INL/EXT-15-34206

AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for Department of Veterans Affairs –VA Manhattan Campus

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October 2014

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

INL/EXT-15-34206

AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for Department of Veterans Affairs –VA Manhattan Campus

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October 2014

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Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

ABSTRACT

Battelle Energy Alliance, LLC, managing and operating contractor for the U.S. Department of Energy's Idaho National Laboratory, is the lead laboratory for U.S. Department of Energy Advanced Vehicle Testing. Battelle Energy Alliance, LLC contracted with Intertek Testing Services, North America (Intertek) to collect and evaluate data on federal fleet operations as part of the Advanced Vehicle Testing Activity's Federal Fleet Vehicle Data Logging and Characterization study. The Advanced Vehicle Testing Activity study seeks to collect and evaluate data to validate the utilization of advanced plug-in electric vehicle (PEV) transportation.

This report focuses on the Department of Veterans Affairs, VA Manhattan Campus (VA - Manhattan) fleet to identify daily operational characteristics of select vehicles and report findings on vehicle and mission characterizations to support the successful introduction of plug-in electric vehicles (PEVs) into the agency's fleet.

Individual observations of these selected vehicles provide the basis for recommendations related to electric vehicle adoption and whether a battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV) (collectively plug-in electric vehicles, or PEVs) can fulfill the mission requirements.

Intertek acknowledges the support of Idaho National Laboratory and VA - Manhattan personnel for participation in the study.

EXECUTIVE SUMMARY

Federal agencies are mandated to purchase alternative-fuel vehicles, increase consumption of alternative fuels, and reduce petroleum consumption. Available plug-in electric vehicles (PEVs) provide an attractive option in the selection of alternative fuel vehicles. PEVs, which consist of both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), have significant advantages over internal combustion engine (ICE) vehicles in terms of energy efficiency, reduced petroleum consumption, reduced production of greenhouse gas (GHG) emissions, and they provide performance benefits with quieter, smoother operation. This study is intended to evaluate the extent to which Department of Veterans Affairs, VA Manhattan Campus (VA - Manhattan) could convert part or all of their fleet of vehicles from petroleum-fueled vehicles to PEVs.

Likely more fuel efficient internal combustion engine (ICE) vehicles, including hybrid electric vehicles, exist which may provide improvements for the current fleet but this study's focus is on replacing ICE vehicles with suitable PEVs.

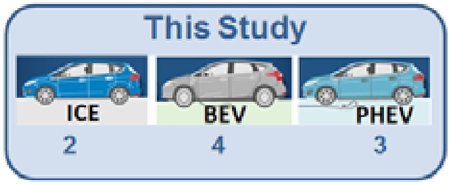
BEVs provide the greatest benefit when it comes to fuel and emissions savings because all the motive power is provided by the energy stored in the on-board battery pack. These vehicles use no petroleum and emit no pollutants at their point of use. PHEVs provide similar savings when their battery provides the motive power but they also have the ability to extend their operating range with an onboard ICE. Since a PHEV can meet all transportation range needs, the adoption of a PHEV will be dependent upon its ability to meet other transportation needs such as cargo or passenger carrying. Operation of PHEVs in battery-only mode can be increased with opportunity charging at available charging stations; it should be noted, however, that not all PHEVs have a mode in which the battery provides all of the motive power at all speeds. This study focuses on the mission requirements of the fleet of vehicles with the objective to identify vehicles that may be replaced with PEVs with emphasis on BEVs that provide maximum benefit.

VA – Manhattan, located at 423 E 23rd Street in New York, NY is a part of the U.S. Department of Veterans Affairs, NY Harbor Healthcare System. It offers a variety of health services to meet the needs of our nation's Veterans. The VA New York Harbor Healthcare System is dedicated to providing quality health care to veterans using the abilities of all employees supported by our commitment to education and research[a].

VA - Manhattan has 100 vehicles in its fleet of which nine were identified as representative of the fleet and instrumented for data collection and analysis. Fleet vehicle mission categories are defined in Section 4, and while the VA - Manhattan vehicles conduct many different missions, two (i.e., pool and support) were selected by agency management to be part of this fleet evaluation. These two mission categories accounted for 85 of the 100 total fleet vehicles. The remaining vehicles were specialty, transport, buses/shuttles, and law enforcement vehicles.

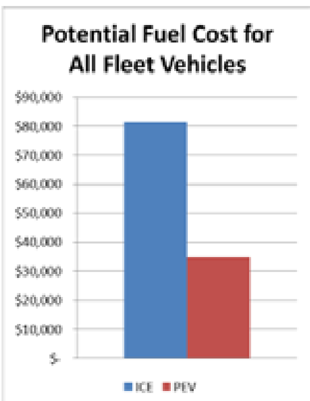
This report observes that a mix of BEVs and PHEVs are capable of performing most of the required missions and of providing an alternative vehicle for the pool and support vehicles, because while some vehicles travel long distances, the group could support some BEVs for the short trips and PHEVs for the longer trips. The recommended mix of vehicles will provide sufficient range for individual trips and time is available each day for charging to accommodate multiple trips per day. These charging events could occur at the vehicle home base. Replacement of vehicles in the current fleet would result in significant reductions in the emission of GHGs and in petroleum use, as well as reduced fleet operating costs.

[a] http://www.nyharbor.va.gov/about/index.asp [accessed October 13, 2014]



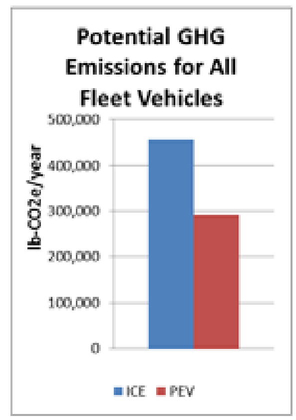
Based upon the data collected for the monitored vehicles, the 9-vehicle fleet subset could possibly consist of two ICE passenger vans, four BEVs and three PHEVs. The replacement of these seven internal combustion vehicles with PEVs could result in an annual GHG savings over 15,791 lbs-CO2e (33% reduction) and an annual fuel cost savings of $4,531 (56% reduction).

Based upon the data collected from the monitored vehicles and extrapolating to the 85 vehicles, the fleet consisting of four conventional heavy-duty trucks, twenty-two conventional passenger vans and 30 BEVs and 29 PHEVs may meet the park's needs. The replacement of the 59 internal combustion vehicles with PEVs could result in an annual GHG savings over 160,000 lbs-CO2e (36% reduction) and an annual fuel cost savings of over $45,000 (57% reduction).



PEV charging stations located near the VA - Manhattan Medical Center could benefit not only VA - Manhattan's own fleet vehicles but also those in the visiting public that own PEVs.

Intertek suggests VA - Manhattan may wish to move forward in the near future with the replacement of pool and support vehicles with PEVs as current budget and vehicle replacement schedules allow. Certainly, the vehicle types studied in this report may be candidates for immediate replacement.



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ACRONYMS

AC	Alternating Current
BEA	Battelle Energy Alliance, LLC
BEV	battery electric vehicle
CD	Charge Depleting
CS	Charge Sustaining
DC	Direct Current
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EVSE	electric vehicle supply equipment
GHG	greenhouse gas emissions
GPS	global positioning system
GSA	General Services Administration
HBPC	Home Based Primary Care
ICE	internal combustion engine
INL	Idaho National Laboratory
Intertek	Intertek Testing Services, North America
LSV	Low-Speed Vehicle
OEM	original equipment manufacturers
PEV	plug-in electric vehicle (includes BEVs and PHEVs, but not hybrid electric vehicles)
PHEV	plug-in hybrid electric vehicle
SAE	Society of Automotive Engineers
VA - Manhattan	US Department of Veterans Affairs, Manhattan Campus
VIN	vehicle identification number

1. INTRODUCTION

Federal agencies are mandated by the Energy Policy Act of 1992[2], Energy Policy Act of 2005[3], Executive Order 13423 (President Bush 2007)[4], Executive Order 13514 (President Obama)[5]and the Energy Independence and Security Act of 2007[6] to purchase alternative-fuel vehicles, increase consumption of alternative fuels, reduce petroleum consumption, and reduce GHG emissions.

Battelle Energy Alliance, LLC (BEA), managing and operating contractor for Idaho National Laboratory (INL), is the lead laboratory for the U.S. Department of Energy's (DOE) advanced vehicle Testing and manages the Advanced Vehicle Testing Activity Federal Fleet Vehicle Data Logging and Characterization study, which promotes utilization of advanced electric drive vehicle transportation technologies. The Advanced Vehicle Testing Activity focuses its testing activities on emerging and newly commercialized plug-in electric vehicle (PEV) technologies because of the high-energy efficiencies and reduced consumption of petroleum by the use of electric-drive vehicles. BEA selected Intertek Testing Services, North America (Intertek) to collect data on federal fleet operations and report the findings on vehicle and mission characterizations to support the successful introduction of PEVs into federal fleets.

> *Executive Order 13514:*
> *"...makes reduction of GHG emissions a priority for Federal Agencies"*

Likely more fuel efficient internal combustion engine (ICE) vehicles, including hybrid electric vehicles, exist which may provide improvements for the current fleet but such are not the focus of this study.

Because of the large number of vehicles in federal fleets in the United States, these fleets provide a substantial opportunity for the introduction of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) (collectively PEVs). However, to assess the scale of this opportunity, additional data are required to characterize the various missions performed by each fleet and to determine which existing vehicles are most suitable for replacement by a PEV.

VA – Manhattan, located at 423 E 23rd Street in New York, NY is a part of the U.S. Department of Veterans Affairs, NY Harbor Healthcare System. It offers a variety of health services to meet the needs of our nation's Veterans. The VA New York Harbor Healthcare System is dedicated to providing quality health care to veterans using the abilities of all employees supported by our commitment to education and research[7]. VA-Manhattan also offers home based primary care (HBPC) for homebound veterans in the New York City area.[8]

VA - Manhattan is an excellent site for fleet evaluation because of its size, location, and travel between this site and other local destinations. VA - Manhattan has an opportunity to be a leader in the adoption of BEVs and PHEVs for its fleet. In addition, electric vehicle charging stations that may be installed at VA - Manhattan may be generally available for use by employees and visitors.

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[2] http://thomas.loc.gov/cgi-bin/query/z?c102:h.r.776.enr [accessed January 10, 2014]

[3] http://www.gpo.gov/fdsys/pkg/BILLS-109hr6enr/pdf/BILLS-109hr6enr.pdf [accessed January 10, 2014]

[4] http://www.gsa.gov/portal/content/102452 [accessed January 10, 2014]

[5] https://www.fedcenter.gov/programs/eo13514/ [accessed September 1, 2014]

[6] http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf [accessed January 10, 2014]

[7] http://www.nyharbor.va.gov/about/index.asp [accessed October 13, 2014]

[8] http://www.nyharbor.va.gov/services/Home_Based_Primary_Care.asp [accessed October 13, 2014]

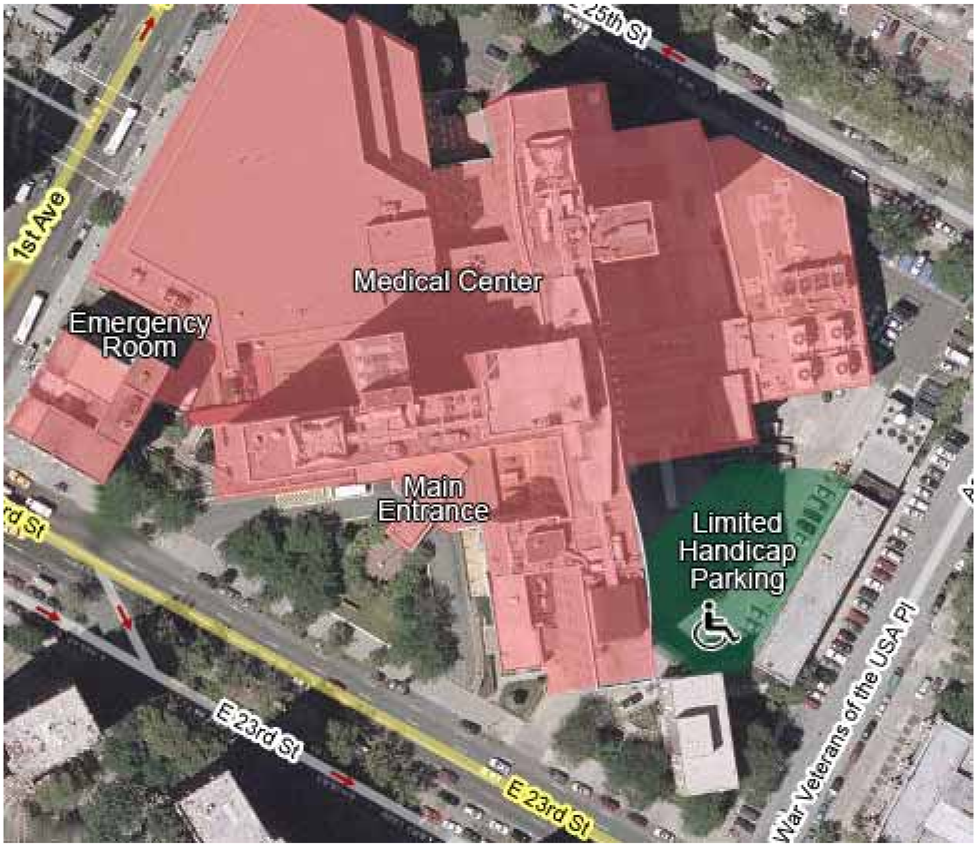

Figure 1. VA - Manhattan facilities graphical representation[9]

[9] http://www.nyharbor.va.gov/visitors/campus.asp [accessed October 13, 2014]

Figure 2. VA - Manhattan Campus[10]

2. PROJECT OBJECTIVE

This study explores federal fleet vehicles and their usage characteristics, with a primary goal of supporting the goals of Presidential Executive Order 13514, which includes the following:

- Pursuing opportunities with vendors and contractors to address and incentivize greenhouse gas (GHG) emission reductions and petroleum use reductions
- Implementing strategies and accommodations for transit, travel, training, and conferences that actively reduce carbon emissions associated with commuting and travel by agency staff
- Meeting GHG emissions reductions associated with other federal government sustainability goals.
- Implementing innovative policies and practices that address agency-specific Scope 3 GHG emissions.[11]

Because of the large number of vehicles in the federal fleets, there is a substantial opportunity for PHEV and BEV adoption. Federal fleets offer an opportunity as a first market replacement for alternative fuels due to their scale, refueling patterns, and regular vehicle turnover.[12]

[10] Google earth [accessed October 12, 2014]

[11] http://energy.gov/sites/prod/files/2013/10/f3/eo13514.pdf [accessed February 5, 2014]

This project has the following four defined tasks:

1. Data collection: Coordinate with the fleet manager to collect data on agency fleet vehicles. This includes collecting information on the fleet vehicle, and installing data loggers on a representative sample of the fleet vehicles to characterize their missions.
2. Data analysis and review: Examine the data collected by the loggers and fleet vehicle characteristics to describe typical fleet activity. Incorporate fleet manager's input on introducing PEVs to the agency's fleet.
3. PEV implementation feedback: Provide feedback to fleet personnel and BEA on the selection criteria for replacement PEVs in their specific fleet vehicle missions.
4. Observations and recommendations: Provide actionable information to introduce PEVs into agency fleet operations and assess any related impacts for the facility.

Data collected from vehicles include trip distance, idle time, time between uses, and stop locations. Data collection continues for 30 to 60 days using a non-intrusive data logger, which gathers and transmits information using global positioning satellites and cellular service. The loggers collect data at one-minute intervals and transmit when an active signal is present.

Extrapolating the results of this analysis to the larger fleet provides estimates of potential savings in gasoline consumption and GHG emissions. This report also provides recommendations relating to fleet management of BEVs and PHEVs for additional consideration.

Fleet managers may use the information supplied in this report to help them to identify which vehicles are candidates for replacement by BEV or PHEV based on their use. BEVs are preferred because of the greater potential reduction of GHG emissions, fuel cost and petroleum usage, but they are not likely to be suitable for all vehicle missions.

The information in this report supports a final report to BEA/INL and the U.S. DOE. The aggregated results for all agencies' fleets will provide an overview of federal fleets, vehicle missions, vehicle uses, and agencies needs to plan and establish a more systematic method for the adoption of BEVs and PHEVs.

3. METHODS

3.1 Fleet Vehicle Survey

Agency fleet managers selected fleet vehicles for this study and provided basic information for each vehicle, including its managing agency, home base for the vehicle, contact information, primary vehicle mission, vehicle ownership, fuel type, and odometer reading.

VA - Manhattan identified 100 vehicles in their fleet. Vehicle missions were assumed based upon VA input as shown in Table 1. (Note that Section 4 provides descriptions of the vehicle mission types.) Intertek coordinated with the VA - Manhattan fleet manager to identify the specific vehicles for data collection for inclusion in the study. The fleet manager assessed their wide range of vehicles and made selections of high-interest, representative vehicles based on vehicle missions and vehicle type/class. Selection also favored vehicles used at least twice a week. Because data loggers rely on the vehicle's battery power, non-use of the vehicle can result in the vehicle having a depleted battery. Intertek received no reports of depleted batteries during the study at VA - Manhattan. Nine vehicles were selected: seven with the pool mission and two with a support mission.

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[12] *Fleet Purchase Behavior: Decision Processes and Implications for New Vehicle Technologies and Fuel*, Nesbitt, Sperling, University of California, Davis 2001

Table 1. Fleet evaluation

Vehicle Mission	Study Vehicles	Total Fleet Reported	Percentage Studied
Pool Vehicles	7	60	12%
Support Vehicles	2	25	8%
Enforcement Vehicles		7	
Buses/Shuttle		4	
Transport		2	
Specialty Vehicles		2	
Total Fleet Vehicles	9	100	9%

3.2 Data Collection

Individual privacy concerns exist when monitoring vehicle movement with data loggers. Data collection occurs by vehicle identification as identified by Intertek, data logger number, and vehicle identification number (VIN) or agency-assigned vehicle number. Intertek receives no information related to the vehicle operator and provides no raw data to the fleet managers. In this manner, Intertek does not collect, analyze, or report on individual driving habits.

3.2.1 Data Logger

Non-intrusive data loggers, produced by InTouchMVC[13] and depicted in Figure 3, were inserted into the vehicle's on-board diagnostic port to collect and transmit the relevant data. The installation of the data logger and the manual recording of information about the vehicle that ties the logger and vehicle together in the data, typically takes less than 5 minutes. Once installed and activated (during vehicle use), the data loggers collect vehicle information once every minute during vehicle operation and transmit by cellular communication to the data center.

Figure 3. InTouchMVC data logger

Intertek maintains the data logger's connectivity and verifies data transmission weekly. Missing data (reported as "null" values) are frequently the result of lost global positioning system (GPS) reception, logger device removal, or extended periods in regions with insufficient cellular reception. Intertek filters

[13] www.intouchmvc.com [accessed January 10, 2014]

the vehicle and data logger information if these null values present a significant impact on the data collected and no resolution is possible. This report also identifies the statistics on this validation process.

VA - Manhattan requested and installed ten data loggers into the selected fleet vehicles. The agency removed and shipped the data loggers to Intertek at the conclusion of the data collection period.

3.2.2 Data Captured

Data consist of key-on events, key-off events, and position updates logged every minute while the vehicle is keyed-on. InTouchMVC converted these data points into records of trip events, stop events, and idle events.

From these data points, the following information was available for evaluation:

- Trip start and stop time and location
- Trip distance and duration
- Idle start time, location, and duration
- Stop start time, location, and duration

3.3 Data Analysis

3.3.1 Definitions

Figure 4 illustrates a vehicle outing, which is comprised of trips, stops, and idle events, that may occur during one day or over several days. The following list provides a definition of these terms:

1. *Outing*: An outing is the combination of trips and stops that begin at the home base and includes all travel until the vehicle returns home.
2. *Trip*: A trip begins with a key-on event and ends with the next key-off event.
3. *Vehicle stop*: A vehicle stop includes a key-off/key-on event pair.
4. *Idle time*: Idle time is the amount of time a vehicle spends stationary after a key-on event when the vehicle is not moving for a period of 3 minutes or longer.
5. *Trip travel time*: Trip travel time is the amount of time required to complete a trip, excluding stops but including idle time.

Definitions of additional analysis and survey terms are as follows:

1. *Operating shift*: Fleet manager-defined period worked.
2. *Study days*: Days during which the data loggers are connected.
3. *Vehicle days*: Study days during which a vehicle is used.
4. *Null values*: Data record unusable for analysis for various reasons.

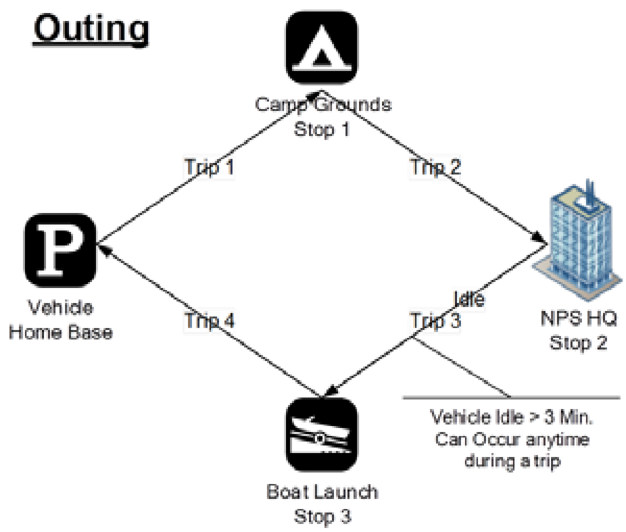

Figure 4. Vehicle outing

3.3.2 Data Evaluation

Processing the data involves removal of null values and aggregation by different spatial and temporal scales. Aggregation was by day, by trip, and by outing to produce figures showing the patterns of use. Aggregation by vehicle mission followed to characterize use for the agency fleet. Section 5 presents these results. Data were extrapolated to provide the overall fleet usage and benefit analysis when fleet information was provided. Section 6 presents these benefits. Intertek observations are included in Section 7.

Statistical data analysis uses Microsoft® Excel and Tableau® software. Frequency distributions summarize travel behavior of each vehicle and vehicle mission during the study period. Rounding of the tables and figures are to three significant digits.

4. VEHICLES

4.1 Vehicle Missions

The vehicle mission is an important characteristic in the fleet study. Information used to define the vehicle mission includes the vehicle's configuration, vehicle use, classification per 40 CFR Part 600.315-82 and Environmental Protection Agency (EPA), the participating agency use, and generally assumed vehicle use. Based upon fleet information gathered, Intertek has established the following seven mission/vehicle categories for analysis. They are listed below and examples are depicted in Figure 5.

