissions comparison between the conventionally fueled and EV for the pilot.

Table 11. Cost and Emissions Comparison of Pilot Study Vehicles

	Pickup Truck	Van
ICE Purchase Price	$34,876	$41,800
ICE Annual Fuel Use (gal)	753	526
ICE Annual Fuel Cost ($3.50/gal)	$2,634	$1,842
ICE Annual Maintenance ($)[21]	$707	$707
ICE Annual GHG emissions (lb.)[22]	19,378	13,550
EV Purchase Price	$40,000	$47,200
EV Annual Fuel Use (kWh)	3,500	3,500
EV Fuel Cost ($0.10/kWh)	$350	$350
EV Annual Maintenance ($)	$427	$427
EV GHG (lb.)	2,604	2,604

Using similar analysis as conducted for the transition of sedans and SUVs, it can be expected that the vehicles involved in the pilot study will provide a favorable return on investment. Deployment of eight electric pickup trucks

[21] Burnham, Andrew, Gohlke, David, Rush, Luke, Stephens, Thomas, Zhou, Yan, Delucchi, Mark A., Birky, Alicia, Hunter, Chad, Lin, Zhenhong, Ou, Shiqi, Xie, Fei, Proctor, Camron, Wiryadinata, Steven, Liu, Nawei, and Boloor, Madhur. "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains", April 2021.

[22] California Air Resources Board. Low Carbon Fuel Standard (LCFS), https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard, November 2021.

and two electric vans will cost an estimated $414,000. It is estimated that each pickup truck will save $2,600 and each van will save $1,800 annually in fuel and maintenance cost for a total annual savings of $24,400. A third and final phase of the pilot study will be an ongoing evaluation of the EVs to determine whether performance and savings are meeting the expected levels.

Recommendation #3: Consider Ford Interceptor Hybrid for Police Use

Ford is developing electrified options that meet the specifications of pursuit and special service vehicles available to law enforcement agencies. The Police Interceptor SUV is based on the popular Ford Explorer and has been in use around the country since 2015. The model year 2022 Interceptor SUV is now offered standard with a hybrid (HEV) drivetrain and all-wheel-drive, boosting the EPA-estimated combined fuel economy rating to 24 mpg. The Mustang Mach-E has recently been equipped as a police pursuit vehicle but has limited deployments to date. Table 12 provides a comparison between the conventionally fueled SUV Police vehicle and the hybrid drive (HEV) Ford Interceptor.

Table 12. Cost and Emissions Comparison of Police SUVs

	Police SUV
ICE Purchase Price	$40,000
ICE Annual Fuel Use (gal)	1,250
ICE Annual Fuel Cost ($3.50/gal)	$4,375
ICE Annual Maintenance ($)[23]	$2,525
ICE Annual GHG emissions (lb.)[24]	32,181
HEV Purchase Price	$45,000
HEV Annual Fuel Use (gal)	1,087
HEV Fuel Cost ($3.50/gal)	$3,804
HEV Annual Maintenance ($)	$2,525
HEV GHG (lb.)	27,984

There are currently 43 patrol SUVs in the Police Department fleet. These are high-use vehicles with long operating hours and high mileage. The modest improvements in driving fuel economy between the conventionally fueled vehicles currently in use (primarily Dodge Durango) result in minimal fuel cost savings, but these could increase it the vehicles experience high idle times (during which the conventional vehicle continues to burn fuel while the HEV could eliminate most engine run time when stationary). Because of their high use, any improvement to fuel efficiency in these patrol vehicles can result in considerable GHG savings over time. The Police are already looking to acquire several HEVs for their non-patrol fleet and if those function well, it is recommended to consider testing one in a patrol unit.

[23] Burnham, Andrew, Gohlke, David, Rush, Luke, Stephens, Thomas, Zhou, Yan, Delucchi, Mark A., Birky, Alicia, Hunter, Chad, Lin, Zhenhong, Ou, Shiqi, Xie, Fei, Proctor, Camron, Wiryadinata, Steven, Liu, Nawei, and Boloor, Madhur. "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains", April 2021.

[24] California Air Resources Board. Low Carbon Fuel Standard (LCFS), https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard, November 2021.

Priority Replacement Schedule of Fleet Vehicles

Based on available EV options, suggested EV replacements for the current fleet inventory are included in this section. These EV recommendations are the closest available equivalents to what is currently in the fleet, with a few opportunities to downsize or switch vehicle classes. No replacements are listed for the BEVs currently in operation and those vehicles without an obvious EV option currently list "TBD". BEV replacements are recommended whenever available as an option (particularly for the compact class), PHEVs are recommended when no BEV option is available. HEVs are generally not recommended because they do not allow for significant petroleum displacement from electrical power, except for patrol vehicles and in cases where HEVs are the only feasible option. These recommendations should be regularly reviewed and updated as new EV models become available. Ideally this is work done by a dedicated staff person, such as a fleet analyst, who coordinates all details related to the fleet.

