INL/EXT-14-32202

AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for the United States Forest Service: Caribou-Targhee National Forest

Stephen Schey
Jim Francfort
Ian Nienhueser

June 2014

Idaho National Laboratory

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

INL/EXT-14-32202

AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for the United States Forest Service: Caribou-Targhee National Forest

Stephen Schey
Jim Francfort[2]
Ian Nienhueser[3]

[1]Project Manager, Infrastructure Planning and Analysis, Intertek Testing Services, North America; Phoenix, Arizona
[2]Vehicle Systems Principal Investigator, Idaho National Laboratory operated by Battelle Energy Alliance, Idaho Falls, Idaho
[3]Data Analyst, Intertek Testing Services, North America, Phoenix, Arizona

June 2014

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://avt.inl.gov

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 the U.S. Department of Energy's Advanced Vehicle Testing Activity. Battelle Energy Alliance, LLC contracted with Intertek Testing Services, North America (ITSNA) 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 use of advanced electric drive vehicle transportation.

This report focuses on the fleet in the Caribou-Targhee National Forest 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 into the agencies' fleets.

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

ITSNA acknowledges the support of Idaho National Laboratory and CTNF for participation in the study.

ITSNA is pleased to provide this report and is encouraged by the enthusiasm and support from the U.S. Forest Service and CTNF personnel.

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 vehicles in terms of energy efficiency, reduced petroleum consumption, and reduced production of greenhouse gas emissions, and they provide performance benefits with quieter, smoother operation. This study evaluated the extent to which the Caribou-Targhee National Forest (CTNF) could convert part or all of their fleet of vehicles from petroleum-fueled vehicles to PEVs.

BEVs provide the greatest benefit when it comes to fuel and emissions savings because all motive power is provided by the energy stored in the onboard battery pack. These vehicles use no petroleum for transportation and emit no pollutants at their point of use.

PHEVs provide similar savings when their batteries provide motive power; however, they also have the ability to extend their operating range with an onboard internal combustion engine. Because a PHEV can meet all transportation range needs, the adoption of a PHEV will be dependent on its ability to meet other transportation needs such as cargo or passenger carrying. Operation of PHEVs on battery-only mode can be increased with opportunity charging at available charging stations. 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.

CTNF contains over three million acres of land and stretches across southeastern Idaho, northeast Utah, and western Wyoming. The geographic size of CTNF creates significant travel demands on its vehicle fleet, but it also provides opportunities for conversion of some vehicles to PEVs. CTNF identified 132 vehicles in its fleet, with 12 of those vehicles being identified as representative of the fleet and instrumented for data collection and analysis. Fleet vehicle mission categories are defined; and, while CTNF vehicles conduct many different missions, two missions (i.e., support and pool) were selected by agency management to be part of this fleet evaluation. These two mission categories accounted for 89 of the 132 total fleet vehicles.

This report observes that a mix of BEVs and PHEVs are capable of performing most of the required missions and 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 greenhouse gases and petroleum use and reducing fleet operating costs.

PEVs that currently are commercially available cannot replace certain vehicles and missions, such as those requiring heavy-duty trucks and vans (some of which were included in this study). However, based on the data collected for the monitored vehicles and extrapolating it to the 89 vehicles, the fleet could possibly consist of 16 heavy-duty pickups, 28 BEVs, and 45 PHEVs.

Electric power generation in the Idaho Falls region heavily relies on hydroelectric sources. This increases the potential benefits of PEVs because the cost of generation is low, resulting in greater fuel savings, and power generation is cleaner, resulting in greater greenhouse gas reduction. In fact, replacement of the 73 internal combustion vehicles with PEVs could result in a potential annual fuel savings of over $70,000 (91% reduction) and greenhouse gas savings over 420,000 lb CO_2e (94% reduction).

PEV charging stations could be located in various locations within CTNF and could benefit not only their own fleet vehicles but also PEVs operated by the visiting public.

CONTENTS

FIGURES

TABLES

ACRONYMS

AC	alternating current
BEA	Battelle Energy Alliance, LLC
BEV	battery electric vehicle
CTNF	Caribou-Targhee National Forest
DC	direct current
EPA	U.S. Environmental Protection Agency
EVSE	electric vehicle supply equipment
GHG	greenhouse gas emissions
GSA	General Services Administration
ICE	internal combustion engine
ITSNA	Intertek Testing Services, North America
PEV	plug-in electric vehicle (includes BEVs and PHEVs, but not hybrid electric vehicles)
PHEV	plug-in hybrid electric vehicle
SUV	sport utility vehicle

AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for the United States Forest Service: Caribou-Targhee National Forest

1. INTRODUCTION

Federal agencies are mandated by the Energy Policy Act of 1992[1], Energy Policy Act of 2005[2], Executive Order 13423 (President Bush 2007)[3], and the Energy Independence and Security Act of 2007[4] to purchase alternative fuel vehicles, increase consumption of alternative fuels, and reduce petroleum consumption.