1. **Pool vehicles**: A pool vehicle is any automobile (other than the low-speed vehicles identified below) manufactured primarily for use in passenger transportation, with not more than 10 passengers.
2. **Enforcement vehicles**: Vehicles specifically approved in an agency's appropriation act for use in apprehension, surveillance, police, or other law enforcement work. This category also includes site security vehicles, parking enforcement, and general use, but the vehicles are capable of requirements to support enforcement activities. Appendix C provides further definition.
3. **Support vehicles**: Vehicles assigned to a specific work function or group to support the mission of that group. Vehicles are generally passenger vehicles or light-duty pickup trucks and may contain after-market modifications to support the mission.

4. **Transport vehicles**: Light, medium, or heavy-duty trucks used to transport an operator and tools or equipment of a non-specific design or nature. The vehicle's uses include repair, maintenance, or delivery.
5. **Specialty vehicles**: Vehicles designed to accommodate a specific purpose or mission (such as ambulances, mobile cranes, and handicap controls).
6. **Shuttles/buses**: Vehicles designed to carry more than 12 passengers and further outlined in 49 CFR 532.2.
7. **Low-speed vehicle (LSV):** Vehicles that are legally limited to roads with posted speed limits up to 45 mph and that have a limited load-carrying capability.

Figure 5. Vehicle missions

4.2 Alternative Fuel Vehicles

As the operating agency, VA - Manhattan has a unique opportunity to plan for the adoption of BEVs and PHEVs, along with planning for the supporting infrastructure. The adoption of PHEVs and BEVs is a primary goal of the General Services Administration (GSA) and supports the directives previously referenced.

As GSA increases its certification of PHEVs and BEVs, agencies can plan for vehicle replacement through GSA for passenger vehicles and trucks. Table 2 presents the replacement requirements for fleet vehicles. Note that both of the age and mileage requirements need to be met in order for the vehicle to qualify for replacement, except where noted as "or".

Table 2. General Services Administration vehicle replacement requirements

GSA Vehicle Replacement Requirements[14]			
	Fuel Type	Years	Miles
Passenger vehicles	Gasoline or Alternative Fuel Vehicle	3	36,000
		4	24,000
		5	Any mileage
		Any age	75,000
	Hybrid	5	Any miles
	Low Speed BEV	6	Any miles
Light trucks 4 x 2	Non-diesel	7	65,000
	Diesel	8 or	150,000
	Hybrid	7	Any mileage
Light trucks 4 x 4	Non-diesel	7 or	60,000
	Diesel	8 or	150,000
	Hybrid	7	Any mileage

4.3 BEV and PHEV Benefits/Challenges

BEVs are fully powered by the battery energy storage system available onboard the vehicle. The Nissan Leaf is an example of a BEV. Because the BEV has no other energy source for propulsion, the range, power requirements, and mission of the needed vehicle factor greatly in purchasing decisions. Maximizing BEV capabilities typically requires batteries more than an order of magnitude larger in capacity than the batteries in hybrid electric vehicles.

PHEVs obtain their power from at least two energy sources. The typical PHEV configuration uses a battery and an internal combustion engine (ICE), powered by either gasoline or diesel. PHEV designs differ between manufacturers. All have a charge-depleting (CD) mode, in which the battery is depleted of its stored energy to propel the vehicle, and a charge-sustaining (CS) mode (or Extended Range Mode) that is entered after CD mode is complete in which the battery and the ICE work together to provide propulsion, while the state of charge of the battery is maintained between set limits. Some PHEVs' operation in CD modes is purely electric while others employ the engine to supplement the battery power during the initial battery depletion to a set state of charge (usually below 50%).

4.3.1 Battery Electric Vehicle Benefits/Challenges

The U.S. Environmental Protection Agency (EPA) identifies the following benefits of BEVs[15].

- **Energy efficient:** Electric vehicles convert about 59 to 62% of the electrical energy from the grid to power at the wheels, whereas conventional gasoline vehicles only convert about 17 to 21% of the energy stored in gasoline to power at the wheels.
- **Environmentally friendly:** PEVs emit no tailpipe pollutants, although the power plant producing the electricity may emit them. Electricity from nuclear, hydro, solar, or wind-powered plants causes no air pollutants.

[14] http://www.gsa.gov/graphics/fas/VehicleReplacementStandardsJune2011Redux.pdf [accessed January 10, 2014]

[15] http://www.fueleconomy.gov/feg/evtech.shtml [accessed December 27, 2013]

- **Performance benefits:** Electric motors provide quiet, smooth operation and exhibit maximum torque at zero and low speeds, while also requiring less maintenance than ICEs.
- **Reduce energy dependence:** Electricity is a domestic energy source.

The EPA also identifies challenges associated with BEVs, including the following:

- **Driving range:** Most BEVs can only travel about 100 to 200 miles (or less) before recharging, whereas gasoline vehicles can often travel over 300 miles before refueling and some much further.
- **Recharge time:** Fully recharging the battery pack can take 4 to 8 hours. With a high-power DC Fast Charger, restoration from a depleted state to 80% capacity can take approximately 30 minutes.
- **Battery cost:** The large battery packs are expensive and may need to be replaced one or more times.
- **Bulk and weight**: Battery packs are heavy and take up considerable vehicle space.

4.3.2 Plug-in Hybrid Electric Vehicle Benefits/Challenges

The U.S. Environmental Protection Agency (EPA) identifies the following benefits of PHEVs[16].

- **Less petroleum use:** PHEVs are expected to use about 40 to 60% less petroleum than conventional vehicles. Because electricity is produced primarily from domestic resources, PHEVs reduce dependence on oil.
- **Fewer emissions:** PHEVs are expected to emit fewer GHG emissions than conventional vehicles, but as with BEVs, the difference depends largely on the type of power plant supplying the electricity.
- **Higher vehicle costs, lower fuel costs:** PHEVs will likely cost $1,000 to $7,000 more than comparable non-PHEVs. Fuel will cost less because electricity is much cheaper than gasoline, but the fuel savings depends on how much of the driving is done on the off-board electrical energy.
- **Recharging takes time:** Recharging the battery typically takes several hours. However, PHEVs do not have to be plugged in to be driven. They can be fueled solely with gasoline, but will not achieve maximum range, fuel economy, or fuel savings without charging.
- **Measuring fuel economy:** Because a PHEV can operate on electricity alone, gasoline alone, or a mixture of the two, EPA provides a fuel economy estimate for gasoline-only operation (charge-sustaining mode), electric-only operation (all-electric charge-depleting mode), or combined gasoline and electric operation (blended charge-depleting mode).

In most cases, the PEV retail cost is higher than a non-PEV model. This incremental purchase cost may be a fleet budget challenge; however, many original equipment manufacturers (OEMs) have offered incentives to encourage the use and adoption of BEVs and PHEVs. Some OEMs have recently reduced the vehicle cost, while also increasing vehicle range. Additionally, federal and state incentives have increased the attractiveness of purchasing a PEV. A common assumption is that increasing PEV sales will result in a reduction in this incremental purchase cost and a positive feedback loop will ensue.

4.4 Plug-In Electric Vehicle Availability

GSA provides a summary of light- and medium-duty passenger vehicles available for lease or purchase through the GSA portal[17], although not all BEVs and PHEVs currently on the market are ‘certified’ to be GSA replacements. Vehicles not on the GSA list of ‘certified’ vehicles require an agency

[16] http://www.fueleconomy.gov/feg/phevtech.shtml [accessed July 19, 2013]

[17] http://www.gsa.gov/portal/content/104224 [accessed March 6, 2014]

to self-certify a functional need or provide alternative measures for exemptions. Table 3 summarizes the vehicles that may be suitable replacements and are certified replacements through GSA. Note that the "CD/CS" column provides the EPA fuel economy values for CD and CS modes. The fuel economy of CD mode is provided in units of miles-per-gallon-of-gasoline-equivalent (MPGe). This metric allows for the electricity consumption during CD mode to be compared with fuel consumption during CS mode (or against conventional vehicles). The Nissan Leaf and Mitsubishi i-MiEV are not included in the alternative fuel guide for 2014, but they have appeared in previous guides.

Replacement is dependent on vehicle configuration characteristics and the vehicle mission. Further evaluation related to vehicle purpose, mission follows in Section 5.

Tables 4 through 7 provide summaries of PHEVs and BEVs either currently available or near commercialization in both passenger cars and pickup trucks, but do not appear on the GSA 'certified' vehicle list. These vehicles may qualify for use by the agency through demonstrating a functional need.

Table 3. GSA certified PEVs

Make/Model	GSA Class	Type	CD/CS	GSA Incremental Price
Chevrolet Volt	Sedan, Subcompact	PHEV	98 MPGe/37 mpg	$17,087.18
Ford C-MAX Energi	Sedan, Subcompact	PHEV	100 MPGe/38 mpg	$14,899.52
Ford Focus Electric	Sedan, Subcompact	BEV	110 MPGe/99 mpg	$16,573.09
Ford Fusion Energi	Sedan, Compact	PHEV	100 MPGe/38 mpg	$19,289.99

Note that EPA differs in vehicle class. EPA identifies the Volt as a compact, the C_MAX Energi as a midsize, the Fusion Energi as a midsize, and the Focus as a compact.[18]

Table 4. OEM PHEV cars and availability

Make	Model	Model Year
Audi	A3 eTron PHEV	2015 (estimate)
Chevrolet	Volt	2011
Honda	Accord PHEV	2014
Toyota	Prius PHEV	2012
Volvo	V60 Plug-in	2016 (estimate)
BMW	i3 with range extender	2014

[18] http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=34130 [accessed August 1, 2014]

Table 5. OEM BEV cars and availability

Make	Model	Model Year
BMW	i3	2014
Chevrolet	Spark EV	2014
Fiat	500e	2013(California only)
Ford	Focus Electric	2012
Honda	Fit EV	2013
Kia	Soul EV	2014 (estimate)
Mercedes-Benz	B-Class ED	2015 (estimate)
Nissan	Leaf	2011
smart	ED	2014
Tesla	Model S	2012
Tesla	Model X	2015 (estimate)
Volkswagen	Golf	2015 (estimate)
Volvo	C30 Electric	2016 (estimate)

Table 6. OEM PHEV trucks, vans, and availability

Make	Model	Model Year
Land Rover	Range Rover Sport	2016 (estimate)
Mitsubishi	Outlander PHEV	2015 (estimate)
Via	VTRUX VR300	2013

Table 7. OEM BEV trucks, vans, and availability

Make	Model	Model Year
Nissan	eNV200	2015 (estimate)
Toyota	RAV4 EV	2013 (California only – elsewhere 2015 estimate)

As further indication of the expanding market for PEVs, companies are offering after-market vehicle upgrades involving the addition of plug-in capabilities to OEM vehicles. For example, Echo Automotive headquartered in Scottsdale, Arizona offers a "…low-cost, bolt-on, plug-in hybrid system that can quickly be installed on new or existing fleet vehicles to increase fuel efficiency and decrease operating costs – all without affecting the OEM power train or requiring costly infrastructure."[19] Options such as this company's conversions might be of benefit to the VA - Manhattan fleet vehicles for which no replacement PEV is currently available.

[19] http://www.echoautomotive.com/index.php?option=com_content&view=article&id=8 [accessed July 14, 2014]

4.5 Plug-In Electric Vehicle Charging

Refueling electric vehicles presents some challenges and some opportunities not encountered when refueling petroleum-fueled vehicles. Recharging the battery of a PHEV follows the same methodology as that for BEVs. This section provides basic information on recharging PEVs.

4.5.1 Electric Vehicle Supply Equipment Design

4.5.1.1 Charging Components

Electric vehicle supply equipment (EVSE) stations deliver electric power from the utility to the applicable charge port on the vehicle. Figure 6 illustrates the primary components of a typical EVSE unit, which in Figure 6 is an alternating current (AC) Level 2.

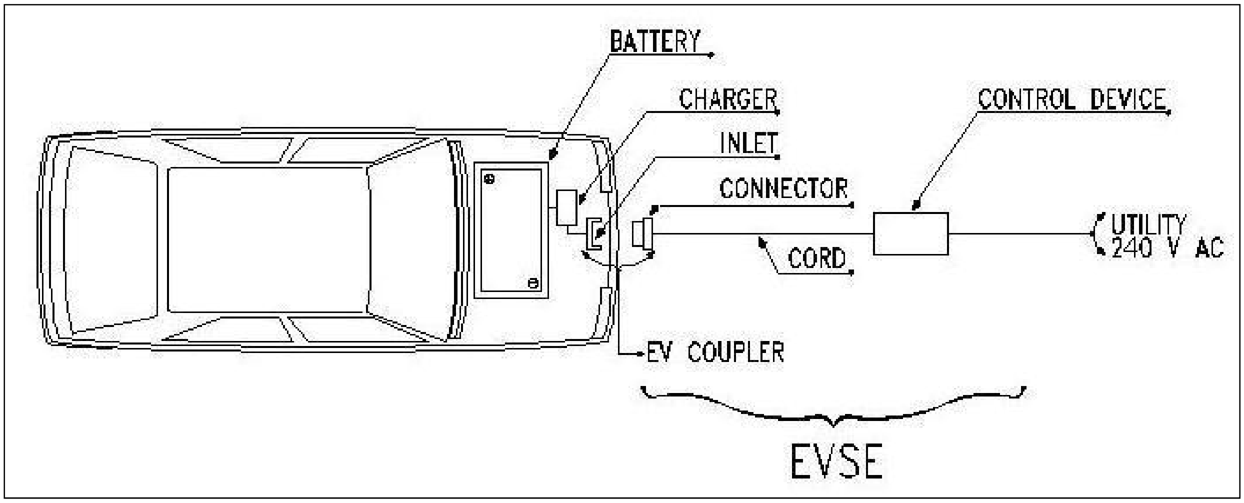

Figure 6. AC Level 2 charging diagram[20]

The electric utility delivers AC current to the charging location. The conversion from AC to direct current (DC) electricity necessary for battery charging can occur either on or off board the vehicle. Section 4.5.1.2 provides further explanation of the different EVSE configurations. For on board conversion, AC current flows through the PEV inlet to the on board charger. The charger converts AC to the DC current required to charge the battery. A connector attached to the EVSE inserts into a PEV inlet to establish an electrical connection to the PEV for charging and information/data exchange. Off board conversion, also known as DC charging, proceeds in a similar manner except that the AC to DC conversion occurs in a charger that is off board the vehicle and, thus, bypasses any onboard charger. For both AC and DC charging, the PEV's battery management system on board the vehicle controls the battery rate of charge, among other functions. All current PEVs have an on board charger; some BEVs (but no PHEVs currently) accommodate DC charging.

4.5.1.2 Charging Configurations and Ratings

The Society of Automotive Engineers (SAE) standardized the requirements, configurations, and equipment followed by most PEV suppliers in the United States in the J1772 Standard. Figure 7 summarizes these attributes and the estimated recharge times. Actual recharge times depend on the onboard equipment, including the charger, battery, and battery management system.

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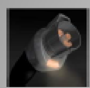
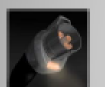
[20] http://www.theevproject.com/downloads/documents/Electric%20Vehicle%20Charging%20Infrastructure%20Deployment%20Guidelines%20for%20the%20Greater%20Phoenix%20Area%20Ver%203.2.pdf [accessed January 15, 2014]

SAE International	SAE Charging Configurations and Ratings Terminology		
AC level 1 (SAE J1772™)	PEV includes on-board charger	*DC Level 1	EVSE includes an off-board charger
	120V, 1.4 kW @ 12 amp 120V, 1.9 kW @ 16 amp		200-450 V DC, up to 36 kW (80 A)
	Est. charge time:		Est. charge time (20 kW off-board charger):
	PHEV: 7hrs (SOC* - 0% to full)		PHEV: 22 min. (SOC* - 0% to 80%)
	BEV: 17hrs (SOC – 20% to full)		BEV: 1.2 hrs. (SOC – 20% to 100%)
AC level 2 (SAE J1772™)	PEV includes on-board charger (see below for different types)	*DC Level 2	EVSE includes an off-board charger
	240 V, up to 19.2 kW (80 A)		200-450 V DC, up to 90 kW (200 A)
	Est. charge time for 3.3 kW on-board charger		Est. charge time (45 kW off-board charger):
	PEV: 3 hrs (SOC* - 0% to full)		PHEV: 10 min. (SOC* - 0% to 80%)
	BEV: 7 hrs (SOC – 20% to full)		BEV: 20 min. (SOC – 20% to 80%)
	Est. charge time for 7 kW on-board charger		
	PEV: 1.5 hrs (SOC* - 0% to full)	*DC Level 3 (TBD)	EVSE includes an off-board charger
	BEV: 3.5 hrs (SOC – 20% to full)		200-600V DC (proposed) up to 240 kW (400 A)
	Est. charge time for 20 kW on-board charger		Est. charge time (45 kW off-board charger):
	PEV: 22 min. (SOC* - 0% to full)		BEV (only): <10 min. (SOC* - 0% to 80%)
	BEV: 1.2 hrs (SOC – 20% to full)		
*AC Level 3 (TBD)	> 20 kW, single phase and 3 phase		

*Not finalized
Voltages are nominal configuration voltages, not coupler ratings
Rated Power is at nominal configuration operating voltage and coupler rated current
Ideal charge times assume 90% efficient chargers, 150W to 12V loads and no balancing of Traction Battery Pack

Notes:
1) BEV (25 kWh usable pack size) charging always starts at 20% SOC, faster than a 1C rate (total capacity charged in one hour) will also stop at 80% SOC instead of 100%
2) PHEV can start from 0% SOC since the hybrid mode is available.

Developed by the SAE Hybrid Committee ver. 031611

Figure 7. Society of Automotive Engineers charging configurations and ratings terminology[21]

Most PEV manufacturers supply an AC Level 1 cord-set with the vehicle, which provides sufficient capabilities for some drivers, but often provides an emergency backup capability because of the long recharge times. AC recharging capabilities found in the public arena more typically are AC Level 2. Figure 8 depicts a typical J1772-compliant inlet and connector for both AC Levels 1 and 2.

[21] http://www.sae.org/smartgrid/chargingspeeds.pdf [accessed January 15, 2014]

Figure 8. J1772 connector and inlet[22]

The J1772 standard also identifies requirements for DC charging. For PEVs that accept both AC and DC inputs, the Society of Automotive Engineers approved a single connector and inlet design. Figure 9 shows this connector, which is colloquially known as the J1772 "combo connector".

Figure 9. J1772-compliant combo connector[23]

Some BEVs introduced in the United States prior to the approval of the J1772 standard for DC charging employ the CHAdeMO (designed in Japan) standard for connector and inlet design. Figure 10 shows this connector. EVSE units that are either J1772-compliant or CHAdeMO-compliant are both known as DC fast chargers (DCFCs).

The presence of the two separate standards for DC charging presents challenges for vehicle owners to ensure that the EVSE accessed provides the appropriate connector for their vehicle inlet. Not all PEV suppliers include DC charging options. BEV suppliers have provided DC inlets where PHEV suppliers have not, because the rapid recharging provides opportunities for expanded vehicle range with minimal operator wait times. PHEV operators can rely on the gasoline drive in the event they deplete the vehicle's

[22] http://carstations.com/types/j09 [accessed January 15, 2014]

[23] http://www.zemotoring.com/news/2012/10/sae-standardizes-j1772-fast-dc-charging-up-to-100-kw [accessed January 15, 2014]

battery; at present, no PHEV on the market or near commercialization has DC charging capability (although the Mitsubishi Outlander PHEV is rumored to be offering DC charging capability as an option). It is noted that DC Level 1 and DC Level 2 charging are commonly combined and labeled "DC fast charging."

Figure 10. CHAdeMO-compliant connector[24]

Because the battery of a BEV is typically much larger than that of a PHEV, recharge times are longer (see Figure 7). BEVs that see daily mileage near the limits of the advertised range do better when recharged using AC Level 2 EVSE or DC fast charging, because AC Level 1 recharge times are usually extensive. PHEVs, on the other hand, generally can use AC Level 1 EVSE for overnight charging to ensure a fully charged battery at the start of daily use. AC Level 2 EVSE units provide greater range in the shortest amount of time when intermediate or opportunity charging. DC fast charging provides the fastest recharge capability for those vehicles equipped with DC fast charge inlets.

4.5.2 Electric Vehicle Supply Equipment Stations

AC Level 2 charging is the predominant rating of publicly accessible EVSE because of its wide acceptance by auto manufacturers and recharge times that are faster than AC Level 1 charging. Purchase and installation costs are more manageable than DCFCs and less space is required. There are several manufacturers of AC Level 2 equipment and the agency should review brands for comparison purposes. Figure 10 provides an example of a public AC Level 2 EVSE unit[25].

[24] https://radio.azpm.org/p/azspot/2012/5/10/1632-electric-cars/ [accessed January 15, 2014]

[25] www.eaton.com/ [accessed January 29, 2014]

Figure 11. Public AC Level 2 EVSE

DCFCs also are available from several manufacturers. Figure 12 illustrates one such charger.[26] This particular charger uses the CHAdeMO connector standard.

Figure 12. Public DCFC unit

In general, installation costs are higher for the DCFC because of the higher voltage requirements and the inclusion of the AC to DC converter and other safety and design features. Costs for both types are

[26] http://evsolutions.avinc.com/products/public_charging/public_charging_b [Accessed April 16, 2014]

highly dependent on site characteristics such as distance to the nearest power source, asphalt or concrete cutting and repair, conduit requirements, and payment systems, if any.

Payment and equipment control systems included by some suppliers provide the potential for use by privately owned vehicles for a fee, but can allow agency fleet vehicle use without direct payment. These systems also allow for accurate record keeping of vehicle charging requirements.

5. VA Medical Center – Manhattan Fleet Evaluation

5.1 VA - Manhattan Fleet

VA - Manhattan reports 100 Agency and GSA vehicle in their complete fleet. Table 8 shows the breakdown of EPA vehicle class.

Table 8. VA - Manhattan fleet vehicles

	Sedan Compact	Sedan Midsize	Sedan Large	SUV	Mini-van	Pass Van	Pickup or LD Truck	MD HD Truck	Bus	Specia lty	Total
Total Fleet	18	20	9	3	12	22	4	6	4	2	100

Based upon VA - Manhattan input on fleet vehicles, an assessment of mission by vehicle type was completed. Table 9 shows the results of that assessment.

Table 9 VA - Manhattan fleet mission assessment

Mission	Sedan Compact	Sedan Midsize	Sedan Large	SUV	Mini-van	Pass Van	Pickup or LD Truck	MD HD Truck	Bus	Speci alty	Total
Pool	12	13	3	2	8	22					60
Support	6	7			4		4	4			25
Law Enforce.			6	1							7
Transport								2			2
Bus									4		4
Specialty										2	2
Total	18	20	9	3	12	22	4	6	4	2	100

5.2 Survey Results

Nine vehicles were included in the study at VA - Manhattan. Seven of the vehicles have pool missions and two have support missions. Table 10 presents a summary of these vehicles and Table 11 provides details of the monitored vehicles.