Department of General Services

The Engineering vehicles present a good opportunity to use BEVs. The vehicles reside at the DGS headquarters and return each afternoon, allowing for a regular charging pattern. The duty cycle and the needed equipment space fits well with available EVs such as the Chevrolet Bolt EV, Bolt EUV, Nissan LEAF, or Hyundai Kona EV. If a pickup is needed, the Ford F-150 Lightning can do the job.

Further, the Department should plan forward as the availability of pickups and vans increases going into 2023/2024. It should choose a reasonable percentage of all pickups, SUVs, and when the duty cycle allows, work vans, to be transitioned to fully electric upon replacement. By setting procurement goals for percentage transition, the fleet will green itself over time.

Figure 17. A Typical SUV in the DGS Fleet

Table 13 identifies ten light-duty DGS vehicles that could most readily be replaced with EVs in the near-term. Vehicles in this table are ordered according to the average annual miles traveled to maximize the return on investment.

Table 13. Prioritized Light-Duty Replacement Vehicles, Department of General Services

Unit ID	Type	Year	Make	Odometer	Annual Mileage	VIN
403	SUV	2013	Ford	119,103	13,234	1FM5K8B86DGA02457
501	SUV	2018	Jeep	36,199	9,050	1C4RJFAG7JC303294
E2	SUV	2016	Jeep	52,628	8,771	1C4RJFAG2GC450891
E3	SUV	2007	Dodge	112,073	7,472	1D8HB38N57F578635
504	SUV	2011	Ford	76,001	6,909	1FMCU5K37BKA56882
E5	SUV	2004	Jeep	103,981	5,777	1J4GW48S94C312570
E6	SUV	2011	Ford	49,544	4,504	1FMCU5K35BKA56881
F3	SUV	2004	Jeep	73,477	4,082	1J4GW48S54C429434
E4	SUV	2011	Ford	33,300	3,027	1FMCU5K30BKA56884
E1	SUV	2018	Jeep	5,307	1,327	1C4RJFAG5JC303293

Department of Water and Water Supply/Water Board

The heavy-duty vehicles used by this department impedes most electrification options but serving as a demonstration for new products could allow the City to test a vehicle at little to no cost (but may come involve other challenges and more staffing resources). Water's light-duty vehicles, particularly the array of Jeeps, could likely be electrified when due for replacement. The lone sedan in the fleet and the smaller SUVs could be replaced immediately with The Chevrolet Bolt EV, Bolt EUV, Nissan LEAF, or Hyundai Kona; their duty cycle would fit well with the EV application, and vehicle sizing for equipment storage should be adequate. These vehicles return to the main facility nightly and can be regularly charged overnight. The Cherokees are used by the Commissioner and Assistant Commissioner. One or both could be transitioned to an EV upon replacement. Likewise, the mail car, which is old, is a perfect application for one of the smaller EVs available on state contract. Table 14 identifies ten light-duty Water Department vehicles that could most readily be replaced with EVs in the near-term. Vehicles in this table are ordered according to the average annual miles traveled to maximize the return on investment.

Table 14. Prioritized Light-Duty Replacement Vehicles, Water Department

Unit ID	Type	Year	Make	Odometer	Annual Mileage	VIN
335	SUV	2015	Jeep	83,790	11,970	1C4NJRBB4FD358239
399	SUV	2017	Ford	43,708	8,742	1FMCU9GD5HUE75805
330	SUV	2012	Ford	75,333	7,533	1FMCU9DG1CKA51038
378	SUV	2010	Ford	73,152	6,096	1FMCU9DG4AKD33848
301	SUV	2015	Jeep	40,720	5,817	1C4RJFAG4FC890951
343	SUV	2006	Jeep	89,026	5,564	1J4GL48K36W201233
348	Sedan	2012	Ford	48,527	4,853	3FADP0L31CR157839
308	SUV	2016	Jeep	27,779	4,630	1C4NJRBB9GD814558
371	SUV	2004	Ford	82,306	4,573	1FMDU83K94UB53570
332	SUV	2016	Jeep	25,941	4,324	1C4NJRBB7GD814557