Table 10. Vehicle study summary

Mission	Sedan Compact	Sedan Midsize	Sedan Large	SUV	Mini-van	Pass Van	Pickup or LD Truck	MD HD Truck	Bus	Specialty	Total
Pool	2	2	1			2					7
Support	1				1						2
Law Enforce.											
Transport											
Bus											
Specialty											
Total	3	2	1		1	2					9

Table 11. Detailed VA - Manhattan vehicle index

Vehicle Index						
Log	**Fleet Vehicle Id**	**Make**	**Model**	**Year**	**EPA Class**	**Mission**
32	G11-2671H	Chevrolet	Impala	2009	Sedan – Large	Pool
33	G10-9461K	Ford	Fusion Hybrid	2011	Sedan – Midsize	Pool
34	G13-1533M	Ford	Focus	2012	Sedan - Compact	Pool
35	G10-0994H	Pontiac	G6	2009	Sedan - Compact	Pool
36	G42-2765B	Chevrolet	G1500	2007	Van – Passenger	Pool
37	G43-25144	Chevrolet	G3500	2009	Van - Passenger	Pool
38	G13-0033M	Ford	Focus	2012	Sedan - Compact	Support
39	G41-3884H	Dodge	Caravan	2009	Minivan	Support
40	G10-9480K	Ford	Fusion Hybrid	2011	Sedan - Midsize	Pool

Appendix B provides the analysis of each individual vehicle included in this study. Grouping the vehicles by mission creates an aggregated view of mission requirements to provide observations related to PEV replacement. The missions of these five categories vary considerably; therefore, these missions are evaluated separately.

5.3 Data Validity

VA - Manhattan data collection took place from April through August 2012. Vehicle data sheets (presented in Appendix B) detail the collected data for each vehicle including specific dates the logger provided data.

Of the data collected, validation occurred for 97.3%, while null values exist for the balance.

5.4 VA - Manhattan Pool Vehicles Evaluation

5.4.1 Survey and Site Information

Pool vehicles are typically light-duty motor vehicles for use in passenger transportation, with not more than 10 passengers. Pool missions can vary by agency, location, and jurisdiction; however, they typically utilize sedans, minivans, SUVs, vans, or small pickup trucks and typically do not carry specific cargo or equipment. Table 11 above identifies the seven vehicles (one large sedan, two midsize sedans, two compact sedans, and two passenger vans).

Incorporation of BEVs and/or PHEVs into the pool mission is a definite possibility. Pool vehicles used for shorter trips or outings qualify for BEV or PHEV replacement, while other pool vehicle activities that are associated with longer trips may require PHEV capabilities.

5.4.2 Summary for Pool Vehicles

Appendix B provides the vehicle data sheets for each of the pool vehicles monitored. This section aggregates data for all pool vehicles for VA - Manhattan. Table 12 summarizes pool travel during the study period for those days in which the vehicle was driven. Vehicle use occurred primarily between 0700 and 1500 hours daily. The vehicles were driven 11,314 miles, logged 941 hours of operation, and idled 351 hours during the study period.

Table 12. VA - Manhattan pool vehicles travel summary

Pool Vehicles Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	30.8/298.3	10.0/293.4	3.2/134.5	11,314
Travel Time (Minutes)	154.0/563.0	49.8/491.0	16.1/199.0	56,508
Idle Time (Minutes)	57.4/NA	18.6/NA	6.0/NA	21,080

5.4.3 Pool Vehicles Daily Summary

Figure 13 identifies daily travel distance and time for all the pool vehicles. The green line and bars indicates typical electric range on a single charge for a PHEV, while the blue line and bars (including the green bars) indicates the same for a BEV. Figures 14 and 15 show the composite history in distance and time traveled for the pool vehicles. In these stacked bar charts of Figures 14 and 15, the contribution of each vehicle is indicated by a different color.

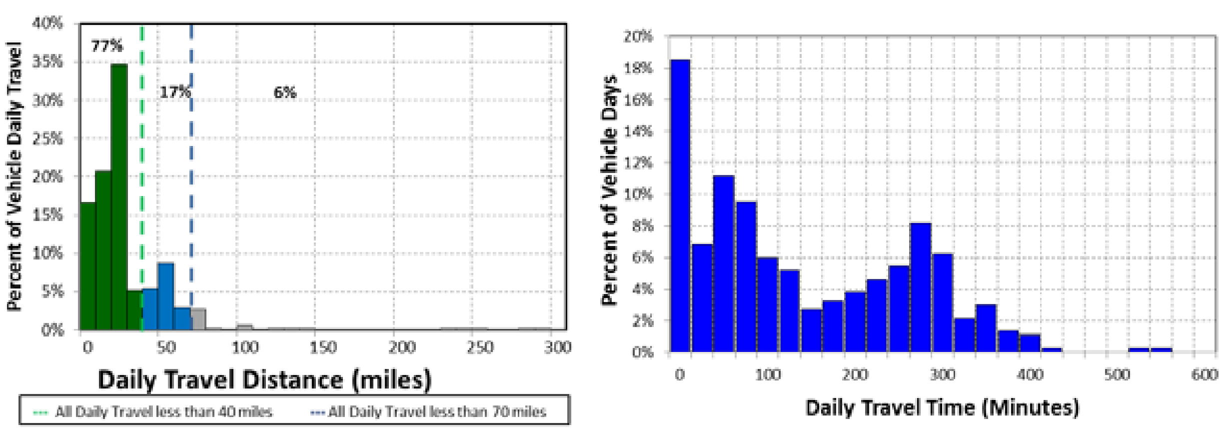


Figure 13. VA - Manhattan pool vehicle daily travel miles and time (all vehicles)

The scale of Figure 13 does not easily show the five daily travel distances that were between 230 and 300 miles. The distances are identified in the data sheets of Appendix B.

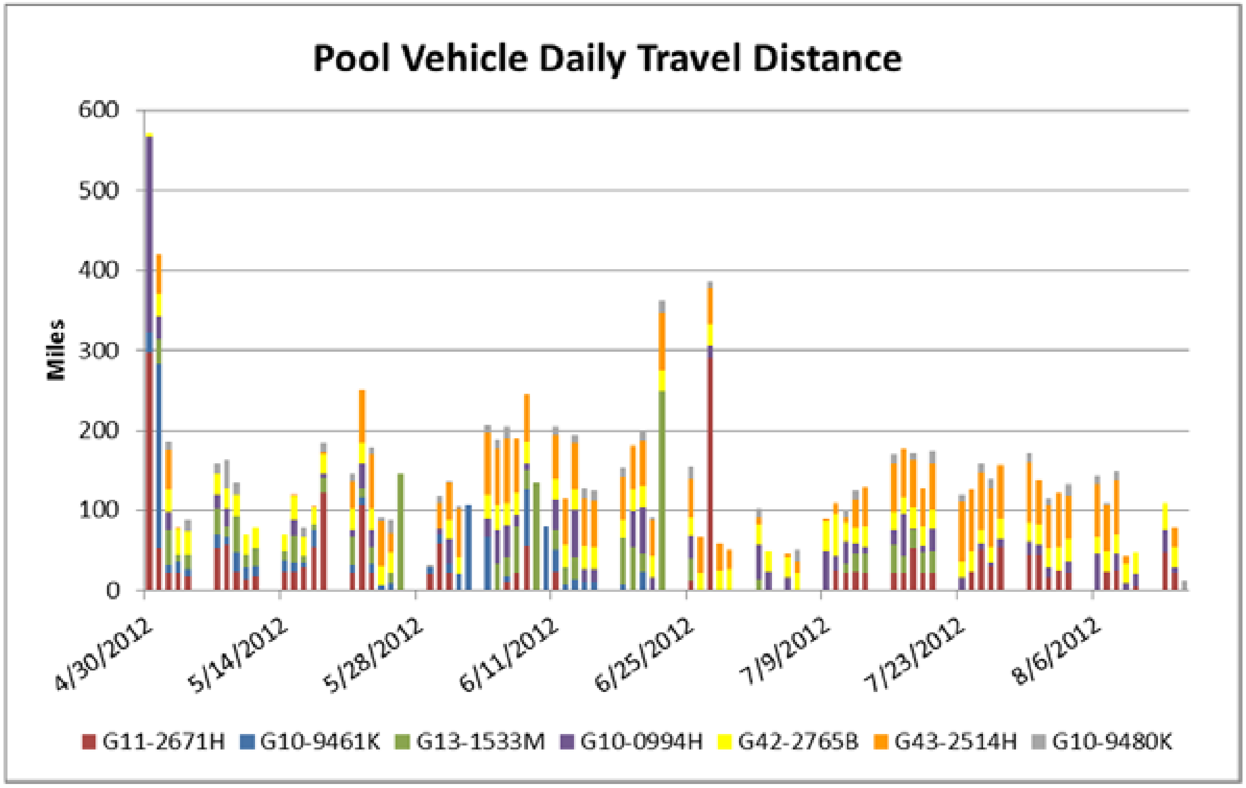


Figure 14. VA - Manhattan pool vehicle daily travel history (all vehicles)

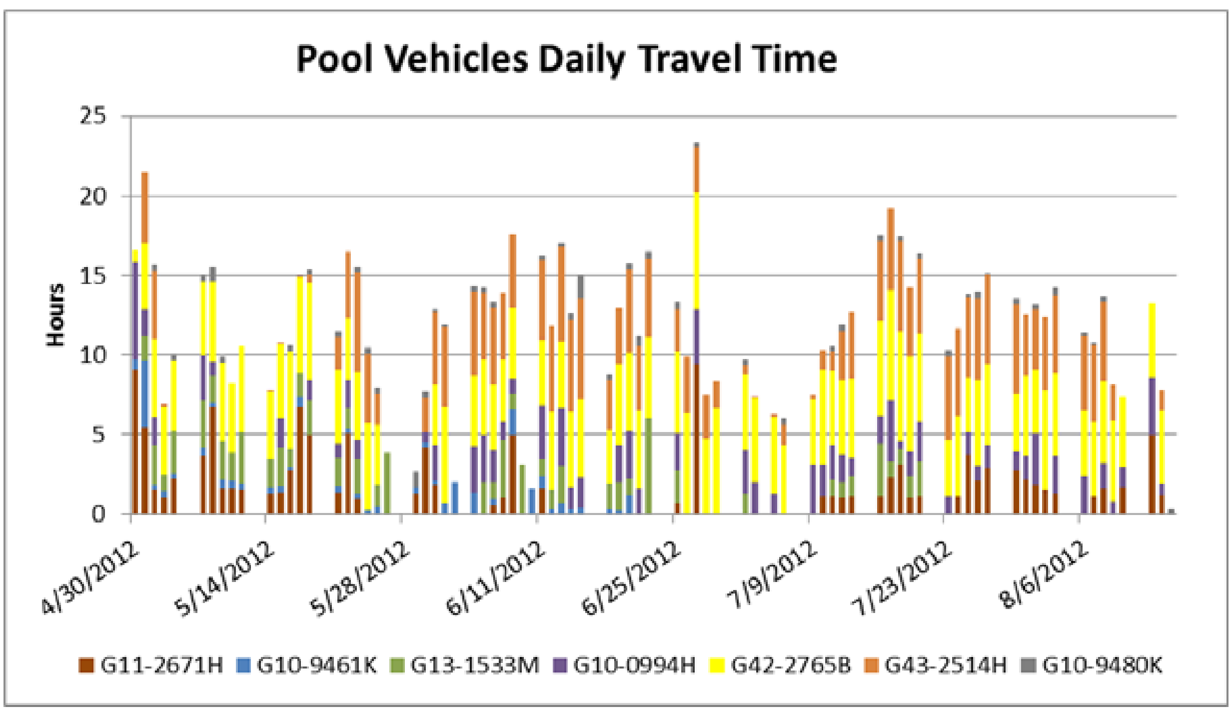


Figure 15. VA - Manhattan pool vehicles travel time (all vehicles)

Vehicles G11-2671H, G10-9461K, G13-1533M and G10-0994H had days of travel exceeding 200 miles while the balance of vehicles did not exceed 85 miles on any day. When driven, the average travel distance per day for pool vehicles is 30.8 miles. On 94% of these vehicle days, the daily travel is less than the 70 miles considered to be within the BEV safe range. That is, while BEV range can vary based on several factors; most BEVs provide at least 70 miles of vehicle range on a single battery charge. 6% percent of pool daily travel is greater than 70 miles. Further, 77% of vehicle travel days are less than 40 miles considered to be within the CD range of a PHEV.

Figures 14 and 15 show that the vehicles are not used every day although there are many days when many of the vehicles are in use. Vehicles G10-9461K and G42-2765B had the highest percentage of use in travel days while vehicles G10-9480K and G11-2671H had the least.

Figure 16 displays the summary of use by time of day for all pool vehicles.

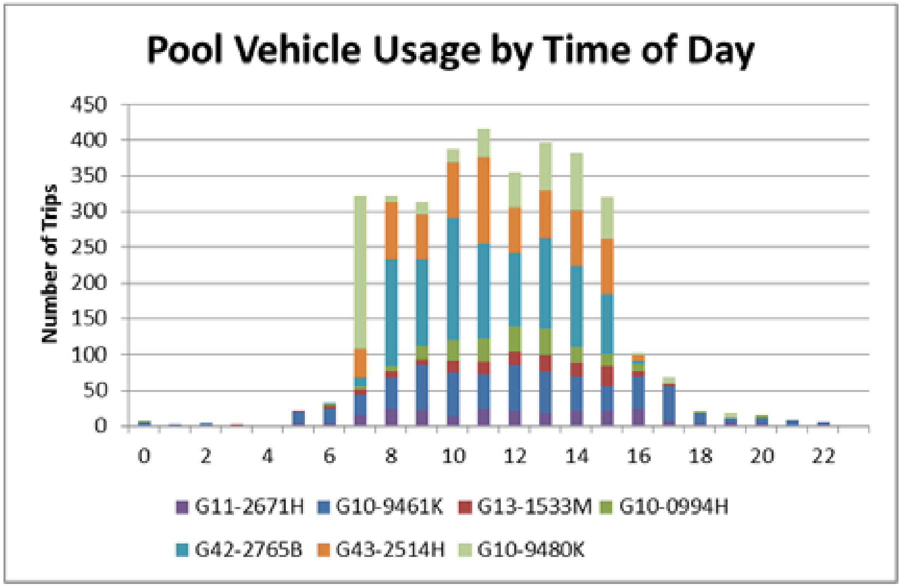


Figure 16. VA - Manhattan pool vehicles hourly usage

Figure 17 shows the outing distances traveled including data for all pool vehicles.

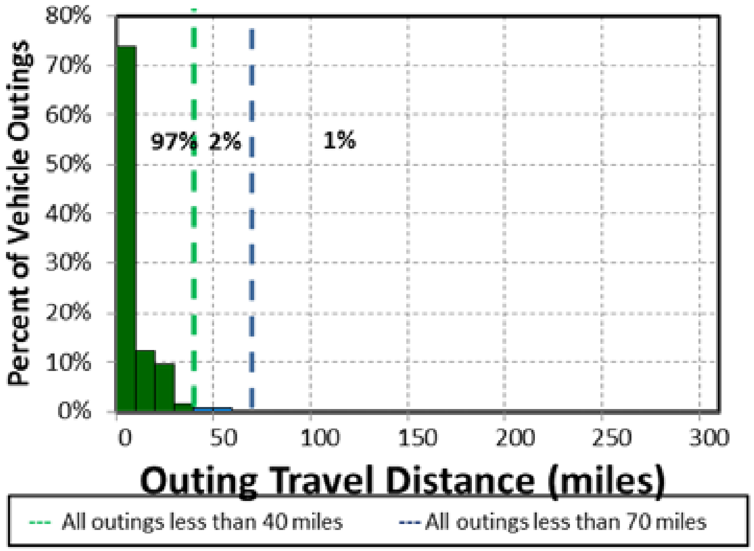


Figure 17. VA - Manhattan pool vehicle outings

The five outings of lengths between 200 and 300 miles do not show clearly in the above figure. Appendix B provides the details of each of the pool vehicle's outing travel.

The average travel outing for pool vehicles is 10 miles. On 99% of these vehicle outings, the distance traveled is less than the 70 miles considered to be within the BEV safe range. Only 1% percent of pool outing travel is greater than 70 miles. Further, 97% of vehicle travel outings are less than 40 miles considered to be within the CD range of a PHEV. In summary, most daily travel and outings are of relatively short distances but four of the vehicles were used in a few days of extended travel. While the average outing is a low value, Vehicles G11-2671H, G10-9461K, G13-1533M and G10-0994H (the same vehicles experiencing longer daily travel) had days of travel outings exceeding 200 miles while the balance of vehicles did not exceed 70 miles on any outing.

5.4.4 VA - Manhattan Pool Vehicle Observations/Summary

There appears to be three choices for VA - Manhattan in implementing PEVs into the pool fleet. It should be noted that the objective would be to incorporate as many BEVs as possible to realize the advantages of reduced petroleum usage and reduced emissions of GHGs.

1. All BEV fleet: While some BEV manufacturers report vehicle range exceeding 70 miles, Intertek recommends careful evaluation of experienced range to ensure vehicle missions are accomplished. Nevertheless, assuming the 70-mile safe range for a BEV, an all-BEV fleet does not appear to be possible due to the length of the daily travel.

2. Mixed BEV/PHEV fleet: Certainly, PHEVs can accomplish the same mission as the current fleet when only considering travel times and distances because the PHEV's gasoline engine can provide motive power when the battery has been depleted. Figure 13 shows that on 77% of all vehicle travel days, the total daily travel is less than 40 miles, which typically is the maximum distance a PHEV will travel in CD mode. This represents a significant operating cost savings opportunity while retaining the ability to go longer distances when needed. In addition, 97% of the outings are less than 40 miles and could be completed in CD mode for certain PHEVs if the battery is fully charged prior to the outing.

   Meanwhile, 99% of the outings are within the typical capability of a BEV, and so the EVSE at the home base could provide recharge energy for another outing. A mixed fleet requires fleet manager attention to assign vehicles appropriately for the anticipated use on that day.

   Figure 13 also shows 94% of daily travel is within the typical range of a BEV. This would suggest that 6% of the fleet could be PHEV to handle the travel greater than 70 miles per day without requiring additional opportunity charging during daytime stops and 94% of the fleet could be BEV. The fact that 99% of the outings are within the range capabilities of a BEV suggest that with additional charging between outings, the BEV could be able to handle more of the daily travel. The pool vehicles averaged 2.5 hours of use daily suggesting that time is available for additional charging.

   However, a fleet with 94% BEV does not allow for the use of several vehicles at the same time and would require a greater level of fleet management, with the daily assignment of vehicles based on anticipated driving distance. The remaining question is whether PEV models are currently available for potential replacement. Two of the vehicles are passenger vans for which no PEV is currently available. Consideration should be given to determine whether a SUV or minivan could accomplish the same mission as these vans. For this analysis, it is assumed that mission requirements are such that passenger vans are required. Allowing more conservatism in assigning vehicles for the balance of five vehicles**, three PHEVs** and **two BEVs** could conservatively meet the demand.

3. All PHEV fleet: As noted above, PHEVs can accomplish the same mission as the current fleet when only considering travel times and distances. Replacing all current vehicles with PHEVs only requires an evaluation of the individual vehicle capabilities of currently available PHEVs to meet current pool

requirements. Five of these seven pool vehicles have replacement PEVs available. Data show that for a significant number of days, the PHEV will operate in a CD mode. The first 40 miles of longer travel days would also be powered by (at least mostly) electricity so that 77% of all pool vehicle travel would be (again, at least mostly) battery powered with only one charge per day. As above, this represents an opportunity for significant operating cost savings while retaining the ability to go longer distances when needed. Intermediate charging opportunities provide additional benefit, enhancing the CD mode. Data show significant charging opportunities throughout the day during stop times.

The vehicle summary shows sufficient time for charging at the base location during the course of the day and additional opportunities at intermediate charging stations are not required. These stations also provide charging opportunities for the visiting public, whose fees may assist in offsetting operating costs. Given the availability of daytime changing, with experience, VA - Manhattan may find a greater fraction of BEVs within the pool vehicle fleet may meet their needs.

Considering a full complement of 60 pool vehicles in the total fleet, Intertek notes that 22 are passenger vans for which no PEV is currently available as a potential replacement. However, for the balance of the vehicles, Intertek suggests that a mixed fleet may be possible. While the remaining vehicles were not monitored, using a similar ratio as above suggests a fleet of **15 BEVs** and **23 PHEVs** conservatively meet vehicle travel requirements. Typically, additional EVSE at frequently visited locations provide recharging for both the BEV and PHEV that may be of benefit.

5.4.5 VA - Manhattan Pool Vehicle Charging Needs

Upon review of these data, Intertek suggests replacement of five of the studied pool fleet with two BEVs and three PHEVs. No available PHEVs at this writing provide for DC fast charging nor do the data suggest that this would be a significant benefit for PHEVs in the pool fleet. A DCFC at the home base will provide a more rapid recharge for BEVs but appears to be unnecessary, given that the data show that 99% of outings are less than a typical BEV's driving range.

As noted above, AC Level 2 overnight charging of BEVs is typical, whereas overnight charging of PHEVs can usually be accomplished with AC Level 1 charging.

Intertek's experience suggests that each vehicle should have an assigned charging parking space at its home base. Assigned stations require less management attention to ensure completion of overnight charging. BEVs and PHEVs not assigned to these stations also benefit during visits to the location as part of their normal operation. For the entire fleet of pool vehicles, the 15 BEVs require 15 AC Level 2 EVSE units for overnight charging and the 23 PHEVs require 23 AC Level 1 outlets at each vehicles overnight parking location. Intertek recommends a minimum of two EVSE at each location to maximize charge capability without a significant increase in installation costs. The PHEVs can utilize the AC Level 2 EVSE at the home base during the day to increase the amount of vehicle miles traveled in CD Mode.

Figure 18 shows the stop locations of all the monitored vehicles in the local area. The longer trips to other states are not shown. This represents the typical service area of these vehicles. This can be helpful in considering other local charge opportunities as at times; fleet vehicles obtain benefit from using public charging infrastructure.