Police Department

The Police Department has several vehicles which present well for electrification. The best fit for EVs is Administrative Services, which has six vehicles operating on a set schedule, from the same location, and could make use of a compact or SUV EV. Animal Control uses small vans; with a fleet of three vehicles, these could be replaced with an E-Transit when ready. Domestic Violence has four vehicles which likewise could be transitioned to a small EV. Community Resources and School Resources, with four and two vehicles respectively, could also make use of the small EVs. The Communications Director has one vehicle, which could be replaced with an electric sedan or SUV and provide a public facing example of the City embracing EVs. The computer unit has two vans that could be transitioned to an SUV EV or Ford E-Transit, if more space is needed. Table 15 identifies ten light-duty Police Department vehicles that could readily be replaced with EVs in the near-term. Given the high number of similar vehicles in the fleet, these representative examples could be substituted with similar models based on the fleet manager's recommendations. As noted above, there may also be specific use cases within the Police Department that make electrification of certain vehicles a higher priority.

Table 15. Prioritized Light-Duty Replacement Vehicles, Police Department

Unit ID	Type	Year	Make	Odometer	Annual Mileage	VIN
54	Van	2010	Kia	N/A	76,289	KNDMG4C38A6356401
480	Sedan	2006	Chevrolet	N/A	115,617	2G1WS551469421200
397	Sedan	2013	Chevrolet	N/A	26,685	2G1WD5E31D1267360
392	Sedan	2013	Chevrolet	N/A	12,300	2G1WD5E30D1267205
393	Sedan	2013	Chevrolet	N/A	59,973	2G1WD5E34D1267059
403	Sedan	2013	Chevrolet	N/A	132,092	6G1MK5U35DL825223
411	Sedan	2014	Chevrolet	N/A	110,644	6G3NS5U26EL948677
673	Sedan	2014	Chevrolet	N/A	100,507	6G3NS5U25EL952333
434	Van	2015	Ford	N/A	38,572	NM0LS6E75F1217690
779	Van	2015	Ford	N/A	11,174	NM0LE7E25K1390024

The Police Headquarters parking lot at 165 Henry Johnson Boulevard is unfenced and accessible to vehicle and pedestrian entry from all directions. The parking lots at South and Central are also unfenced. There is concern that this could present a site control issue as anyone could walk past and unplug the vehicle from its charger. Vehicles are typically equipped such that a charger cannot be unplugged unless the doors are unlocked and there are technologies to address such a situation, including cloud-based notifications that the vehicles have been unplugged, or innovative emerging technology solutions such as wireless, in-ground chargers which charge from below the vehicle. It was noted that the Communications Director's location is fenced, further bolstering that vehicle as a good first choice for an EV.

Fire Department

The Fire Prevention and Investigation Unit has five SUVs, MY2011 to MY2013 Ford Explorers. The primary and secondary investigator vehicles will respond to fires and stay afterwards as investigations are conducted. They utilize emergency lighting, computers, and other electronics such as Mobile Data Terminals, and may be on scene for an extended period. Other vehicles in the Fire Prevention and Investigation Unit operate from 8:00am to

4:00pm, doing operational work. These two vehicles could be electrified upon replacement with a compact or SUV EV, which would be large enough to stow necessary gear.

Battalion Chiefs currently use MY2004/MY2005 Chevrolet Tahoe SUVs. One or two of these could be electrified, provided the selected vehicle has the electronic capacity to power needed for computers and lights; an F-150 Lightning EV with a generator capacity is a potential fit for the Battalion Chiefs. This would serve as an example that a chief's vehicle can be easily electrified and a successful EV. It would also need to be large enough to carry the Chief's gear and ancillary equipment, which is why a pickup equipped with a lockable bed cover is likely needed.

Fire presents an interesting opportunity for a pilot project which could lead as a state-wide example to other fire departments. As the Capital city, other municipalities look to the Albany AFD for leadership and innovation. Those other municipalities are not able to do things on a scale as large as the Fire Department of the City of New York but can emulate a city such as Albany. The leadership of the department appeared willing to engage in such a pilot effort, though supplemental funds would be needed for EV integration, which is currently not in the Fire Department budget. Table 16 identifies ten light-duty Fire Department vehicles that could most readily be replaced with EVs in the near-term. Odometer readings were not available for these vehicles. Therefore, the table identifies the ten light-duty vehicles in the fleet that are more than ten years old.

Table 16. Prioritized Light-Duty Replacement Vehicles, Fire Department

Unit ID	Type	Year	Make	Odometer	Annual Mileage	VIN
57	SUV	2002	Dodge	N/A	N/A	1B4HS38N52F198702
59	Sedan	2003	Chevrolet	N/A	N/A	2G1WF52E439360485
17	SUV	2004	Chevrolet	N/A	N/A	1GNEC16ZX4J224618
61	SUV	2004	Chevrolet	N/A	N/A	1GNEK13V04J296609
770	Sedan	2005	Chevrolet	N/A	N/A	2G1WF52K759216485
19	SUV	2005	Chevrolet	N/A	N/A	1GNECI6Z35J241262
64	SUV	2006	Dodge	N/A	N/A	1D5HB58206F180704
22	SUV	2007	Dodge	N/A	N/A	1D8HB48N87F578263
23	SUV	2007	Dodge	N/A	N/A	1D8HB48N67F578262
24	SUV	2009	Dodge	N/A	N/A	1D8HB38P69F712704

Department of Recreation

Recreation presents as an opportunity to fully electrify a department. It has a small fleet which could be electrified incrementally upon vehicle replacement, starting with the vans (which are old and due for replacement), moving on to pickups and eventually, when market ready, the dump and rack trucks. The rack truck could be ordered with an XL hybrid drivetrain in the near term. The vehicles domicile at a central location and generally work one shift, allowing for overnight charging. As a community-oriented department which works throughout the City, Recreation provides a visible public facing platform for community-wide EV awareness. The discrete size of the department allows for full electrification, which could be used as a model to provide data on performance for other departments. Table 17 identifies five Recreation Department vehicles that could be considered for near-term electrification. Vehicles in this table are ordered according to the vehicle type and average annual miles traveled to maximize the return on investment within each class.

Table 17. Prioritized Light-Duty Replacement Vehicles, Department of Recreation

Unit ID	Type	Year	Make	Odometer	Annual Mileage	VIN
201	SUV	2011	Ford	39,610	3,601	1FMCU5K32BKA56885
R15	SUV	2015	Jeep	21,697	3,100	1C4NJCBA3FD285871
YS 2	Van	1998	Ford	75,894	3,162	1FBSS31LWHB13762
YS 1	Van	2005	Ford	47,350	2,785	1FBSS31L65HB27085
R16	Van	2019	Chevy	2,912	971	1GAZGLFG3K1316166

Electric Vehicle Charging

A key element to fleet electrification is proper planning for EV charging infrastructure, commonly referred to as electric vehicle supply equipment (EVSE). Each EV needs to have convenient and reliable access to charging at the time of deployment. Comprehensive, proactive planning for near-term and long-term charging needs helps to ensure that future needs are met and lowers fueling cost. There are numerous factors to consider when contemplating the need for charging infrastructure. Although the cost of charging station hardware can be determined relatively easily, site preparation requirements can have a significant impact on installation cost. Capital investment is usually discussed in terms of "cost per port", which spreads the cost of site preparation and access across multiple charging access points when installation involves more than one charging station at a single site.

Charging Station Types

There are generally three types of EVSE that provide various power levels to charge the EV at different rates. Alternating current (AC) Level 1 stations use 120 volts (V) to provide up to two kilowatts (kW) of charging, resulting in 2 - 5 miles of electrical driving range per hour of charging. Most, if not all, EVs will come with a Level 1 cord set, so no additional charging equipment is required. On one end of the cord is a standard NEMA (three-prong household style) connector and on the other end is an SAE J1772 standard connector. The J1772 connector plugs into the EV's J1772 charge port and the NEMA connector plugs into a standard NEMA wall outlet on its own dedicated circuit. Level 1 charging is typically used by fleets when an EV can be parked and charged overnight. For example, eight hours of charging at Level 1 can replenish about 40 miles of electric range for a mid-size EV. The advantage to using Level 1 charging is that very little site preparation or special equipment is required.

AC Level 2 equipment is the EVSE type most used by fleets. Level 2 EVSE use 240V to provide up to 19.2 kW, resulting in 10-20 miles of electrical driving range per hour of charging. Level 2 EVSE uses the same J1772 connector that Level 1 equipment uses. All commercially available EVs can charge using Level 2 EVSE. Figure 18 shows the two types of Level 2 EVSE designs.