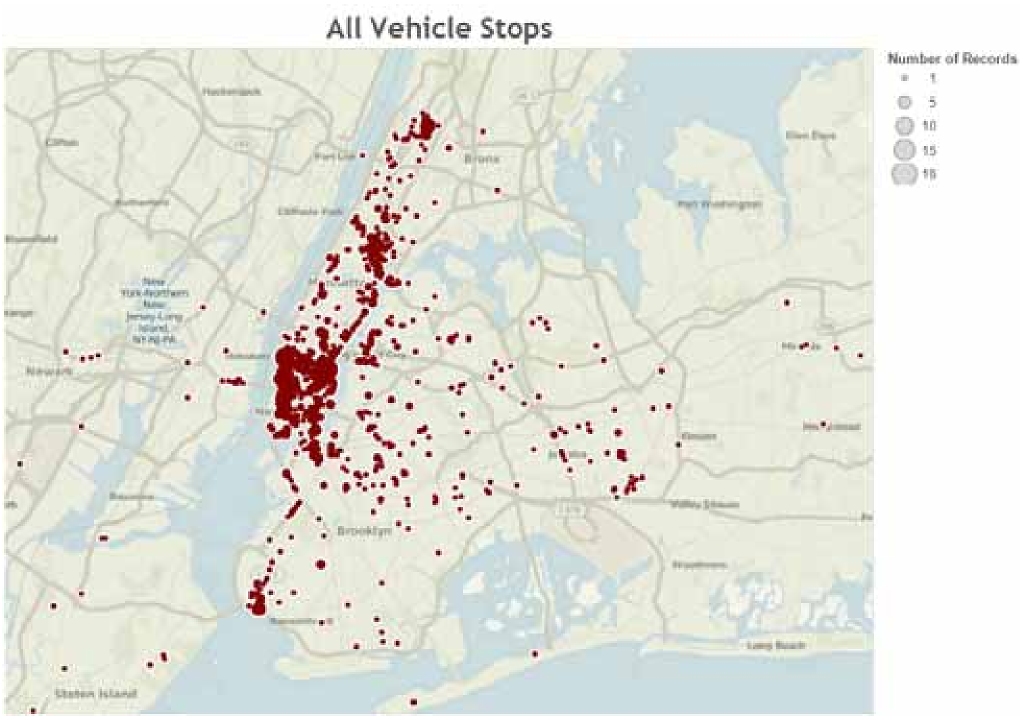


Figure 18. All vehicle local stops

Figure 19 displays availability of public charging at the time of this writing for the VA - Manhattan area. All the indicated stations are available to the public and provide AC Level 2 or Level 1 EVSE. Some of these may be located along the traffic routes used by VA - Manhattan vehicles.

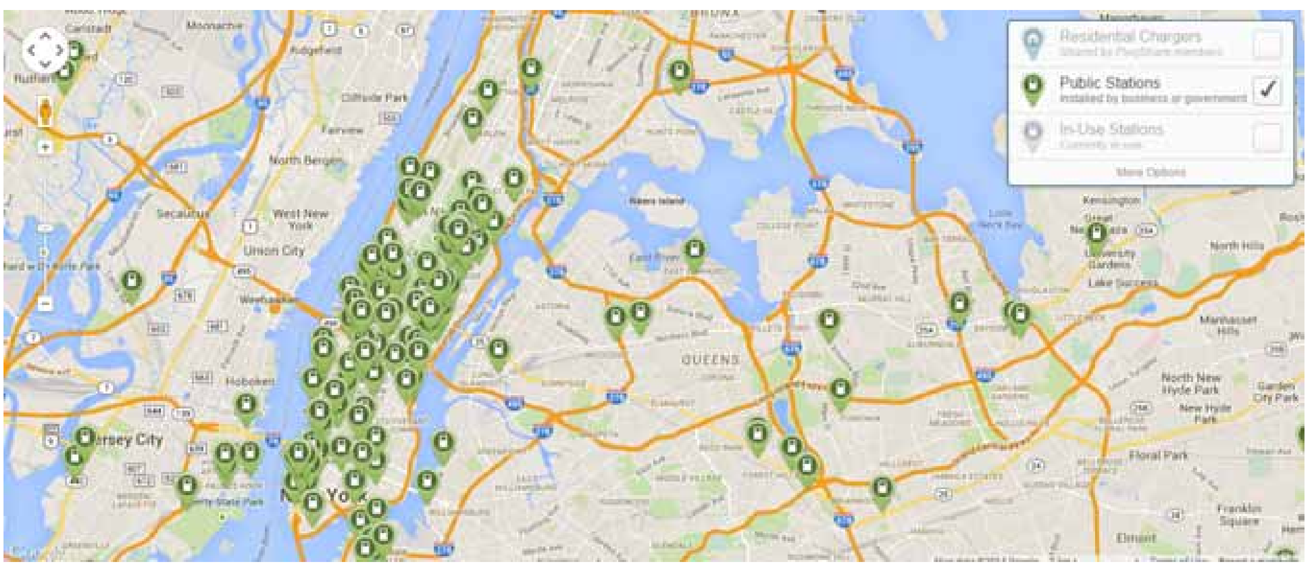


Figure 19. Public EVSE in VA - Manhattan region[27]

27 http://www.plugshare.com/ [accessed October 21, 2014]

5.5 VA - Manhattan Support Vehicles Evaluation

5.5.1 Survey and Site Information

Support vehicles provide a specific work function, facilitating the mission of a particular group. The vehicles are generally passenger or light-duty pickup trucks and may contain after-market modifications to support the mission. While assigned to maintenance and service areas, missions may vary depending on agency needs.

Incorporation of BEVs and/or PHEVs into the support mission is a definite possibility. Support vehicles used for shorter trips or outings qualify for BEV or PHEV replacement, while other support vehicle activities that are associated with longer trips may require PHEV capabilities.

5.5.2 Summary for Support Vehicles

Appendix B provides the vehicle data sheets for each of the support vehicles monitored. This section aggregates data for all support vehicles for VA - Manhattan. Table 13 summarizes support travel during the study period for those days in which the vehicle was driven. Vehicle use occurred primarily between 0800 and 1500 hours daily. The vehicles were driven 2,041 miles, logged 175 hours of operation, and idled 53 hours during the study period.

Table 13. VA - Manhattan support vehicles travel summary

Support Vehicles Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	17.6/68.7	13.7/68.1	4.7/24.2	2,041
Travel Time (Minutes)	90.9/249.0	70.8/352.0	24.3/102.0	10,548
Idle Time (Minutes)	27.4/NA	21.3/NA	7.3/NA	3,181

5.5.3 Support Vehicles Daily Summary

Figure 20 identifies daily travel distance and time for all the support vehicles. The green line and bars indicates typical electric range on a single charge for a PHEV, while the blue line and bars (including the green bars) indicates the same for a BEV. Figures 21 and 22 show the composite history in distance and time traveled for the support vehicles. In these stacked bar charts of Figures 21 and 22, the contribution of each vehicle is indicated by a different color.

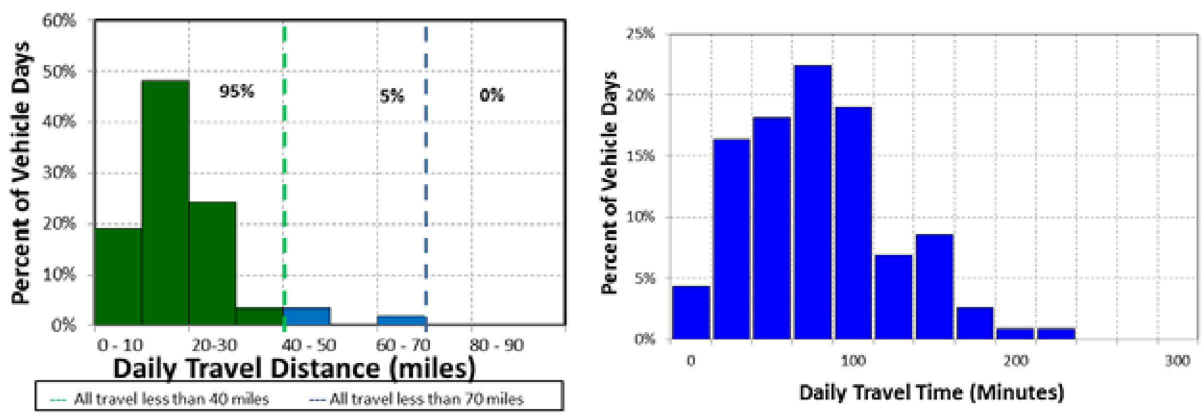


Figure 20. VA - Manhattan support vehicle daily travel miles and time (all vehicles)

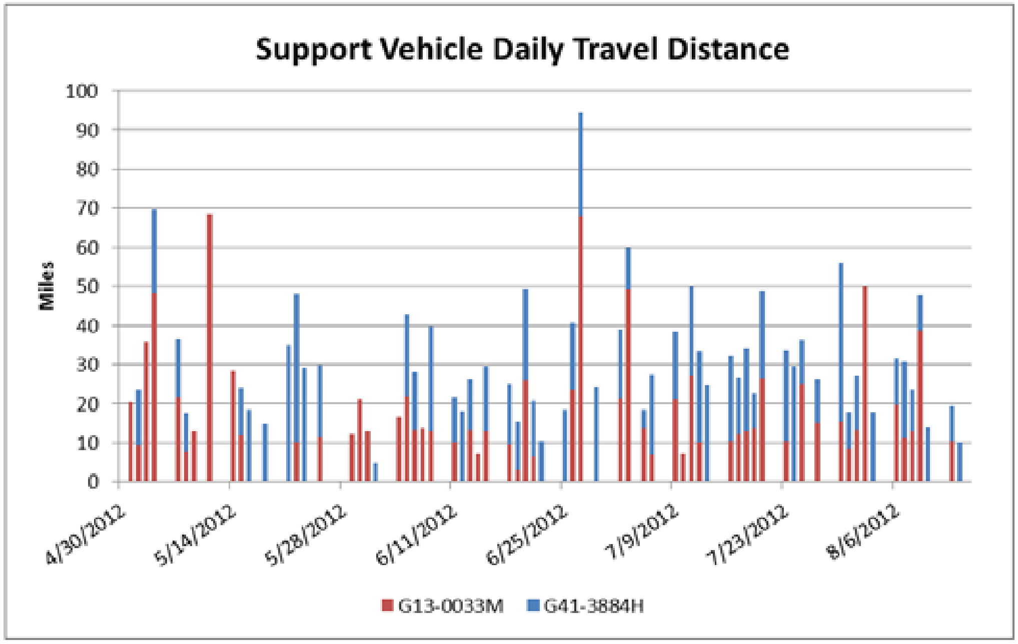


Figure 21. VA - Manhattan support vehicle daily travel history (all vehicles)

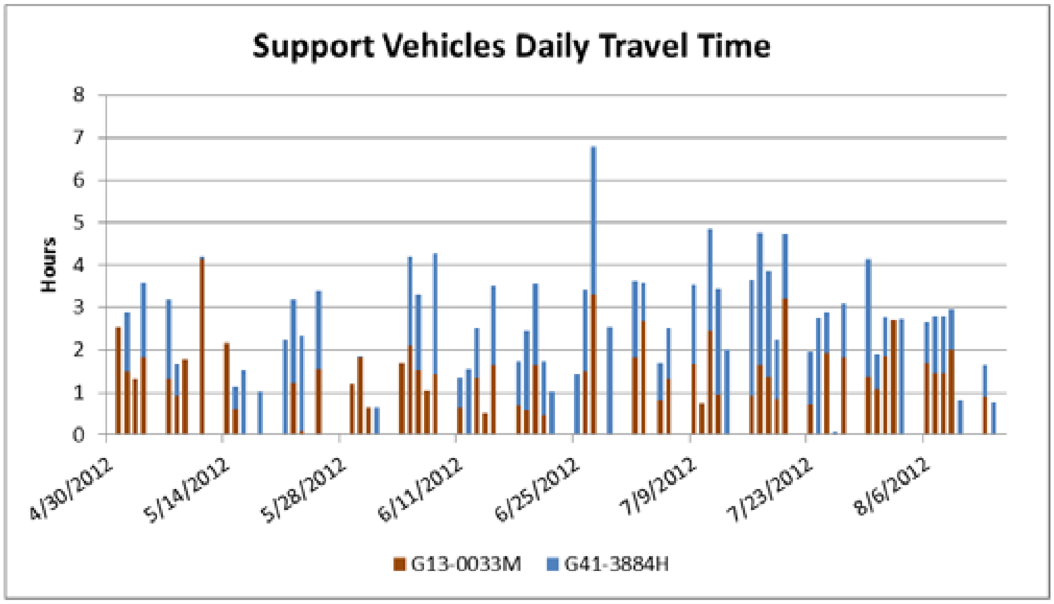


Figure 22. VA - Manhattan support vehicles travel time (all vehicles)

When driven, the average travel distance per day for support vehicles is 17.6 miles. On all of these vehicle days, the daily travel is less than the 70 miles considered to be within the BEV safe range. That is, while BEV range can vary based on several factors; most BEVs provide at least 70 miles of vehicle range on a single battery charge. Further, 95% of vehicle travel days are less than 40 miles considered to be within the CD range of a PHEV.

Figures 14 and 15 show that the vehicles are not used every day although there are many days when both of the vehicles are in use.

Figure 16 displays the summary of use by time of day for the support vehicles.

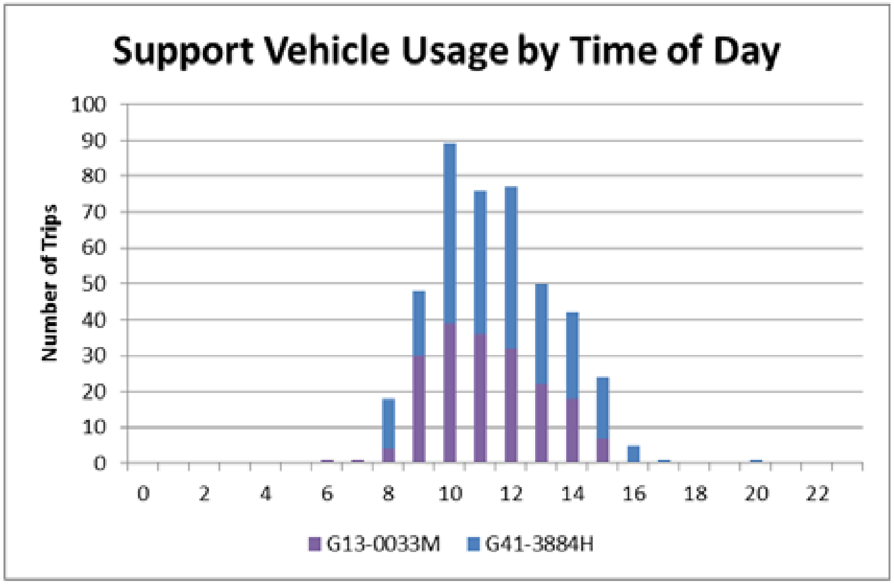


Figure 23. VA - Manhattan support vehicles hourly usage

Figure 17 shows the outing distances traveled including data for both support vehicles.

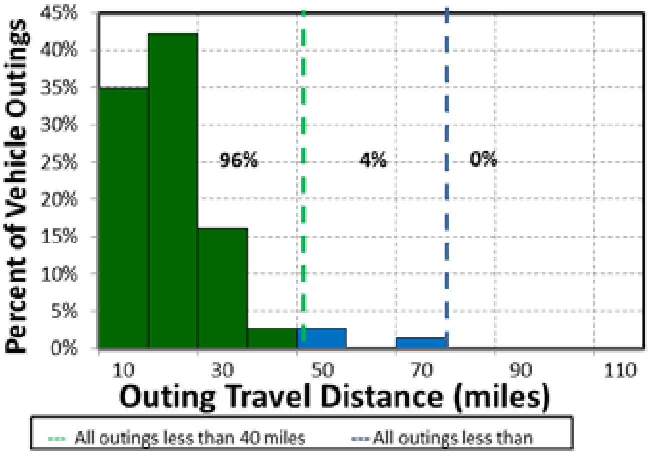


Figure 24. VA - Manhattan support vehicle outings

Appendix B provides the details of each of the support vehicle's outing travel.

The average travel outing for support vehicles is 13.7 miles. On all of these vehicle outings, the distance traveled is less than the 70 miles considered to be within the BEV safe range. Further, 96% of vehicle travel outings are less than 40 miles considered to be within the CD range of a PHEV.

5.5.4 VA - Manhattan Support Vehicle Observations/Summary

There appears to be three choices for VA - Manhattan in implementing PEVs into the support fleet. It should be noted that the objective would be to incorporate as many BEVs as possible to realize the advantages of reduced petroleum usage and reduced emissions of GHGs.

1. All BEV fleet: While some BEV manufacturers report vehicle range exceeding 70 miles, Intertek recommends careful evaluation of experienced range to ensure vehicle missions are accomplished. Nevertheless, assuming the 70-mile safe range for a BEV, an all-BEV fleet does appear to be possible

due to the length of the daily travel. Support travel is generally in the local vicinity so that longer distance travel is less likely.

2. Mixed BEV/PHEV fleet: Certainly, PHEVs can accomplish the same mission as the current fleet when only considering travel times and distances because the PHEV's gasoline engine can provide motive power when the battery has been depleted. Figure 20 shows that on 95% of all vehicle travel days, the total daily travel is less than 40 miles, which typically is the maximum distance a PHEV will travel in CD mode. This represents a significant operating cost savings opportunity while retaining the ability to go longer distances when needed. In addition, 96% of the outings are less than 40 miles and could be completed in CD mode for certain PHEVs if the battery is fully charged prior to the outing.

   Meanwhile, all of the outings are within the typical capability of a BEV, and so the EVSE at the home base could provide recharge energy for another outing. A mixed fleet requires fleet manager attention to assign vehicles appropriately for the anticipated use on that day.

   Figure 20 also shows all the daily travel is within the typical range of a BEV. This would suggest that all of the fleet could be BEV. The fact that all of the outings are within the range capabilities of a BEV suggest that with additional charging is not required between outings. The support vehicles averaged 1.5 hours of use daily suggesting that time is available for additional charging.

   A fleet of all BEVs does require a greater level of fleet management, with the daily assignment of vehicles based on anticipated driving distance if distances may exceed the BEV range limit. For these two support vehicles**, two BEVs** could conservatively meet the demand.

3. All PHEV fleet: As noted above, PHEVs can accomplish the same mission as the current fleet when only considering travel times and distances. Replacing all current vehicles with PHEVs only requires an evaluation of the individual vehicle capabilities of currently available PHEVs to meet current support requirements. Both of these support vehicles have replacement PEVs available. Data show that for a significant number of days, the PHEV will operate in a CD mode. The first 40 miles of longer travel days would also be powered by (at least mostly) electricity so that 95% of all support vehicle travel would be (again, at least mostly) battery powered with only one charge per day. As above, this represents an opportunity for significant operating cost savings while retaining the ability to go longer distances when needed. Intermediate charging opportunities provide additional benefit, enhancing the CD mode. Data show significant charging opportunities throughout the day during stop times.

The vehicle summary shows sufficient time for charging at the base location during the course of the day and additional opportunities at intermediate charging stations are not required. These stations also provide charging opportunities for the visiting public, whose fees may assist in offsetting operating costs. Given the availability of daytime changing, with experience, VA - Manhattan may find a greater fraction of BEVs within the support vehicle fleet may meet their needs.

Considering a full complement of 25 support vehicles in the total fleet, Intertek notes that four are heavy duty trucks for which no PEV is currently available as a potential replacement. However, for the balance of the vehicles, Intertek suggests that a mixed fleet may be possible. While the remaining vehicles were not monitored, it would appear from above that all vehicles could be BEVs. However, it is assumed that some support vehicles may need to have longer travel days so some PHEV capabilities may be desired. Thus, a fleet of **15 BEVs** and **6 PHEVs** should meet vehicle travel requirements. Typically, additional EVSE at frequently visited locations provide recharging for both the BEV and PHEV that may be of benefit.

5.5.5 VA - Manhattan Support Vehicle Charging Needs

Upon review of these data, Intertek suggests replacement of these two studied support fleet with two BEVs. A DCFC at the home base will provide a more rapid recharge for BEVs but appears to be unnecessary, given that the data show that all of outings and all daily travel is less than a typical BEV's driving range.

As noted above, AC Level 2 overnight charging of BEVs is typical, whereas overnight charging of PHEVs can usually be accomplished with AC Level 1 charging.

Intertek's experience suggests that each vehicle should have an assigned charging parking space at its home base. Assigned stations require less management attention to ensure completion of overnight charging. BEVs and PHEVs not assigned to these stations also benefit during visits to the location as part of their normal operation. For the entire fleet of support vehicles, the 15 BEVs require 15 AC Level 2 EVSE units for overnight charging and the 6 PHEVs require 6 AC Level 1 outlets at each vehicles overnight parking location. Intertek recommends a minimum of two EVSE at each location to maximize charge capability without a significant increase in installation costs. The PHEVs can utilize the AC Level 2 EVSE at the home base during the day to increase the amount of vehicle miles traveled in CD Mode.

5.6 Balance of Fleet Vehicles

The balance of the VA - Manhattan fleet consists of two mobile clinic vehicles having a specialty mission, two heavy-duty trucks, seven law enforcement vehicles, and four busses and shuttles. Certain select PEVs are being demonstrated for various specialty applications but none is listed in the GSA schedule. The law enforcement vehicles are six large sedans and one SUV. Depending on the nature of the law enforcement work, PHEVs can certainly fulfill the mission while BEVs may be able to support as well. VA - Manhattan may wish to review these fleet vehicles for replacement considerations. Electric buses are currently available but because their charging needs are typically much different from other vehicles, they were not analyzed in this project. VA-Manhattan may wish to evaluate this potential replacement.

6. GREENHOUSE GAS EMISSIONS AVOIDED AND FUEL COST REDUCTION ANALYSIS

PEV substitution for an existing conventional vehicle avoids GHG emissions and reduces fuel costs. The GHG emissions avoided occur due to the difference in emissions associated with power plant electricity generation versus fuel combustion that occurs in the engine of a conventional vehicle. This analysis does not account for life-cycle emissions that occur outside of electricity generation and fuel combustion phases (i.e., materials and resource extraction, production supply-chains, and decommissioning are not accounted for). These phases are beyond the scope of this report due to the significant effort required to conduct an accurate environmental life-cycle assessment for a transportation system in a very specific setting. The analysis used is known as a "tank-to-wheel" analysis rather than a "well-to-wheel" analysis that would include the aforementioned phases. Cost reduction also occurs because the cost of electricity is comparable to the cost of gasoline on a unit of energy basis but PEVs are more efficient than conventional ICE vehicles. Because fuel logs were not kept, the mileage accumulated by each vehicle and the extrapolation to annual miles provide one source of annual miles estimates. VA - Manhattan also provided information related to anticipated annual miles. These are compared to that calculated during the study to identify the source of fuel consumption estimates for the study vehicles.

In order to perform the analysis, EPA fuel economy ratings are used.[28] Tables 14 and 15 provide these ratings. Ratings for the PHEVs in Table 15 include CD operation. Because these data are estimates, assumptions include the following:

1. PHEVs operate in CD mode only for the percentage of travel less than 40 miles per day. This is reasonable for most daily operations, as described in Section 5. This is conservative since there exists additional charge time between most outings. It is also conservative in that the replacement PEV typically will have greater fuel economy when operating in CS mode. BEVs operate in electric mode for 100% of travel.
2. The energy consumption for the Mitsubishi Outlander is assigned the same value as the RAV4 EV because the EPA has not yet created ratings for this vehicles.
3. Figure 19 15 suggests the PEVs to replace existing monitored vehicles. See section 4.4 for vehicle availability.

Annual miles are calculated from the actual miles identified in the study and extrapolated to a full 365-day year. The average annual miles were not reported by VA - Manhattan so vehicle odometer reading was compared to the model year to estimate the annual mileage figures. These annual miles are used for the reduction calculations, since they were averaged over a much longer period. Miles in CD mode then are the VA - Manhattan annual miles times percent of daily travel less than 40 miles for the PHEV replacement and full annual miles for the BEV replacement.