Figure 18. Pedestal (left) and wall-mounted (right) Level 2 charging stations

Direct-current fast charging (DCFC) equipment uses 208/480V AC three-phase input and converting that to direct current energy that feeds directly into the EV batteries, enabling rapid charging. DCFC power levels range from 25 kW to 350 kW (50-150 kW are most common). DCFC charging is usually used by fleets when vehicle duty cycles do not allow for overnight or prolonged connection time. There are three types DCFC connectors, depending on the type of charge port on the vehicle: SAE Combined Charging System (CCS), CHAdeMO, and Tesla. The CCS connector (also known as J1772 combo) is unique because a driver can use the same charge port when charging with Level 1, Level 2, or DCFC equipment. Figure 19 shows the four common EV charging connectors.[25]

Figure 19. EV charging station connector types

DCFC equipment and site preparation costs are often significantly higher than those associated with Level 2 EVSE. Therefore, fleets usually install DCFC stations on a more limited basis. Figure 20 shows an example of a charging station with multiple connector types (Combo and CHAdeMO) for use by more EVs, however, most EVSE of this type allow for only one of the connectors to be used at a time.

Figure 20. DC Fast charge station

Networked vs. Non-Networked Charging Stations

Most charging station service providers offer the option to subscribe to station performance service that allows fleet managers to monitor use and generate reports on individual or groups of stations. This data is essential if fleet managers wish to accurately evaluate the demand for charging. The reporting can also be used to inform policy decisions related to the use of vehicles and charging stations. While adding cost to the overall investment in

[25] Graphic sources: http://m.eet.com/media/1200053/sae-j1772c.jpg, http://m.eet.com/media/1200054/sae-combo.jpg, www.ryot.org/tesla-motors-releases-secrets-hopes-innovate/733589, and http://circarlife.com/sites/default/files/conector_chademo.png

charging infrastructure, if used effectively the data provided by networked stations can provide insight and help fleet managers to make informed decisions on how charging stations are used. The complexity and design of access to charging station data can vary widely among service providers. Since access to the data is provided through proprietary software, how data is accessed needs to be a consideration when determining which charging station manufacturer to use.

Equipment and Installation Cost Considerations

Equipment costs vary based on location, charging level, and EVSE type. Single connector unit costs can range from $300 to $1,500 for Level 1, $400 to $6,500 for Level 2, and $10,000 to $40,000 for DCFC. It is important to consider available features such as networking capabilities, security, power output, number and type of connectors, number of vehicles that can simultaneously charge, and operation and maintenance considerations (e.g., payment and data collection capabilities).

The installation of a charging station includes locating or constructing a secure structure or mounting surface and getting sufficient electrical power to the charging station. Typically, the station is mounted on a concrete base for a free-standing pedestal unit (more expensive) or mounted to an existing structure for a wall unit (less expensive). The distance between the electrical panel and charging station will impact the cost, as well as the surface (e.g., pavement, concrete sidewalk, dirt) and structure (building envelop) that conduit must be routed through. Upgrades to the electrical service or panel, if the existing infrastructure is not sufficient, will also add cost to the installation. Based on these factors, installation costs per port range widely, from up to $3,000 for Level 1, $1,000 to $15,000 for Level 2, and $10,000 to $60,000 for DCFC. Local permitting and inspection fees may also apply.

Signage is used to regulate how the charging stations are used (e.g., specifying that only charging EVs should be parked in these spaces), who is allowed to use the stations, and create EV awareness. Installations in controlled-access locations have different signage requirements than locations where public access is available and this needs to be considered at the time of installation. Installation of signage might add up to $500 to the total station cost[26].

On-Going Cost Considerations

Networked EVSE cost more to purchase because they have cellular communication modules that allow them to send and receive information. They will also have additional installation costs for site validation (to verify that there is a sufficient cellular signal) and station activation (to initiate and verify proper communication). Ongoing expenses for a networked charging station include networking fees, electricity, and maintenance. Networking fees around $300-$600 per charging port per year cover the needed cellular data plan and the services to maintain the networking features which include monitoring, alerts, and reporting. While varying based on the battery capacity of an EV and its state of charge when plugging in, on average one charge event dispenses about $0.77 of electricity to an EV (~7.7 kWh at $0.10 per kWh). The project team is currently leading a US Department of Energy effort to monitor 3,500 charging ports in New York, New Jersey, and Pennsylvania. The EVSE participating in this effort that are installed at fleet charging locations average just over 1.5 charge events per week per port[27]. Rounding this to 80 charge events per year per port would cost the site approximately $60 in electricity annually. Maintenance costs will depend on the location and use, but a properly cared for charging station should only have minor repairs ($1,000 or less) for parts that wear from use over ten years.

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[26] US Department of Energy, Vehicle Technologies Office, Alternative Fuels Data Center. Charging Infrastructure Procurement and Installation. https://afdc.energy.gov/fuels/electricity_infrastructure_development.html.

[27] Energetics, 'EV WATTS Charging Station Dashboard Q2-21', 2021. [Online]. Available: https://www.energetics.com/evwatts. [Accessed 12-26-2021}.