Table 14. U.S. EPA fuel economy ratings of current fleet vehicles

Vehicle	Logger	Mission	Make & Model	Model Year	Fuel Economy-Combined (miles/gallon)
G11-2671H	32	Pool	Chevrolet Impala	2009	23
G10-9461K	33	Pool	Ford Fusion Hybrid	2011	39
G13-1533M	34	Pool	Ford Focus	2012	31
G10-0994H	35	Pool	Pontiac G6	2009	26
G42-2765B	36	Pool	Chevrolet G1500	2007	14
G43-2514H	37	Pool	Chevrolet G3500	2009	14
G13-0033M	38	Support	Ford Focus	2012	31
G41-3884H	39	Support	Dodge Caravan	2009	19
G10-9480K	40	Pool	Ford Fusion Hybrid	2011	39

Table 15. U.S. EPA PEV energy consumption assumptions

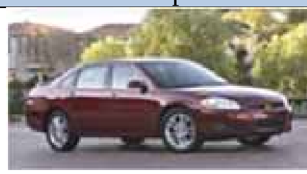
Vehicle	Mission	Replacement PEV	Wh/mile
Chevrolet Impala	Pool	Ford Fusion PHEV	370
Ford Fusion Hybrid	Pool	Ford Fusion PHEV	370
Ford Focus	Pool	Chevrolet Volt PHEV	350
Pontiac G6	Pool	Ford Focus BEV	310
Chevrolet G1500	Pool	NA	-
Chevrolet G3500	Pool	NA	-
Ford Focus	Support	Ford Focus BEV	310

[28] http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=33558 [accessed August 27, 2014]

Dodge Caravan	Support	Toyota Rav4	440
Ford Fusion Hybrid	Pool	Nissan Leaf	300

Table 16 provides a pictorial view of potential replacement PEVs.

Table 16. PEV substitutions for current vehicles

Vehicle Class	Current Vehicle Example	Replacement PHEV	Replacement BEV
Sedan – Midsize/Large	 Chevrolet Impala	 Ford Fusion Energi 370 Wh/mi	 Nissan Leaf 300 Wh/mi
Sedan - Compact	 Pontiac G6	 Chevrolet Volt 350 Wh/mi	 Ford Focus BEV 310 Wh/mi
SUV and Minivan	 Dodge Caravan	 Mitsubishi Outlander 440 wh/mi	 Toyota RAV4 440 wh/mi

Calculations provided for GHG emissions and fuel savings include both a total U.S. perspective and for the local area. The electricity generation mix of power plants for the total United States is different from the local mix of generation in the VA - Manhattan area. Likewise, the national average cost for petroleum fuel is different from the local cost for fuel. This analysis includes both approaches in order to allow for local evaluation and to provide the potential benefit for fleet vehicles in other locations of the United States that may be of interest. The final report summarizing results from all sites studied across the U.S. from Intertek to Idaho National Laboratory primarily will consider the national figures. For clarity, only the local New York figures are shown here. The national figures are included in Appendix C.

For the GHG emissions avoided portion of the analysis, the GHG emissions (in pounds of carbon dioxide equivalent (which also accounts for other GHGs such as methane and nitrous oxide), *lb-CO_2e*) from combustion of gasoline is 20.1 lb-CO_2e/gallon.[29] The United States averages for GHG emissions for the production of electricity is 1.53 lb-CO_2e/kWh[30].

[29] http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf [accessed 19 July 2013].

[30] http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf [accessed July 19, 2013]

Consolidated Edison Company provides power to the VA-Manhattan area. It operates oil and gas plants in the New York area and reports the addition of solar plants in recent years.[31] Consolidated Edison reports emissions to EPA and EPA reports GHG emissions from all plants in the production of electricity. The annual report is available in the Emissions and Generation Resource Integrated Database. The most recent publication is for 2010[32]. Using the information provided for Consolidated Edison plants, emissions for 2010 for the production of electricity were 1.3431lb-CO2e/kWh.

GHG emissions avoided are the GHG emitted by the current vehicle (total annual gallons gasoline × GHG emissions/gallon) minus the annual GHG emitted by the replacement PEV (total annual kWh × GHG emissions/kWh). For the PHEVs, the percentages of outings less than 40 miles are counted for the annual miles saved in CD Mode, with the balance of the miles accounted as fueled with gasoline.

Table 17 shows the calculation of annual miles based upon the recorded and extrapolated miles in this study. The VA - Manhattan reported annual miles is also shown for comparison. The replacement vehicle is identified for each vehicle. It is important to note that the analysis conducted above suggests replacement vehicles for the fleet of vehicles rather than necessarily replacing the exact vehicle monitored. The percent of miles in CD mode is 100% for BEVs since all travel is battery powered. The percent of miles in CD mode for PHEVs is obtained from the daily travel shown in Appendix B. Miles in CD mode then is the percentage of VA - Manhattan reported annual miles.

Table 17. CD mode miles calculations

Vehicle	Replacement Vehicle	Study Calculated Annual Miles	Odometer based Annual Miles	Percent of Miles CD Mode	CD Mode Miles
Impala	Fusion PHEV	7,467	8,000	68%	5,440
Ford Fusion Hyb	Ford Fusion PHEV	6,835	20,000	86%	17,200
Ford Focus	Chevrolet Volt	6,796	7,000	81%	5,670
Pontiac G6	Ford Focus BEV	4,835	11,000	100%	11,000
Chevrolet G1500	NA	6,472	7,600	NA	NA
Chevrolet G3500	NA	10,161	18,000	NA	NA
Ford Focus	Ford Focus BEV	3,700	4,000	100%	4,000
Dodge Caravan	Toyota Rav4	3,464	14,500	100%	14,500
Ford Fusion Hyb	Nissan Leaf	1,719	7,000	100%	7,000

For the cost-avoided piece of the analysis, fuel cost assumptions are $3.186/gallon of regular gasoline for the United States and $3.660 gallon in Manhattan, NY[33]. Electrical cost are 0.0984 $/kWh for the United States and 0.152$/kWh in New York[34]. Therefore, fuel costs savings are the current vehicle's calculated annual gasoline cost (total annual gallons gasoline × cost/gallon) minus the electricity cost (total annual kWh × cost/kWh) of the replacement PEV traveling the same distance.

The miles calculated above for CD Mode yields estimates for yearly GHG emissions avoided and fuel cost reductions. The results of this analysis (shown in Table 18) demonstrate that the substitution of a conventional ICE vehicle with a PEV can reduce the GHG emissions and fuel costs dramatically. The table also shows the percentage reduction in GHG emissions and fuel costs for ease of comparison. For

[31] http://www.conedison.com/ehs/2011annualreport/environmental-stewardship/reducing-greenhouse-gases.html [accessed October 13, 2014]

[32] http://www.epa.gov/cleanenergy/energy-resources/egrid/ [accessed September 20, 2014]

[33] http://www.newyorkgasprices.com/GasPriceSearch.aspx [October 13, 2014]

[34] http://www.eia.gov/electricity/state/ [Accessed October 3, 2014]

example, if the Chevrolet Volt replaces the Ford Focus pool vehicle G13-1533M, a 28% reduction in GHG emissions in New York occurs. The Focus travels 7,000 miles per year but 81% of those miles could be powered by the battery of the Volt. The Focus traveling 5,670 miles per year produces 3,676 lb-CO2e/year whereas the Volt produces 2,665 lb-CO2e/year for that same distance for a reduction of 1,011 lb-CO2e/year.

Table 18. Greenhouse gas emissions avoidance and fuel cost reduction analysis summary

Mission	Replacement Model	Extrapolated Local. Yearly CO_2e Avoided (lb-CO_2e/year)	% reduction	Extrapolated Local Yearly Fuel Cost Reduction	% reduction
Pool	Ford Fusion PHEV	2,051	43%	$508	62%
Pool	Ford Fusion PHEV	318	4%	$550	36%
Pool	Chevrolet Volt PHEV	1,011	28%	$328	52%
Pool	Ford Focus BEV	3,924	46%	$937	64%
Pool	NA	NA	NA	NA	NA
Pool	NA	NA	NA	NA	NA
Support	Ford Focus BEV	928	36%	$255	58%
Support	Toyota Rav4	6,771	44%	$1,656	63%
Pool	Nissan Leaf	787	22%	$298	48%
	Total	**15,791**	**33%**	**$4,531**	**56%**

Table 18 shows the high potential benefit in the reduction of GHG emissions in the local VA - Manhattan area. In addition, the fuel cost reduction potential benefit is also significant due to the low cost of power. Notice that a Ford Fusion PHEV is suggested to replace the Ford Fusion hybrid vehicle. Because the hybrid model has excellent fuel economy, the reduction in GHG emission is small. However, the reliance on electricity for fuel for 86% of its miles provides significant fuel cost savings. It is also noted that the Leaf is suggested to replace another Ford Fusion hybrid. In this case, since the battery fuels all miles, significant savings in both GHG and fuel costs result.

As presented in Section 5, 15 BEVs and 23 PHEVs could replace 38 of the pool fleet of 60 vehicles while retaining the 22 passenger vans. The support fleet of 25 vehicles would retain four heavy-duty trucks and replace the balance with 15 BEVs and 6PHEVs. Using an average savings per vehicle, Table 19 provides the avoided GHG and fuel cost savings should these replacements occur. The table also shows the percentage reduction in GHG emissions and fuel costs for ease of comparison. Only local New York savings are projected in this table while national figures are presented in Appendix C.

Table 19. Extrapolated greenhouse gas emissions avoided and fuel cost savings for the entire fleet

Mission	Extrapolated Local Yearly CO_2e Avoided (lb-CO_2e/year)	% reduction	Extrapolated Local Yearly Fuel Cost Reduction ($/year	% reduction
Pool	107,464	35%	$32,036	57%
Support	55,288	38%	$14,683	59%
Total	162,752	36%	$46,719	57%

7. OBSERVATIONS

Intertek appreciates the opportunity to present the results of this evaluation. Observations for possible follow-up action include the following:

Observation #1:

Implementation: VA - Manhattan can move forward in the near future with the replacement of pool and support vehicles with PEVs as current budget and vehicle replacement schedules allow. Certainly, seven of the vehicle types studied in this report are candidates for immediate replacement.

Observation #2:

Fleet Inventory: A more thorough examination of the quantities and types of fleet vehicles within each usage category may be beneficial to quantify the potential for replacement by PEVs. While Intertek suggests a mix of BEVs and PHEVs, a more refined look may be possible. In addition, this study did not look at the other fleet vehicle categories, such as those with specialty, enforcement, or transport missions, in detail.

Observation #3:

Vehicle Replacement Plan: The development of a detailed vehicle replacement plan could be beneficial. Such a plan would include cost and schedule for vehicle replacement. A more detailed survey and calculation of the use of the fleet vehicles (such as vehicle parking locations, age of vehicle, expected replacement time, expected replacement costs, GSA vehicle costs, EVSE cost, total life costs, and EVSE installation costs) provide support to this replacement plan. A more refined estimate for reduced GHG emissions, petroleum usage reduction, and fuel cost savings flow from this detailed plan.

Observation #4:

Infrastructure Planning: In conjunction with the replacement plan, evaluation of the VA - Manhattan sites for the placement of PEV charging infrastructure could be beneficial. Intertek has significant experience in this area and such plans will consider not only fleet vehicle charging needs, but also the convenience that charging infrastructure provides employees and visitors. This planning also considers the existing facility electrical distribution system. Vehicle home base considerations factor into the ratio of PEVs to EVSE units to maintain all vehicles at operational readiness.

Charging stations at VA - Manhattan may also provide an opportunity for charging by employees and the public.

Appendix A - Definitions

Alternative fuel	An alternative fuel means any fuel other than gasoline and diesel fuels, such as methanol, ethanol, and gaseous fuels (40 CFR 86.1803-01). A fuel type other than petroleum-based gasoline or diesel as defined by the Energy Policy Act (examples include ethanol, methanol, compressed natural gas, propane, and electrical energy).
City fuel economy (MPG)	City fuel economy means the city fuel economy determined by operating a vehicle (or vehicles) over the driving schedule in the federal emission test procedure or determined according to the vehicle-specific 5-cycle or derived 5-cycle procedures (40 CFR 600.001).
Conventional fuel	A petroleum-based fuel (examples include gasoline and diesel fuel).
Daily travel	The sum of daily trips and stops in one day.
Diesel fuel	Diesel means a type of engine with operating characteristics significantly similar to the theoretical diesel combustion cycle. The non-use of a throttle during normal operation is indicative of a diesel engine (49 CFR 86-1803).
E85	Ethanol fuel blend of up to 85% denatured ethanol fuel and gasoline or other hydrocarbons by volume.
Electric vehicle	Electric vehicle means a motor vehicle that is powered solely by an electric motor drawing current from a rechargeable energy storage system, such as from storage batteries or other portable electrical energy storage devices, including hydrogen fuel cells, provided that (1) The vehicle is capable of drawing recharge energy from a source off the vehicle, such as residential electric service (2) The vehicle must be certified to the emission standards of Bin #1 of Table S04-1 in § 86.1811-09(c)(6) (3) The vehicle does not have an onboard combustion engine/generator system as a means of providing electrical energy (40 CFR 86-1803).
Ethanol-fueled vehicle	Ethanol-fueled vehicle-means any motor vehicle or motor vehicle engine that is engineered and designed to be operated using ethanol fuel (i.e., a fuel that contains at least 50% ethanol ($C_2 H_5 OH$) by volume) as fuel (40 CFR 86.1803-01).
Federal vehicle standards	The document that establishes classifications for various types and sizes of vehicles, general requirements, and equipment options. The GSA Vehicle Acquisition and Leasing Service's Automotive Division issues it annually.
Government motor vehicle	Any motor vehicle that the government owns or leases. This includes motor vehicles obtained through purchase, excess, forfeiture, commercial lease, or GSA fleet lease.
Gross vehicle weight rating	Gross vehicle weight rating (GVWR) means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle (e.g., vocational vehicle) (US Government Printing Office 2009)
GSA fleet	GSA fleet lease means obtaining a motor vehicle from the General Services Administration fleet (GSA fleet) (41 CFR 102-34).
Heavy light-duty truck	Heavy light-duty truck means any light-duty truck rated greater than 6,000 lb. GVWR. The light-duty truck 3 (LDT3) and LDT4 classifications comprise the heavy light-duty truck category (40 CFR 86.1803-01).

Highway fuel economy (Hwy MPG)	Highway fuel economy means the highway fuel economy determined either by operating a vehicle (or vehicles) over the driving schedule in the federal highway fuel economy test procedure or determined according to either the vehicle-specific, 5-cycle equation, or the derived 5-cycle equation for highway fuel economy (40 CFR 600.001).
Hybrid electric vehicle	Hybrid electric vehicle means a motor vehicle that draws propulsion energy from onboard sources of stored energy that are both an internal combustion engine or heat engine using consumable fuel and a rechargeable energy storage system (such as a battery, capacitor, hydraulic accumulator, or flywheel), where recharge energy for the energy storage system comes solely from sources on board the vehicle.
Idle time	Idle time is logged whenever a vehicle idles with the engine running for 3 minutes or longer.
Law enforcement	Law enforcement motor vehicle means a light-duty motor vehicle that is specifically approved in an agency-s appropriation act for use in apprehension, surveillance, police, or other law enforcement work or specifically designed for use in law enforcement. If not identified in an agency's appropriation language, a motor vehicle qualifies as a law enforcement motor vehicle only in the following cases: (1) A passenger automobile having heavy-duty components for electrical, cooling, and suspension systems and at least the next higher cubic inch displacement or more powerful engine than is standard for the automobile concerned (2) A light truck having emergency warning lights and identified with markings such as "police" (3) An unmarked motor vehicle certified by the agency head as essential for the safe and efficient performance of intelligence, counterintelligence, protective, or other law enforcement duties (4) A forfeited motor vehicle seized by a federal agency that subsequently is used for performing law enforcement activities (41 CFR Part 102-34.35).
Light-duty motor vehicle	Any motor vehicle with a GVWR of 8,500 pounds or less (41 CFR 102-34).
Light-duty truck	Light-duty truck means any motor vehicle rated at 8,500 pounds GVWR or less, which has a curb weight of 6,000 pounds or less and, which has a basic vehicle frontal area of 45 square feet or less, which is as follows: (1) Designed primarily for purposes of transportation of property or is a derivation of such a vehicle (2) Designed primarily for transportation of persons and has a capacity of more than 12 persons (3) Available with special features, enabling off-street or off-highway operation and use. LDT1 means any light light-duty truck up through 3,750-lb loaded vehicle weight. LDT2 means any light light-duty truck greater than 3,750-lb loaded vehicle weight. LDT3 means any heavy light-duty truck up through 5,750-lb adjusted loaded vehicle weight. LDT4 means any heavy light-duty truck greater than 5,750-lb adjusted

	loaded vehicle weight (US Government Printing Office 2009)
Light-duty vehicle	Light-duty vehicle means a passenger car or passenger car derivative capable of seating 12 passengers or less.
Low-speed vehicle	Low-speed vehicle means a motor vehicle (1) That is 4-wheeled (2) Whose speed attainable in 1.6 km (1 mile) is more than 32 kilometers per hour (20 miles per hour) and not more than 40 kilometers per hour (25 miles per hour) on a paved level surface (3) Whose GVWR is less than 1,361 kilograms (3,000 pounds) (49 CFR 571.3 – Definitions).
Medium-duty passenger vehicle	Medium-duty passenger vehicle means any heavy-duty vehicle (as defined in this subpart) with a GVWR of less than 10,000 pounds that is designed primarily for transportation of persons. The medium-duty passenger vehicle definition does not include any vehicle which (1) Is an "incomplete truck" as defined in this subpart (2) Has a seating capacity of more than 12 persons (3) Is designed for more than 9 persons in seating rearward of the driver's seat (4) Is equipped with an open cargo area (for example, a pick-up truck box or bed) of 72.0 inches in interior length or more. A covered box not readily accessible from the passenger compartment will be considered an open cargo area for purposes of this definition (US Government Printing Office 2009)
Model year	Model year means the manufacturer's annual production period (as determined by the administrator), which includes January 1 of such calendar year; provided that if the manufacturer has no annual production period, the term "model year" shall mean the calendar year (40 CFR 86-1803.01).
MPG	"MPG" or "mpg" means miles per gallon. This generally may be used to describe fuel economy as a quantity or it may be used as the units associated with a particular value.
MPGe	MPGe means miles per gallon equivalent. This generally is used to quantify a fuel economy value for vehicles that use a fuel other than gasoline. The value represents miles the vehicle can drive with the energy equivalent of one gallon of gasoline: (c) SCF means standard cubic feet (d) SUV means sport utility vehicle (e) CREE means carbon-related exhaust emissions [76 FR 39527, July 6, 2011].
Non-passenger automobile	A non-passenger automobile means an automobile that is not a passenger automobile or a work truck and includes vehicles described in paragraphs (a) and (b) of 49 CFR 523.5.
Owning agency	Owning agency means the executive agency that holds the vehicle title, manufacturer's Certificate of Origin or is the lessee of a commercial lease. This term does not apply to agencies that lease motor vehicles from the GSA fleet (41 CFR Part 102-34.35).

Passenger automobile	A passenger automobile is any automobile (other than an automobile capable of off-highway operation) manufactured primarily for use in the transportation of not more than 10 individuals (49 CFR 523.4 – Passenger automobile). A sedan or station wagon designed primarily to transport people (41 CFR 102-34).
Pickup truck	Pickup truck means a non-passenger automobile, which has a passenger compartment and an open cargo bed (49 CFR 523.2).
Plug-in hybrid electric vehicle	PHEV means a hybrid electric vehicle that has the capability to charge the battery from an off-vehicle electric source, such that the off-vehicle source cannot be connected to the vehicle while the vehicle is in motion (40 CFR 86.1803).
Vehicle class	The designation of motor vehicle types that include sedans, station wagons, ambulances, buses, and trucks, or different categories of vehicles according to Federal vehicle standards and further defined in 49 CFR 600.315-82.
Vehicle configuration	Vehicle configuration means a unique combination of basic engine, engine code, inertia weight class, transmission configuration, and axle ratio.
Vehicle days	The number of days a vehicle was driven or utilized during the (vehicle) study period.
Vehicle home base	The primary assigned outing beginning and ending parking location for the vehicle.
Vehicle study period	The number of days the vehicle was equipped with a data logger.

Appendix B - VA - Manhattan Vehicle Data Sheets

Table B-1. VA - Manhattan vehicle index

Vehicle Index						
Log	**Fleet Vehicle Id**	**Make**	**Model**	**Year**	**EPA Class**	**Mission**
32	G11-2671H	Chevrolet	Impala	2009	Sedan – Large	Pool
33	G10-9461K	Ford	Fusion Hybrid	2011	Sedan – Midsize	Pool
34	G13-1533M	Ford	Focus	2012	Sedan - Compact	Pool
35	G10-0994H	Pontiac	G6	2009	Sedan - Compact	Pool
36	G42-2765B	Chevrolet	G1500	2007	Van – Passenger	Pool
37	G43-25144	Chevrolet	G3500	2009	Van - Passenger	Pool
38	G13-0033M	Ford	Focus	2012	Sedan - Compact	Support
39	G41-3884H	Dodge	Caravan	2009	Minivan	Support
40	G10-9480K	Ford	Fusion Hybrid	2011	Sedan - Midsize	Pool

Vehicle G11-2671H

Make Model / Year	Chevrolet Impala/2009
EPA Class Size	Sedan - Large
Mission	Pool
Vehicle Identification Number (VIN):	2G1WB57k291317412
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G11-2671H
Fuel Type	Gas E85
EPA Label / MPG (City/Hwy/Combined)	19/29/23 14/22/17
EPA GHG Emissions (Grams CO2/Mi)	386 365
Study Logger ID	32
Total Vehicle Days / Total Study Days	51/106

Vehicle G11-2671H Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	42.5/298.3	24.9/293.4	9.1/130.5	2,169
Travel Time (Minutes)	150.0/563.0	87.7/491.0	31.9/196.0	7,629
Idle Time (Minutes)	43.7/NA	25.6/NA	9.3/NA	2,230

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	172	90.5%	< 2	112
10 – 20	7	3.7%	2 – 4	10
20 – 40	4	2.1%	4 – 8	20
> 40	7	3.7%	> 8	48

Figure B-1. Vehicle G11-2671H stops

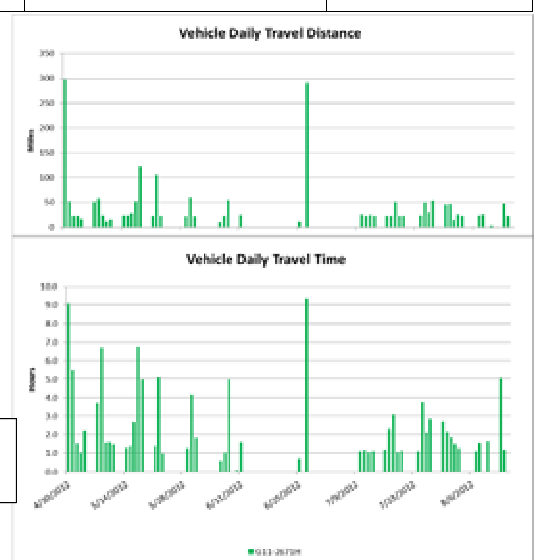


Figure B-2. Vehicle G11-2671H history

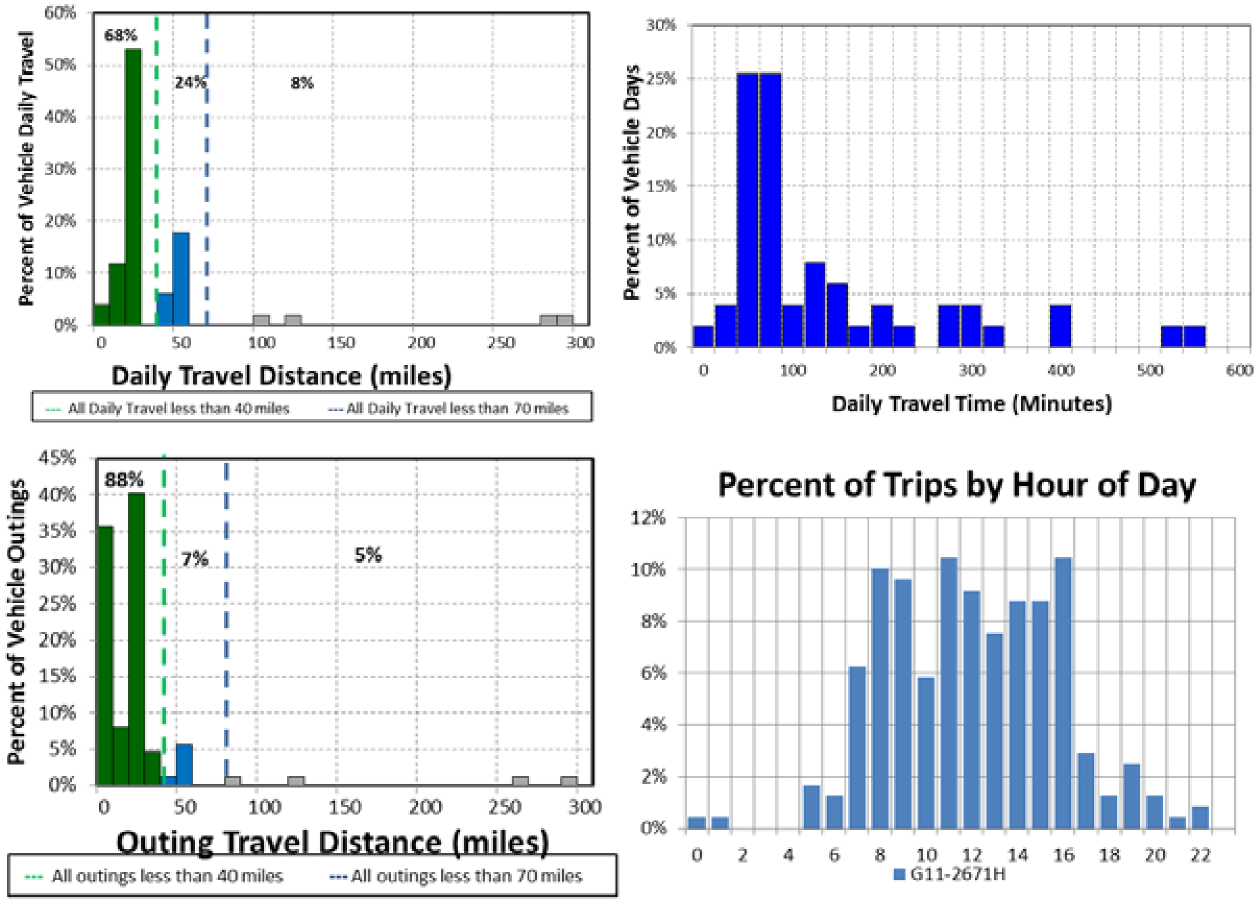


Figure B-3. Vehicle G11-2671H travel graphs

Vehicle G11-2671H Observations

Logger 32 collected data on this vehicle for 51 days of the 106-day study period. Validation occurred on 93.8% of the input data. VA - Manhattan reports that this vehicle has a pool mission for dispatch. This vehicle's data indicates it parks near the VA Medical Center as shown in Figure B-1 and the figure below.

VA - Manhattan reports the vehicle odometer indicated 19,794 miles during the study but annual mileage information was not provided. Based upon model year, it is estimated at 8,000 miles. The vehicle was used on 48% of available days with an average daily usage of 2.5 hours and a peak daily usage of 9.4 hours on the days it was used. The vehicle is used primarily during dayshift hours.

Figure B-3 shows several days of travel exceeding the advertised range of a BEV of approximately 70 miles. 92% of daily travel is within the BEV range. 95% of the outings are also within this range. Further, 68% of daily travel and 88% of outings are within the typically advertised CD mode for PHEVs of 40 miles. The peak outings of 293 and 269 miles occurred over a several day excursion to locations in Pennsylvania and New Jersey.

A BEV could not meet the daily travel but a PHEV could provide benefits for a significant amount of travel that was local. Thus, a fleet of pool vehicles would likely contain a mix of BEVs and PHEVs.

Vehicle G10-9461K

Make / Model / Year	Ford Fusion Hybrid/2011
EPA Class Size	Sedan - Midsize
Mission	Pool
Vehicle Identification Number (VIN):	3FADPOL34BR117446
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G10-9461K
Fuel Type	Gas
EPA Label / MPG (City/Hwy/Combined)	41/36/39
EPA GHG Emissions (Grams CO2/Mi)	228
Study Logger ID	33
Total Vehicle Days / Total Study Days	37/51

Vehicle G10-9461K Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	25.8/230.2	18.4/244.0	1.5/51.7	955
Travel Time (Minutes)	40.0/252.0	28.1/272.0	2.3/46.0	1,463
Idle Time (Minutes)	3.2/NA	2.3/NA	0.2/NA	117

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	268	85.6%	< 2	252
10 – 20	25	8.0%	2 – 4	12
20 – 40	10	3.2%	4 – 8	13
> 40	10	3.2%	> 8	36

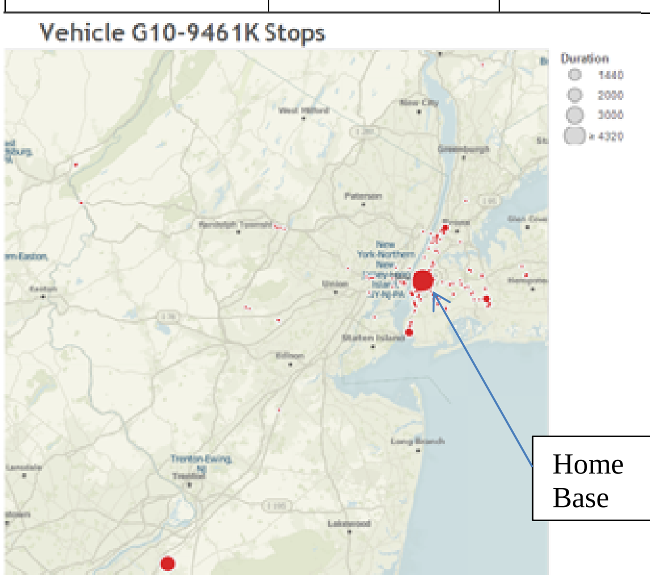


Figure B-4. Vehicle G10-9461K stops

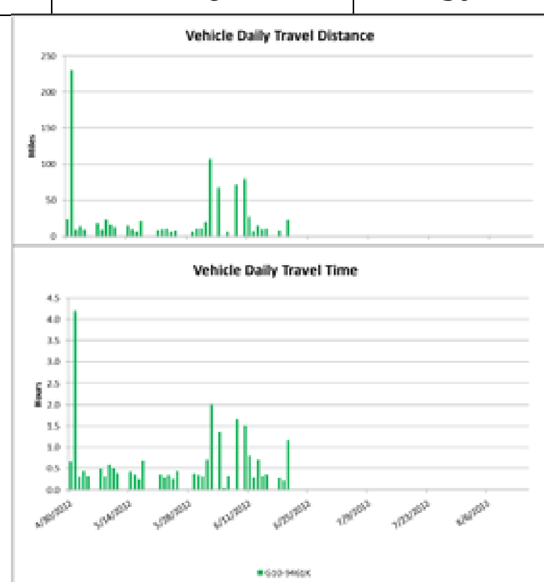


Figure B-5. Vehicle G10-9461K history

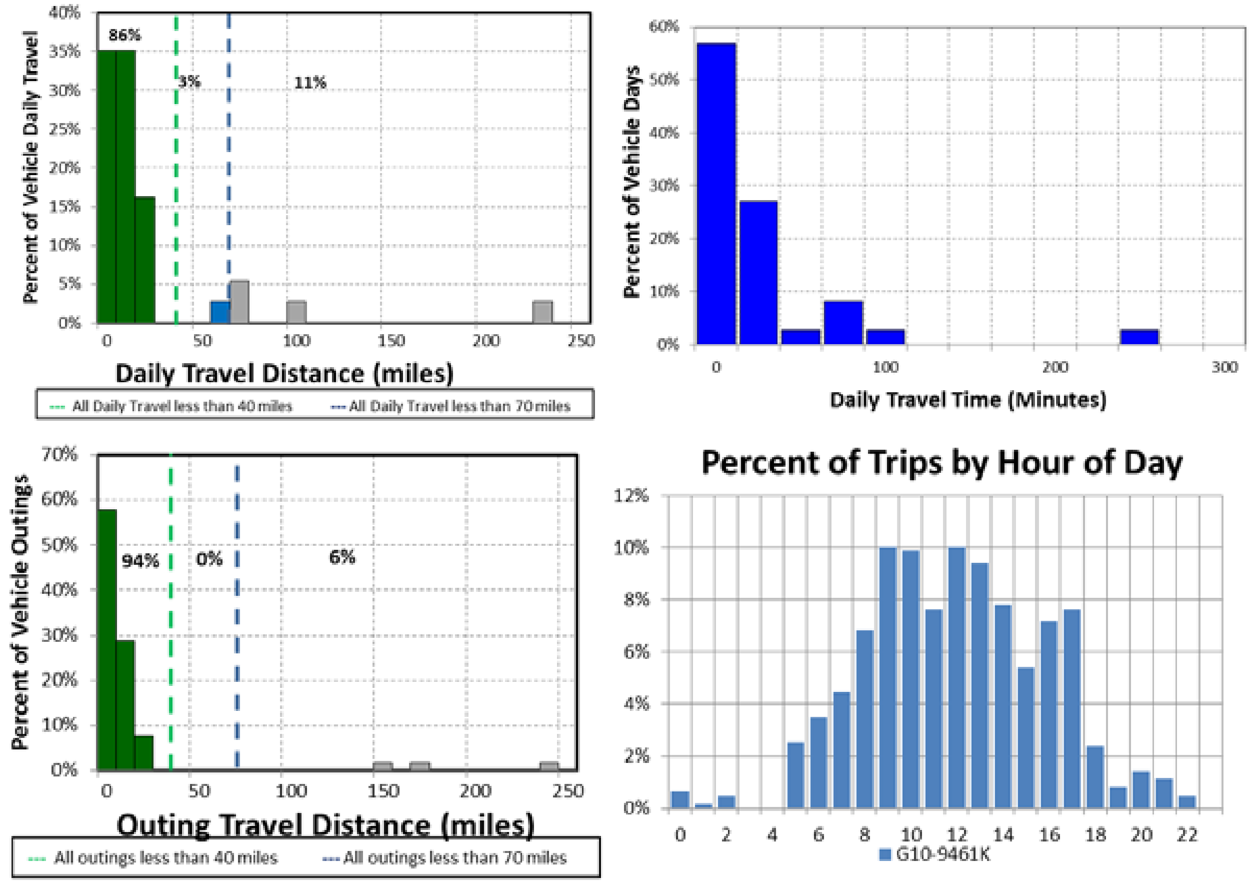


Figure B-6. Vehicle G10-9461K travel graphs

Vehicle G10-9461K Observations

Logger 33 collected data on this vehicle for 37 days of the 51-day study period. Validation occurred on 96.2% of the input data. VA - Manhattan reports this vehicle has a pool mission for dispatch. This vehicle's data indicates it parks near the VA Medical Center in Figure B-4.

VA - Manhattan reports the vehicle odometer indicated 19,979 miles during the study but annual mileage information was not provided. Based upon model year, it is estimated at 20,000 miles. The vehicle was used on 73% of available days with an average daily usage of 0.7 hours and a peak daily usage of 4.2 hours on the days it was used. The vehicle is used during day shift hours.

Figure B-6 shows 89% of the daily travel and 94% of the outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 86% of daily travel and 94% of outings are within the typically advertised CD mode for PHEVs of 40 miles. The longest outing occurred on a multi-day excursion to New Jersey and Pennsylvania.

A BEV cannot meet all of the daily travel because of the long daily distances. A PHEV could provide benefits for a significant amount of travel that was local. Thus, a fleet of pool vehicles would likely contain a mix of BEVs and PHEVs.

***Vehicle* G13-1533M**

Make / Model / Year	Ford Focus/2012
EPA Class Size	Sedan - Compact
Mission	Pool
Vehicle Identification Number (VIN):	1FAHP3F20CL411416
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G13-1533M
Fuel Type	Gas
EPA Label / MPG (City/Hwy/Combined)	28/38/31
EPA GHG Emissions (Grams CO2/Mi)	287
Study Logger ID	34
Total Vehicle Days / Total Study Days	42/80

Vehicle G13-1533M Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	35.5/250.6	31.7/250.6	9.3/134.5	1,490
Travel Time (Minutes)	115.0/360.0	102.9/357.0	30.2/199.0	4,835
Idle Time (Minutes)	33.1/NA	29.6/NA	8.7/NA	1,389

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	118	90.1%	< 2	74
10 – 20	4	3.1%	2 – 4	8
20 – 40	2	1.5%	4 – 8	8
> 40	7	5.4%	> 8	41

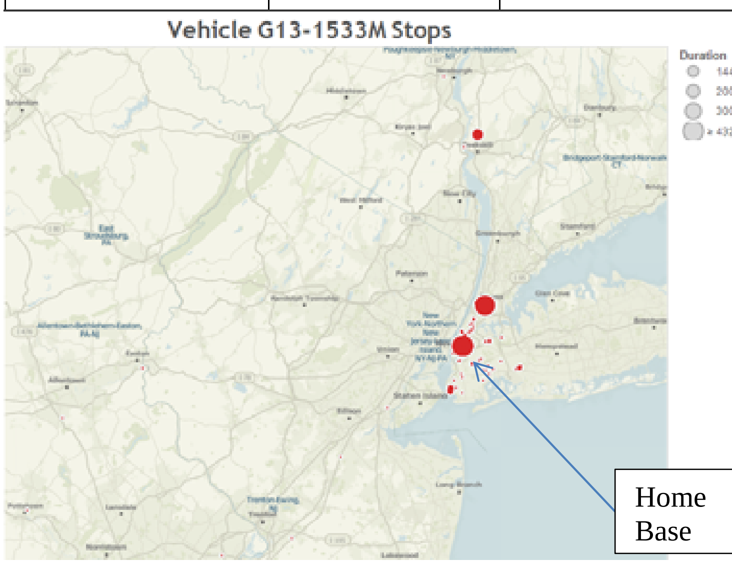


Figure B-7. Vehicle G13-1533M stops

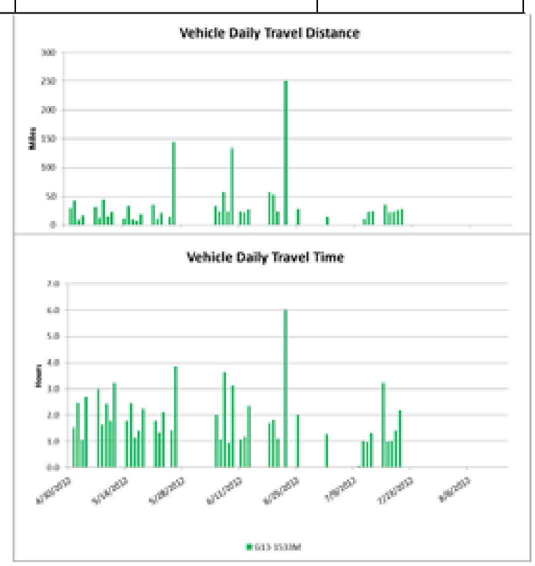


Figure B-8. Vehicle G13-1533M history

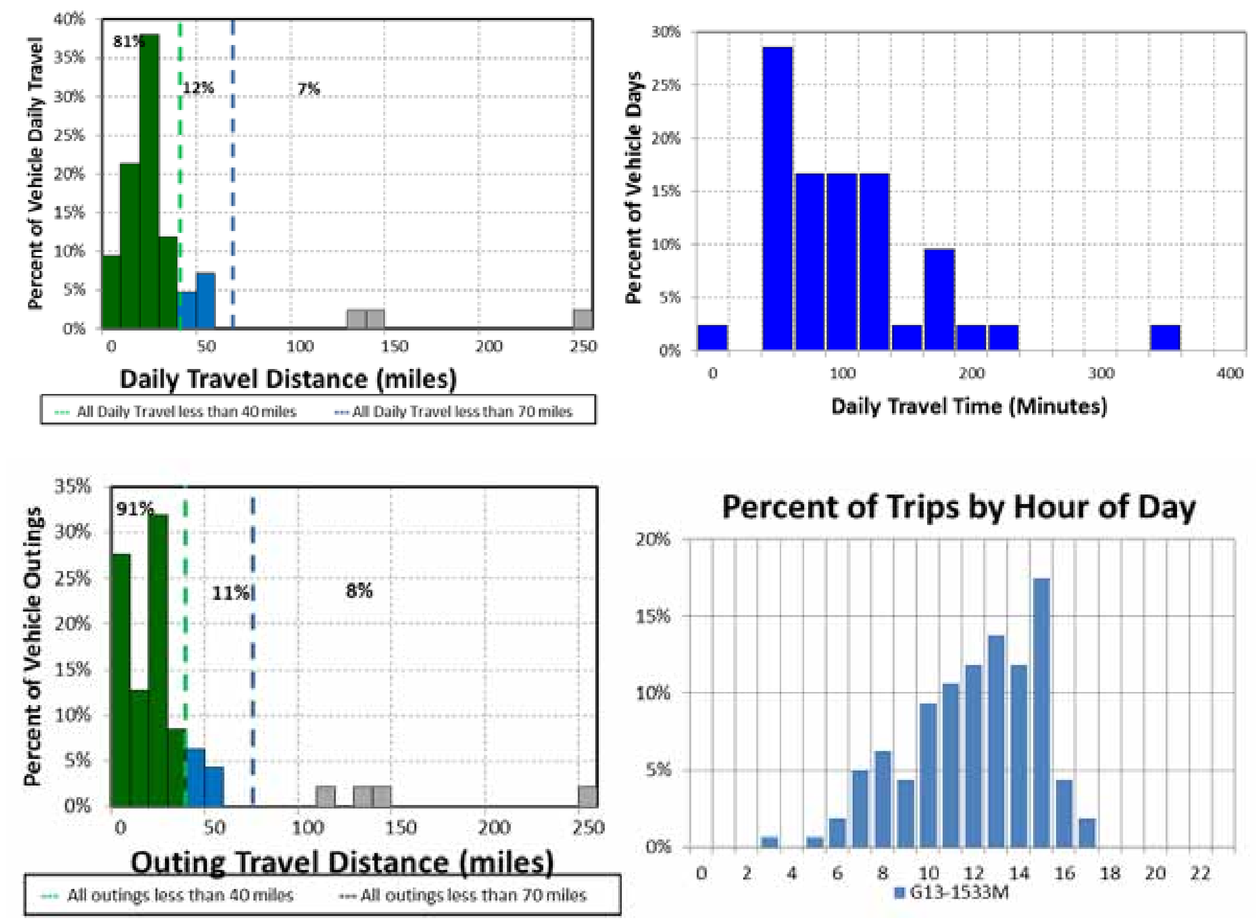


Figure B-9. Vehicle G13-1533M travel graphs

Vehicle G13-1533M Observations

Logger 34 collected data on this vehicle for 42 days of the 80-day study period. Validation occurred on 94.6% of the input data. VA - Manhattan reports this vehicle has a pool mission and is used for dispatch. This vehicle's data indicates it parks near the VA Medical Center as shown in the Figure B-7.

VA - Manhattan reports the vehicle odometer indicated 38 miles during the study but annual mileage information was not provided. The vehicle was used on 53% of available days with an average daily usage of 1.9 hours and a peak daily usage of 6.0 hours on the days it was used. The vehicle is used during typical day shift hours.

Figure B-9 shows 93% of daily travel and 92% outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 81% of daily travel and 91% of outings are within the typically advertised CD mode for PHEVs of 40 miles. The peak outing of 250.6 miles occurred on a single excursion to Pennsylvania.

A BEV could not meet the daily travel because of the long travel distance. A PHEV could provide benefits for a significant amount of travel that was local. Thus, a fleet of pool vehicles would likely contain a mix of BEVs and PHEVs.

Vehicle G10-0994H

Make / Model / Year	Pontiac G6/2009
EPA Class Size	Pool
Mission	Sedan - Compact
Vehicle Identification Number (VIN):	1G2Z157B194241715
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G10-0994H
Fuel Type	Gas
EPA Label / MPG (City/Hwy/Combined)	22/33/26
EPA GHG Emissions (Grams CO2/Mi)	342
Study Logger ID	35
Total Vehicle Days / Total Study Days	53/106

Vehicle G10-0994H Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	26.5/243.9	21.3/243.7	6.3/116.1	1,404
Travel Time (Minutes)	120.0/369.0	96.7/359.0	28.5/166.0	6,382
Idle Time (Minutes)	37.9/NA	30.4/NA	9.0/NA	2,007

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	178	92.2%	< 2	134
10 – 20	12	6.2%	2 – 4	5
20 – 40	0	0%	4 – 8	4
> 40	3	1.6%	> 8	50

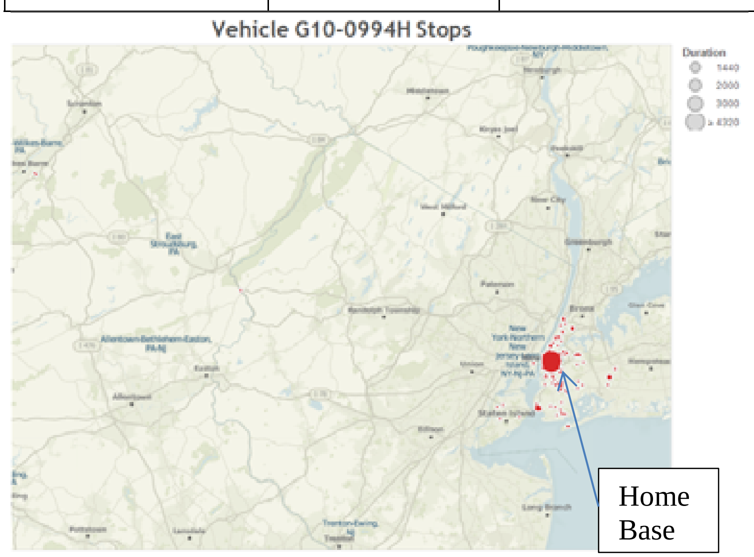


Figure B-10. Vehicle G10-0994H stops

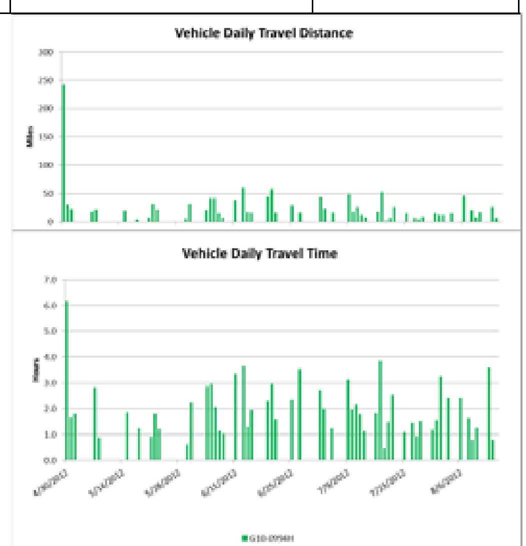


Figure B-11. Vehicle G10-0994H history

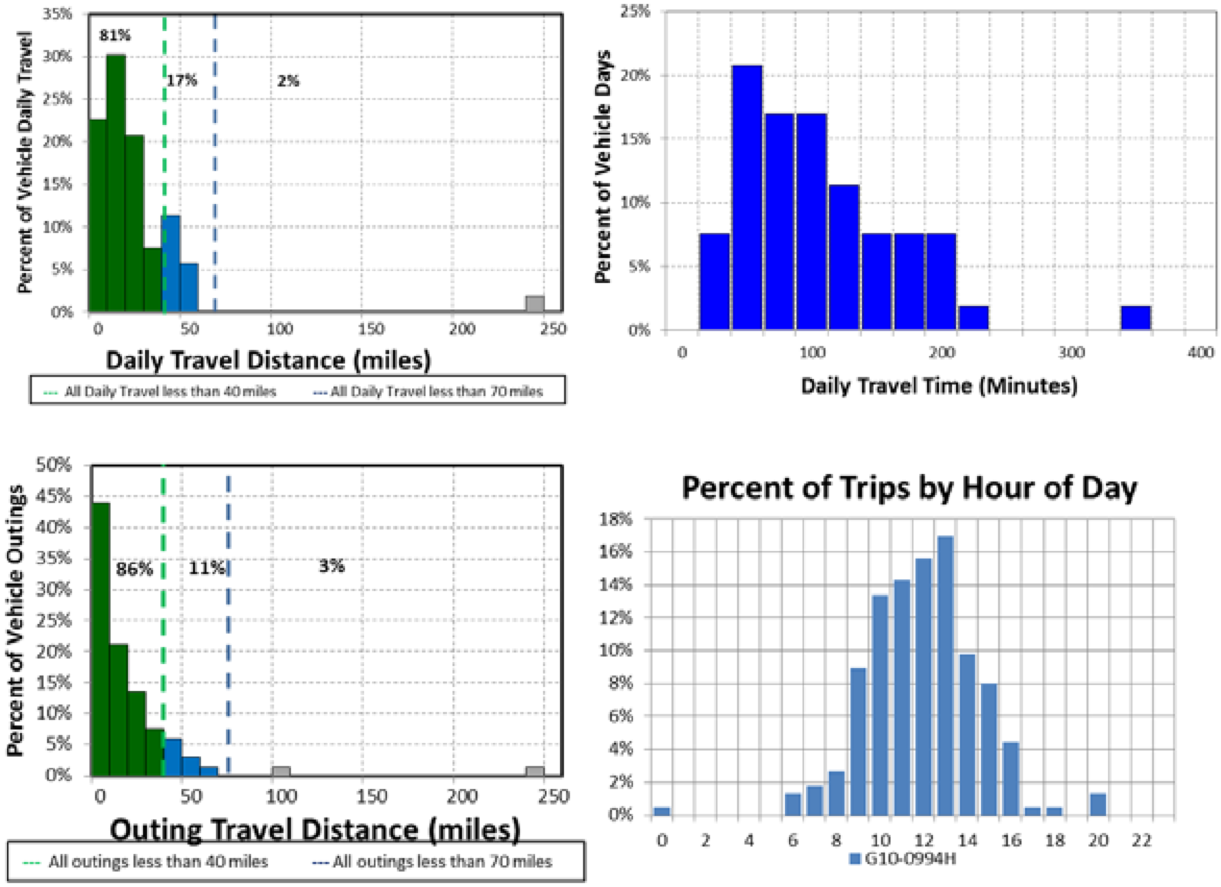


Figure B-12. Vehicle G10-0994H travel graphs

Vehicle G10-0994H Observations

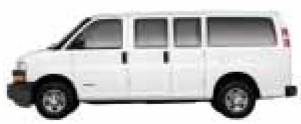
Logger 35 collected data on this vehicle for 53 days of the 106-day study period. Validation occurred on 96.4% of the input data. VA - Manhattan reports this vehicle has a pool mission for dispatch. This vehicle's data indicates it parks near the VA Medical Center as shown in the Figure B-10.

VA - Manhattan reports the vehicle odometer indicated 27,308 miles during the study but annual mileage information was not provided. Based upon model year, it is estimated at 11,000 miles. The vehicle was used on 50% of available days with an average daily usage of 2.0 hours and a peak daily usage of 6.2 hours on the days it was used. The vehicle is used primarily during typical day shift hours.

Figure B-12 shows 98% of daily travel and 97% of outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 81% of daily travel and 86% of outings are within the typically advertised CD mode for PHEVs of 40 miles. The longest single day and outing occurred on a single day excursion to Pennsylvania.

A BEV could not meet the all the daily travel noted because of the travel distance. A PHEV could provide benefits for a significant amount of travel that was local. Thus, a fleet of pool vehicles would likely contain a mix of BEVs and PHEVs.

Vehicle G42-2765B

		
	Make / Model / Year	Chevrolet Express G1500/2007
	EPA Class Size	Van - Passenger
	Mission	Pool
	Vehicle Identification Number (VIN):	1GNFG15Z171209035
	Parking Location	Asser Levy Pl/23 or 25 St
	Fleet Vehicle ID	G42-2765B
	Fuel Type	Gas
	EPA Label / MPG (City/Hwy)	13/16/14
	EPA GHG Emissions (Grams CO_2/Mi)	635
	Study Logger ID	36
	Total Vehicle Days / Total Study Days	74/106

Vehicle G42-2765B Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	25.4/53.2	5.4/31.6	1.8/15.8	1,880
Travel Time (Minutes)	288.0/438.0	60.8/278.0	20.9/172.0	21,275
Idle Time (Minutes)	142.7/NA	30.2/NA	10.4/NA	10,562

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	741	99.7%	< 2	673
10 – 20	2	0.3%	2 – 4	1
20 – 40	0	0%	4 – 8	0
> 40	0	0%	> 8	69

Figure B-13. Vehicle G42-2765B stops

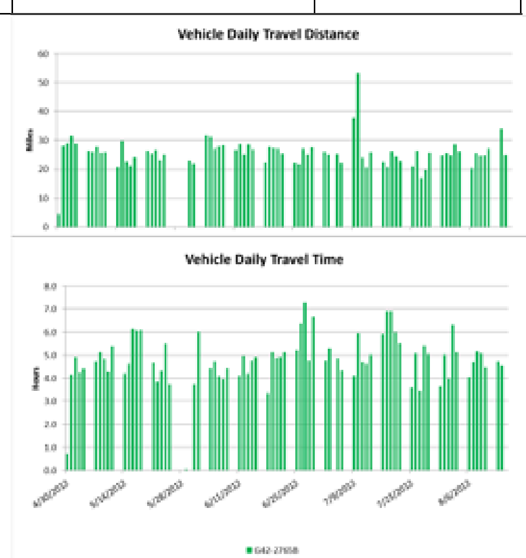


Figure B-14. Vehicle G42-2765B history

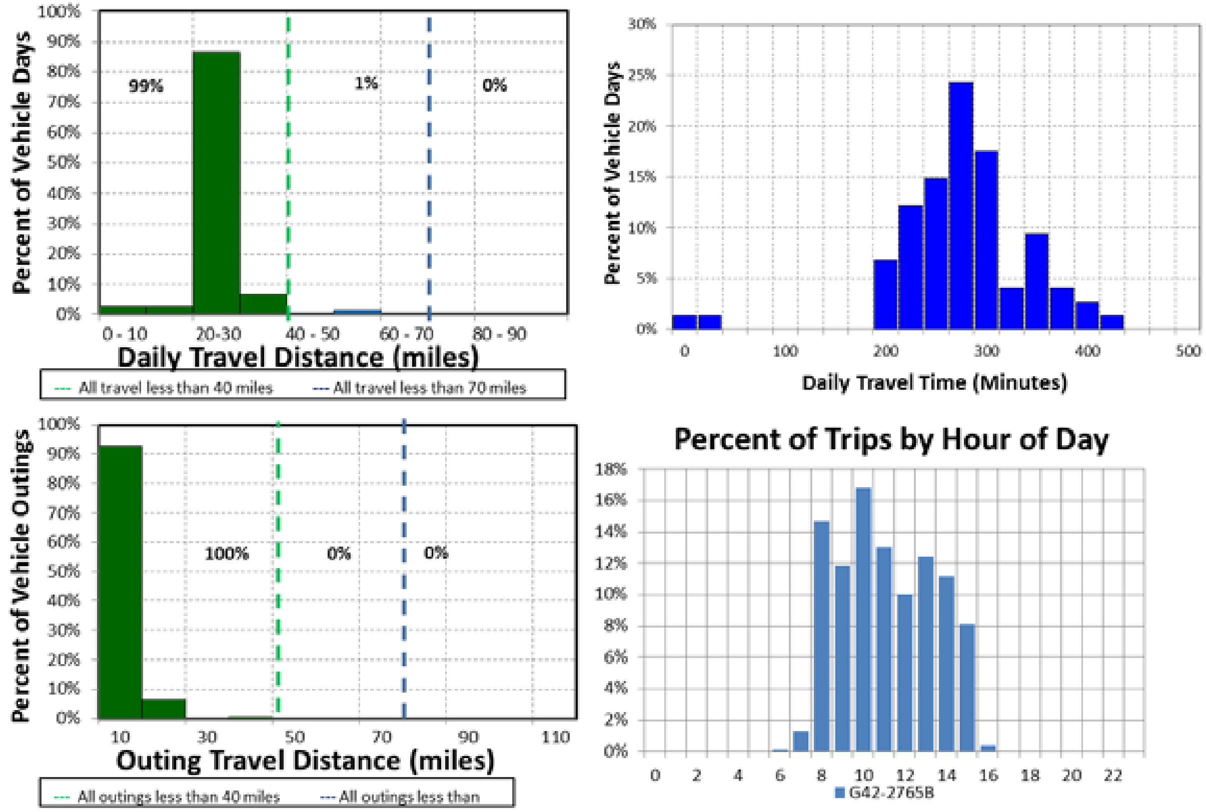


Figure B-15. Vehicle G42-2765B travel graphs

Vehicle G42-2765B Observations

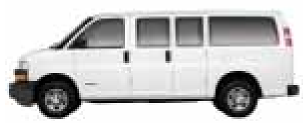
Logger 36 recorded information on this vehicle for 74 days of the 106-day study period. Validation occurred on 98.6% of the input data. VA - Manhattan reports this vehicle has a pool mission as a shuttle. This vehicle's data indicates it parks near the VA Medical Center as shown in Figure B-13.

VA - Manhattan reports the vehicle odometer indicated 34,240 miles during the study but annual mileage information was not provided. Based upon model year, it is estimated at 7,600 miles. The vehicle was used on 70% of available days and is used primarily during normal dayshift hours.

Figure B-15 shows 100% of daily travel and 100% of outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 99% of daily travel and 100% of outings are within the typically advertised CD mode for PHEVs of 40 miles.

A BEV could meet the all the daily travel noted if such a vehicle could meet the shuttle mission requirements. At present, there are no PEVs available as replacements for passenger vans. In some cases, a minivan or SUV can conduct the shuttle operation. Without additional information, the current vehicle may need to be retained in this fleet.

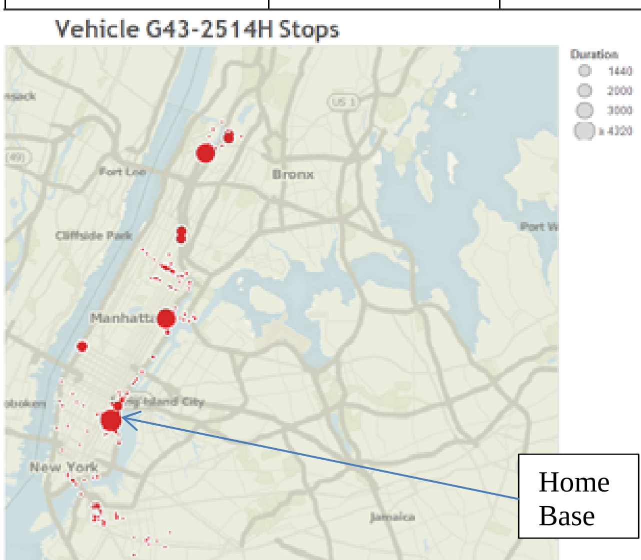
__Vehicle G43-2514H__



Make / Model / Year	Chevrolet G3500/2009
EPA Class Size	Van - Passenger
Mission	Pool
Vehicle Identification Number (VIN):	1GAHG39X291159090
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G43-2514H
Fuel Type	Gas E85
EPA Label / MPG (City/Hwy/Combined)*	13/16/14 9/12/10
EPA GHG Emissions (Grams CO2/Mi)*	635 620
Study Logger ID	37
Total Vehicle Days / Total Study Days	64/105

Vehicle G43-2514H Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	45.7/81.1	6.7/32.4	4.3/21.7	2,923
Travel Time (Minutes)	216.0/378.0	31.9/155.0	20.5/137.0	13,830
Idle Time (Minutes)	72.8/NA	10.7/NA	6.9/NA	4,657

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	508	99.6%	< 2	444
10 – 20	1	0.2%	2 – 4	6
20 – 40	0	0%	4 – 8	3
> 40	0	0%	> 8	57



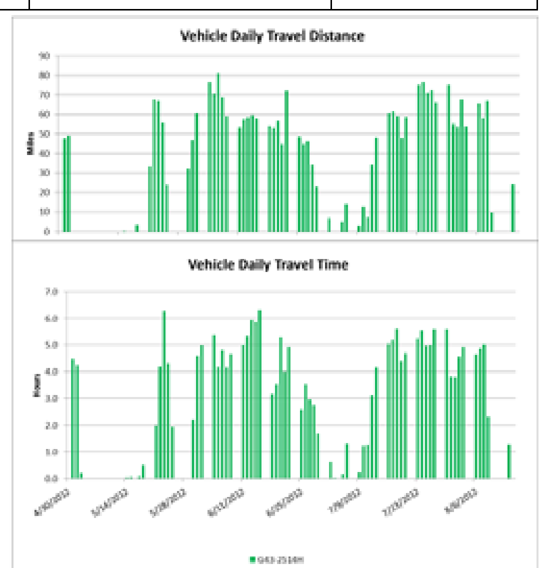


Figure B-16. Vehicle G43-2514H stops

Figure B-17. Vehicle G43-2514H history

*Fuel economy for G3500 is not available. Information shown is for G1500.

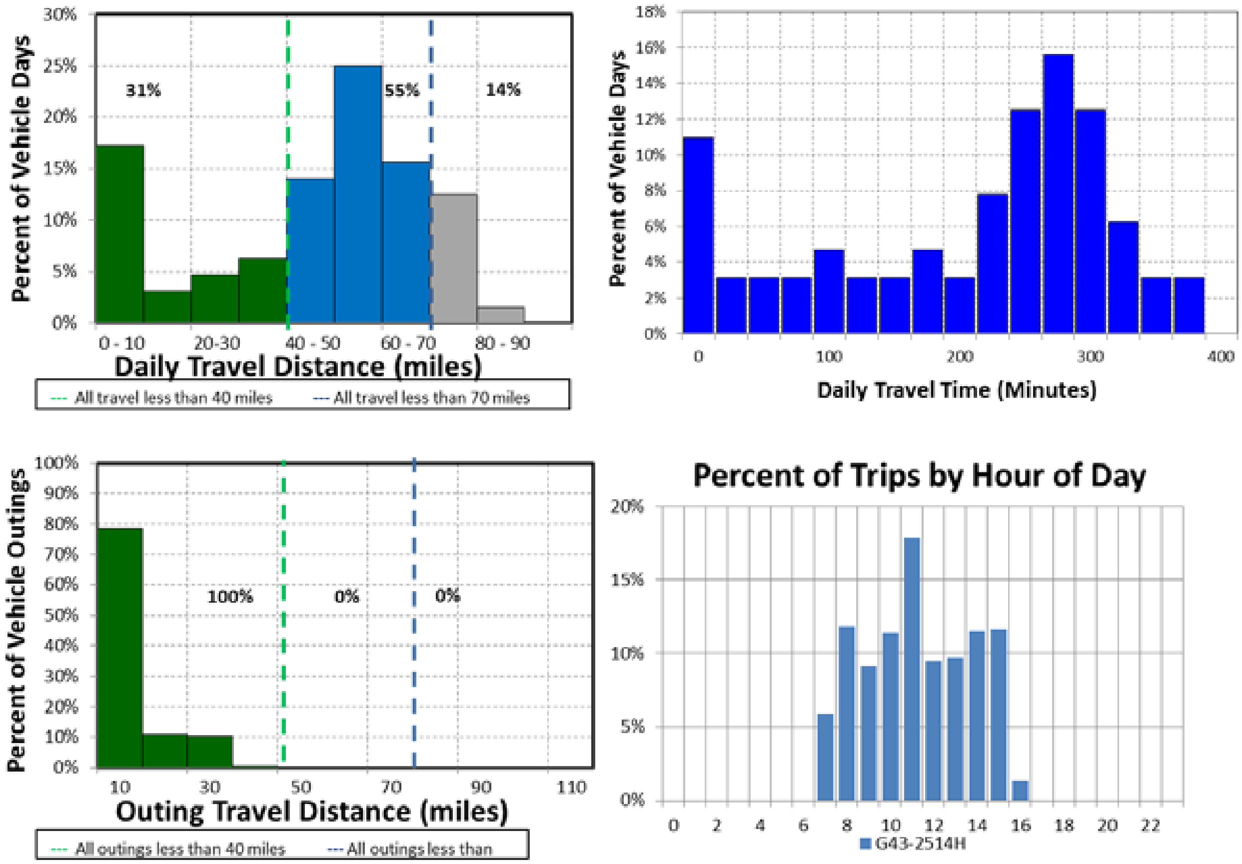


Figure B-18. Vehicle G43-2514H travel graphs

Vehicle G43-2514H Observations

Logger 37 collected data on this vehicle for 64 days of the 105-day study period. Validation occurred on 98.6% of the input data. VA - Manhattan reported this vehicle has a pool mission as a shuttle. This vehicle's data indicates it parks near the VA Medical Center as shown in Figure B-16.

VA - Manhattan reports the vehicle odometer indicated 46,514 miles during the study but annual mileage information was not provided. Based upon model year, it is estimated at 18,000 miles. The vehicle was used on 61% of available days with an average daily usage of 3.6 hours and a peak daily usage of 6.3 hours on the days it was used. The vehicle is used during typical day shift hours.

Figure B-18 shows 86% of daily travel and 100% of outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 31% of daily travel and 100% of outings are within the typically advertised CD mode for PHEVs of 40 miles.

A BEV could not meet the all the daily travel noted without additional charge opportunities. At present, there are no PEVs available as replacements for passenger vans as a shuttle. In some cases, a minivan or SUV can conduct the shuttle operation. Without additional information, the current vehicle may need to be retained in this fleet.

Vehicle G13-0033M

Make / Model / Year	Ford Focus/2012
EPA Class Size	Sedan - Compact
Mission	Support
Vehicle Identification Number (VIN):	IFAHP3F27CL411414
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G13-0033M
Fuel Type	Gas
EPA Label / MPG (City/Hwy/Combined)	28/38/31
EPA GHG Emissions (Grams CO2/Mi)	287
Study Logger ID	38
Total Vehicle Days / Total Study Days	57/104

Vehicle G13-0033M Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	18.5/68.7	16.2/68.1	5.6/24.2	1,054
Travel Time (Minutes)	89.0/249.0	77.7/352.0	26.6/102.0	5,052
Idle Time (Minutes)	25.9/NA	22.8/NA	7.8/NA	1,479

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	158	92.9%	< 2	114
10 – 20	12	7.1%	2 – 4	0
20 – 40	0	0%	4 – 8	1
> 40	0	0%	> 8	55

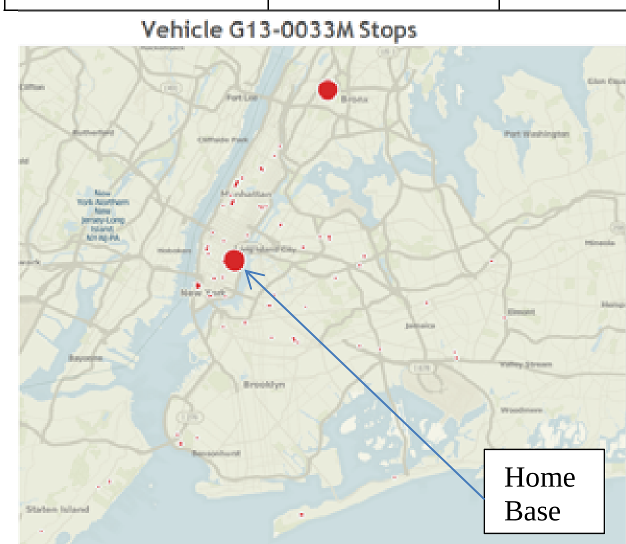


Figure B-19. Vehicle G13-0033M stops

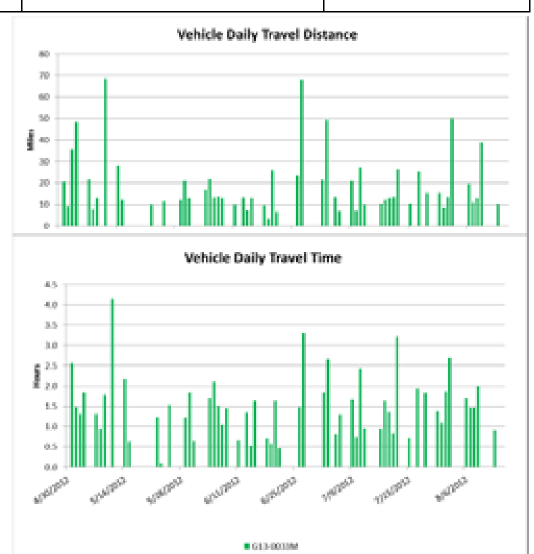


Figure B-20. Vehicle G13-0033M history

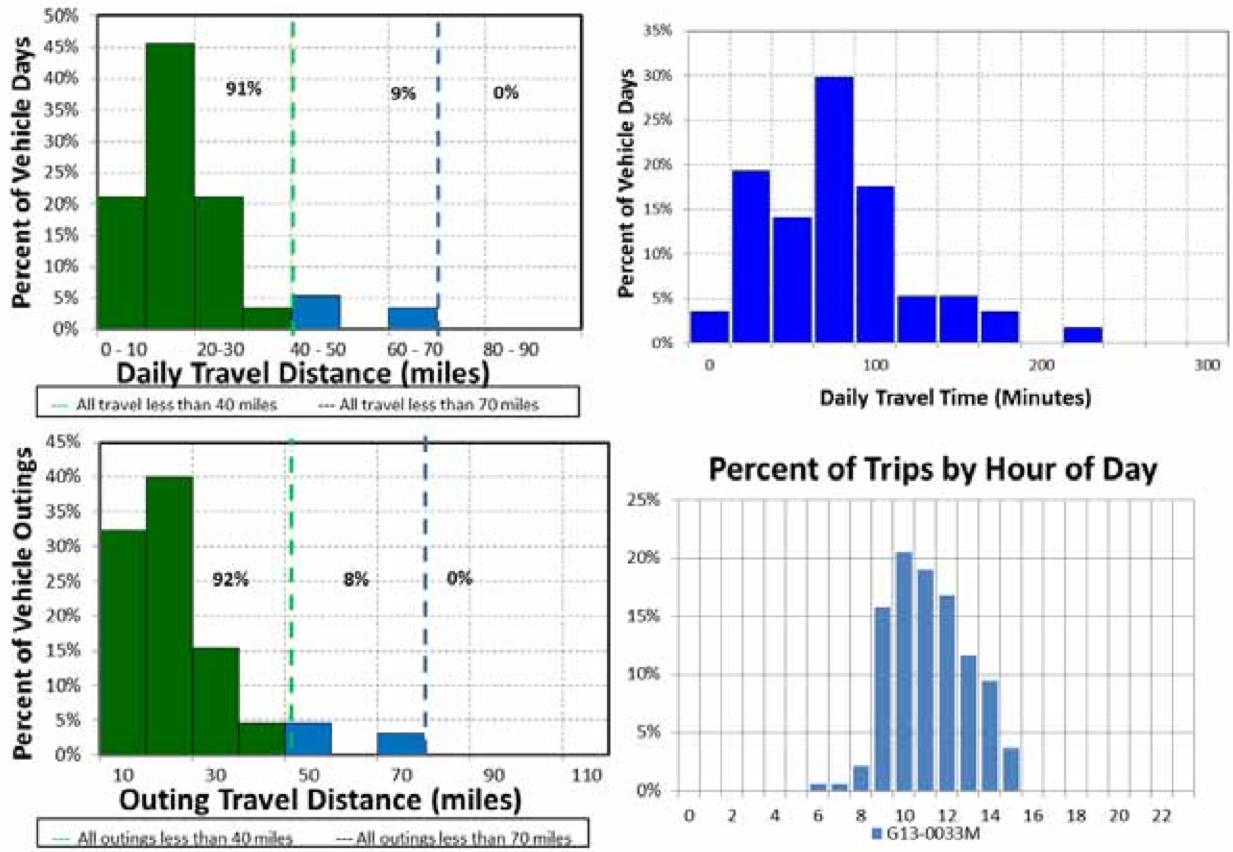


Figure B-21. Vehicle G13-0033M travel graphs

Vehicle G13-0033M Observations

Logger 38 collected data on this vehicle 57 days of the 104-day study period. Validation occurred on 96.1 % of the input data. VA - Manhattan reports this vehicle has a support mission as a HBPC (home based primary care). This vehicle's data indicates it parks near the VA Medical Center as noted in Figures B-19.

VA - Manhattan reports the vehicle odometer indicated 38 miles during the study but annual mileage information was not provided. The vehicle was used on 55% of available days with an average daily usage of 1.5 hours and a peak daily usage of 4.2 hours on the days it was used. The vehicle is used during typical day-shift hours.

Figure B-21 shows 100% of daily travel and 100% of outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 91% of daily travel and 92% of all outings are within the typically advertised CD mode for PHEVs of 40 miles.

A BEV could meet the all the daily travel requirements. A PHEV could provide benefits nearly all travel. BEV models are available as replacements for this compact sedan.

Vehicle G41-3884H

Make / Model / Year	Dodge Caravan/2009
EPA Class Size	Minivan
Mission	Support
Vehicle Identification Number (VIN):	2D8HN44E29R623366
Parking Location	Asser Levy Pl/23 or 25 St
Fleet Vehicle ID	G41-3884H
Fuel Type	Gas E85
EPA Label / MPG (City/Hwy/Combined)	17/24/19 11/16/13
EPA GHG Emissions (Grams CO2/Mi)	468 477
Study Logger ID	39
Total Vehicle Days / Total Study Days	59/104

Vehicle G41-3884H Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	16.7/40.7	11.8/40.7	4.1/18.4	987
Travel Time (Minutes)	93.0/209.0	65.4/209.0	22.6/78.0	5,496
Idle Time (Minutes)	28.8/NA	20.3/NA	7.0/NA	1,702

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	212	99.1%	< 2	158
10 – 20	2	0.9%	2 – 4	2
20 – 40	0	0%	4 – 8	0
40 - 60	0	0%	> 8	54

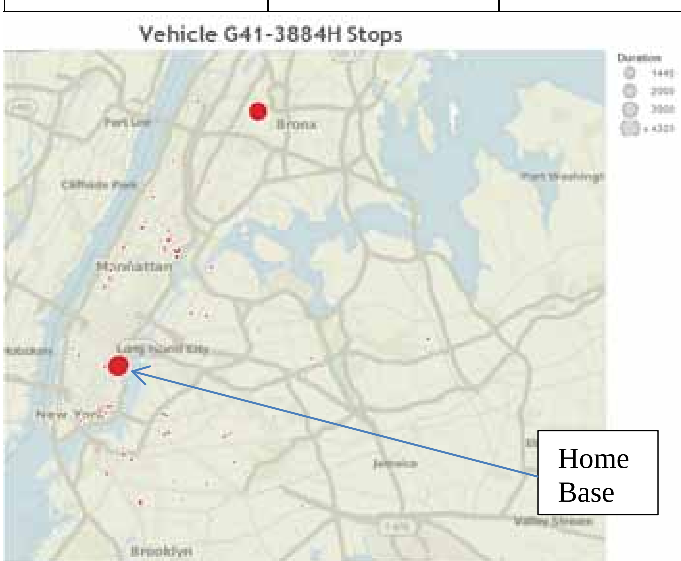


Figure B-22. Vehicle G41-3884H stops

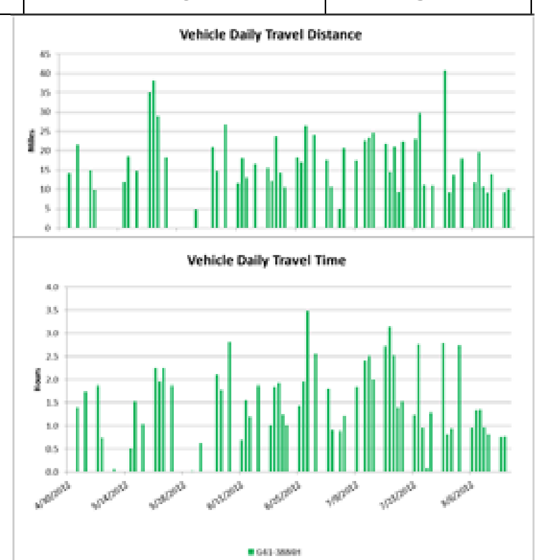


Figure B-23. Vehicle G41-3884H history

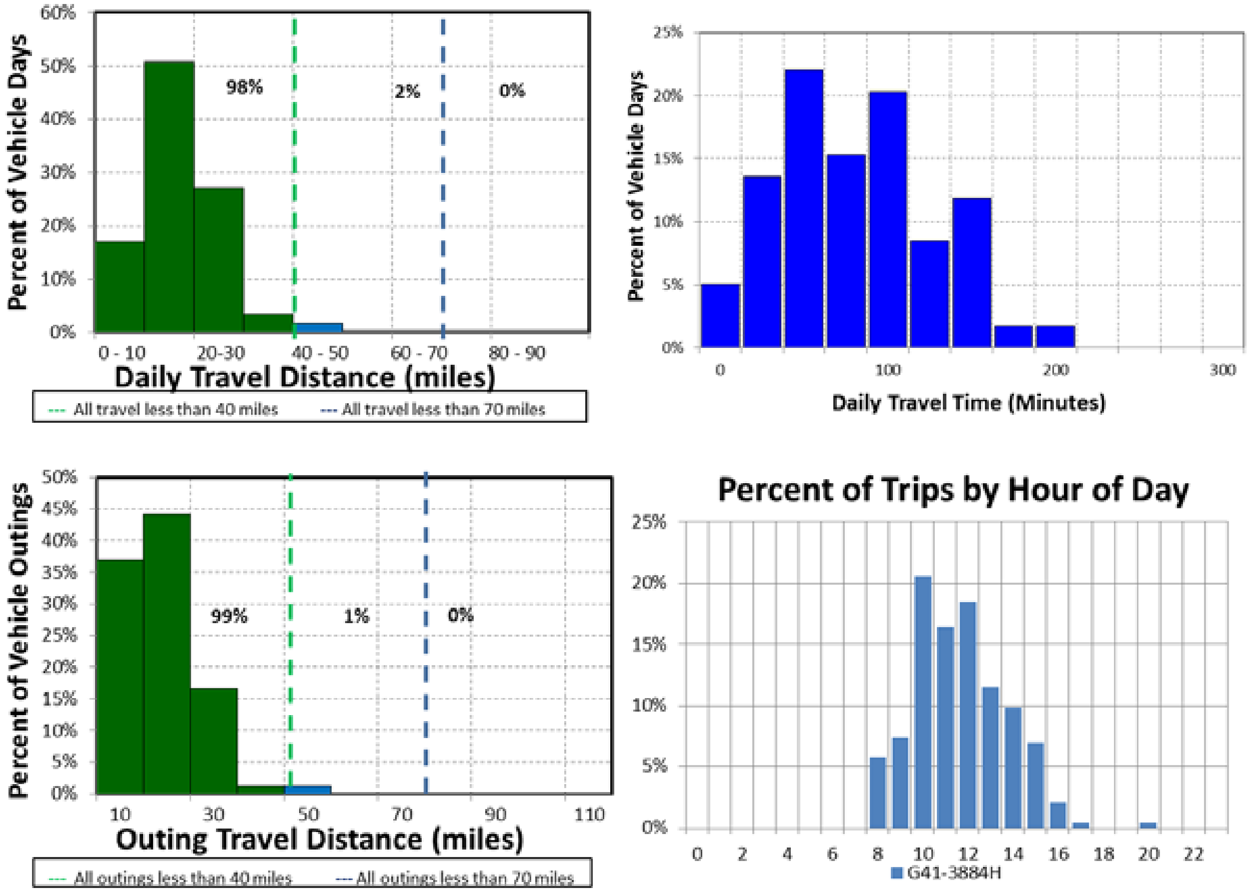


Figure B-24. Vehicle G41-3884H travel graphs

Vehicle G41-3884H Observations

Logger 39 reported data on this vehicle for 59 days of the 104-day study period. Validation occurred on 98.0% of the input data. VA - Manhattan reports this vehicle has a support mission as a HBPC (home based primary care). This vehicle's data indicates it parks near the VA Medical Center as noted in Figure B-22.

VA - Manhattan reports the vehicle odometer indicated 36,427 miles during the study but annual mileage information was not provided. Based upon model year, it is estimated at 14,500 miles. The vehicle was used on 57% of available days with an average daily usage of 1.6 hours and a peak daily usage of 3.5 hours on the days it was used. The vehicle is used during typical day shift hours.

Figure B-24 shows 100% of daily travel and 100% of outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 98% of daily travel and 99% of all outings are within the typically advertised CD mode for PHEVs of 40 miles.

A BEV could meet the all the daily travel requirements. A PHEV could provide benefits nearly all travel. BEV models are available as replacements for this compact sedan.

Vehicle G10-9480K

		
	Make / Model / Year	Ford Fusion Hybrid/2011
	EPA Class Size	Sedan - Midsize
	Mission	Pool
	Vehicle Identification Number (VIN):	3FADPOL37BR123936
	Parking Location	Asser Levy Pl/23 or 25 St
	Fleet Vehicle ID	G10-9480K
	Fuel Type	Gas
	EPA Label / MPG (City/Hwy)	41/36/39
	EPA GHG Emissions (Grams CO2/Mi)	228
	Study Logger ID	40
	Total Vehicle Days / Total Study Days	46/105

Vehicle G10-9480K Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	10.8/34.1	5.0/21.4	0.9/7.0	495
Travel Time (Minutes)	24.0/85.0	11.1/82.0	1.9/63.0	1,094
Idle Time (Minutes)	2.6/NA	1.2/NA	0.2/NA	118

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
< 10	231	90.9%	< 2	170
10 – 20	23	9.1%	2 – 4	7
20 – 40	0	0%	4 – 8	33
> 40	0	0%	> 8	44

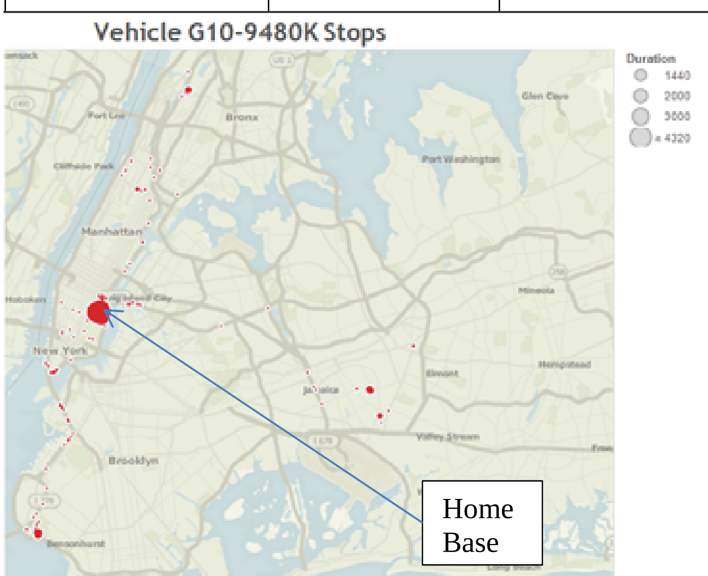


Figure B-25. Vehicle G10-9480K stops

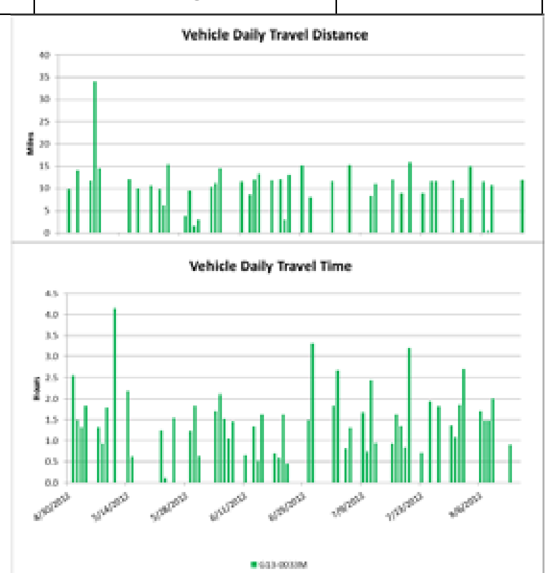


Figure B-26. Vehicle G10-9480K history

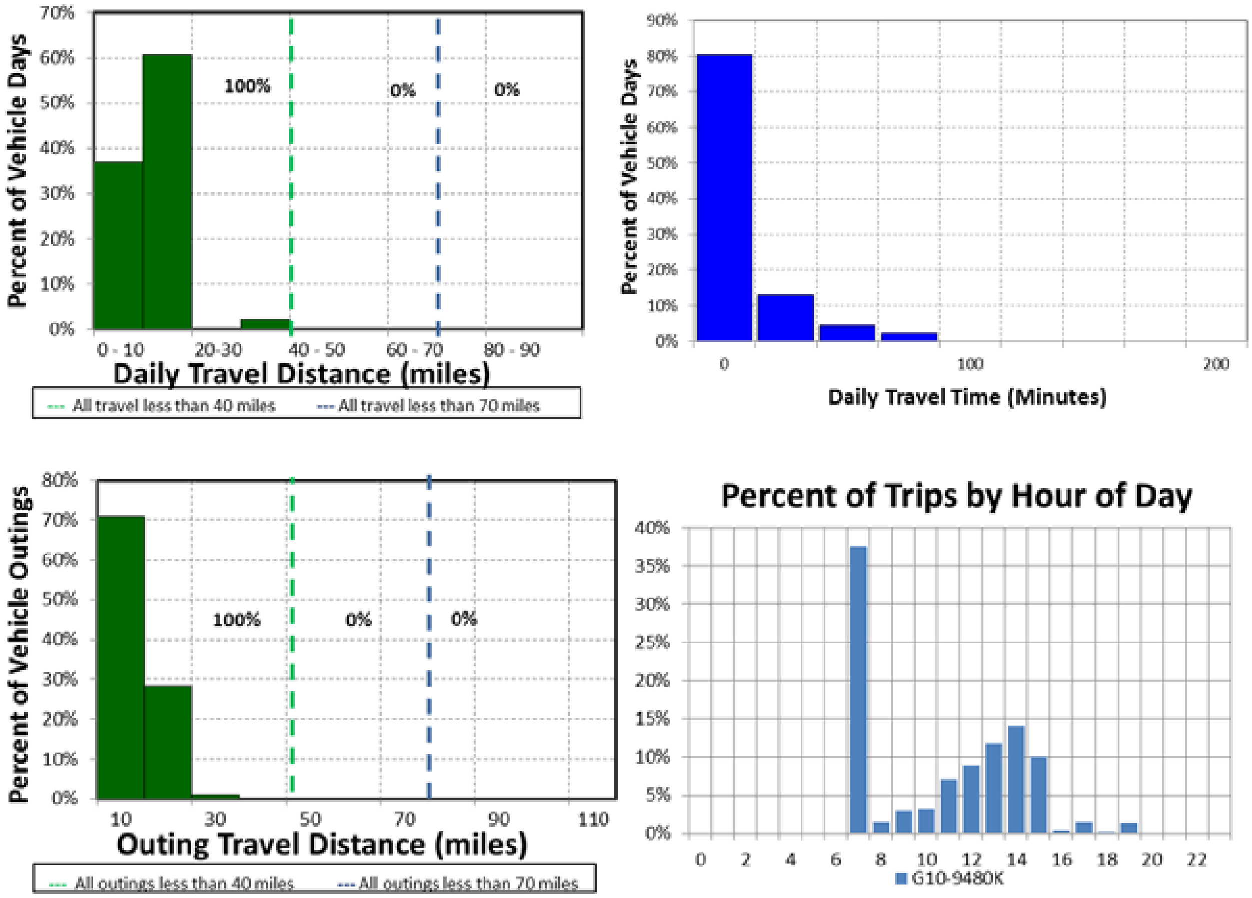


Figure B-27. Vehicle G10-9480K travel graphs

Vehicle G10-9480K Observations

Logger 40 collected data on this vehicle for 46 days of the 105-day study period. Validation occurred on 96.7% of the input data. VA - Manhattan reports this vehicle indicated that it has a pool mission for the executive office. This vehicle's data indicates it parks near the VA Medical Center as shown in Figure B-25.

VA - Manhattan reports the vehicle odometer indicated 7,413 miles during the study but annual mileage information was not provided. The vehicle was used on 44% of available days with an average daily usage of 0.4 hours and a peak daily usage of 1.4 hours on the days it was used. The vehicle is used during typical day shift hours.

Figure B-27 shows 100% of daily travel and 100% of outings are within the typically advertised range of a BEV of approximately 70 miles. Further, 100% of daily travel and 100% of outings are within the typically advertised CD mode for PHEVs of 40 miles.

A BEV could meet the all the daily travel requirements. A PHEV could provide benefits nearly all travel. BEV models are available as replacements for this midsize sedan.

Appendix C – National Fuel Cost and GHG Savings

Section 5 notes that fuel cost and GHG savings are calculated on a local and a national basis. Local savings are of higher interest to the facility while national figures are of higher interest in evaluating all sites. Section 5 provides the savings on the local level. Table C-1 presents these savings on a national basis for the PEV replacement of monitored vehicles.

Table C-1. Fuel cost and GHG savings on a national basis

Mission	Replacement Model	Extrapolated National Yearly CO_2e Avoided (lb-CO_2e/year)	% reduction	Extrapolated National Yearly Fuel Cost Reduction	% reduction
Pool	Ford Fusion PHEV	1,675	35%	$555	74%
Pool	Ford Fusion PHEV	(872)	-10%	$779	55%
Pool	Chevrolet Volt PHEV	640	17%	$387	66%
Pool	Ford Focus BEV	3,287	39%	$1,012	75%
Pool	NA	NA	NA	NA	NA
Pool	NA	NA	NA	NA	NA
Support	Ford Focus BEV	696	27%	$289	70%
Support	Toyota Rav4	5,578	36%	$1,804	74%
Pool	Nissan Leaf	395	11%	$365	64%
	Total	**11,398**	**24%**	**$5,192**	**69%**

Note that while the Ford Fusion PHEV as a replacement for the Ford Fusion Hybrid provides a reduction in GHG locally, as shown in Section 6, it produces more GHG using national figures. This is because the power plant emissions in the Consolidated Edison service territory are less than the national average. It is also noted that even though the hybrid has excellent fuel economy, the reliance on electricity for fuel for 86% of its miles provides significant fuel cost savings.

As presented in Section 5, 15 BEVs and 23 PHEVs could replace 38 of the pool fleet of 60 vehicles while retaining the 22 passenger vans. The support fleet of 25 vehicles would retain four heavy-duty trucks and replace the balance with 15 BEVs and 6PHEVs. Using an average savings per vehicle, Table C-2 provides the avoided GHG and fuel cost savings should these replacements occur.

Table C-2. Extrapolated greenhouse gas emissions avoided and fuel cost savings for the entire fleet

Mission	Extrapolated U.S. Yearly CO_2e Avoided (lb-CO_2e/year)	% reduction	Extrapolated U.S. Yearly Fuel Cost Reduction ($/year	% reduction
Pool	79,409	26%	$38,580	71%
Support	42,746	29%	$16,782	72%
Total	122,155	27%	$55,362	71%