Battelle Energy Alliance, LLC (BEA), managing and operating contractor for Idaho National Laboratory, is the lead laboratory for the U.S. Department of Energy's advanced vehicle testing and manages the Advanced Vehicle Testing Activity's 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 through use of electric-drive vehicles. BEA selected Intertek Testing Services, North America (ITSNA) 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.

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 referred to as 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.

The Caribou-Targhee National Forest (CTNF), combined from the individual Caribou and Targhee National Forests in 2000, contains over three million acres of land (Figures 1 and 2) and stretches across southeastern Idaho, northeast Utah, and western Wyoming[5]. Known for its scenic beauty, wilderness areas, trails, campgrounds, and varied recreational uses, there were approximately 1,557,000 site visits in fiscal year 2005 (the most recently reported data).[6]

CTNF is an excellent site for fleet evaluation, not only due to its size, diversity of terrain, and vehicle types, but because of its accessibility by the public. CTNF has an opportunity to be a leader in the adoption of BEVs and PHEVs for its fleet.

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

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

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

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

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

[5] http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5370788.pdf [accessed April 16, 2014].

[6] http://apps.fs.usda.gov/nrm/nvum/results/ReportCache/Rnd2_A04015_Master_Report.pdf [accessed April 16, 2014].

- 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.[7]

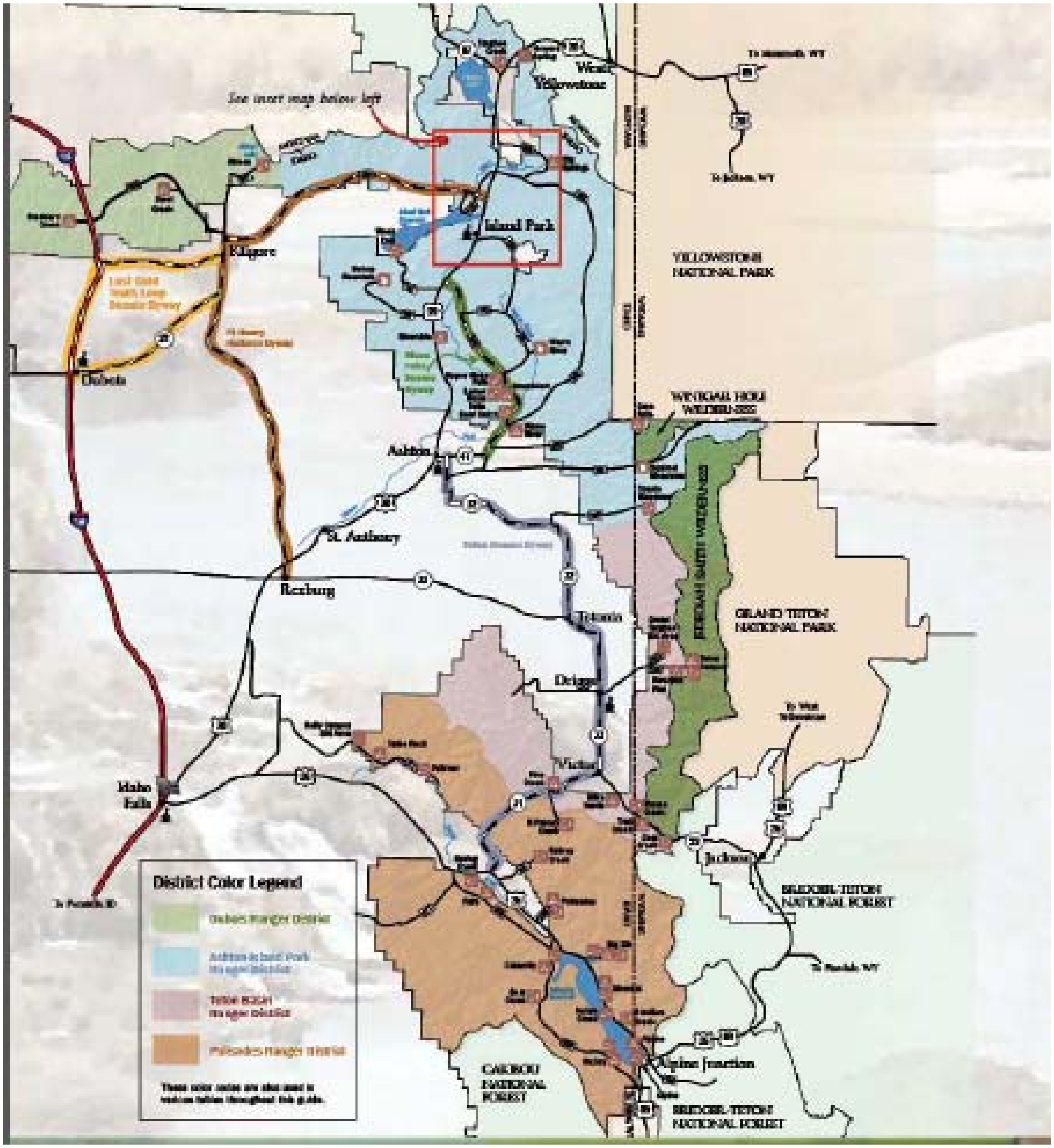


Figure 1. Targhee portion of Caribou-Targhee National Forest.

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

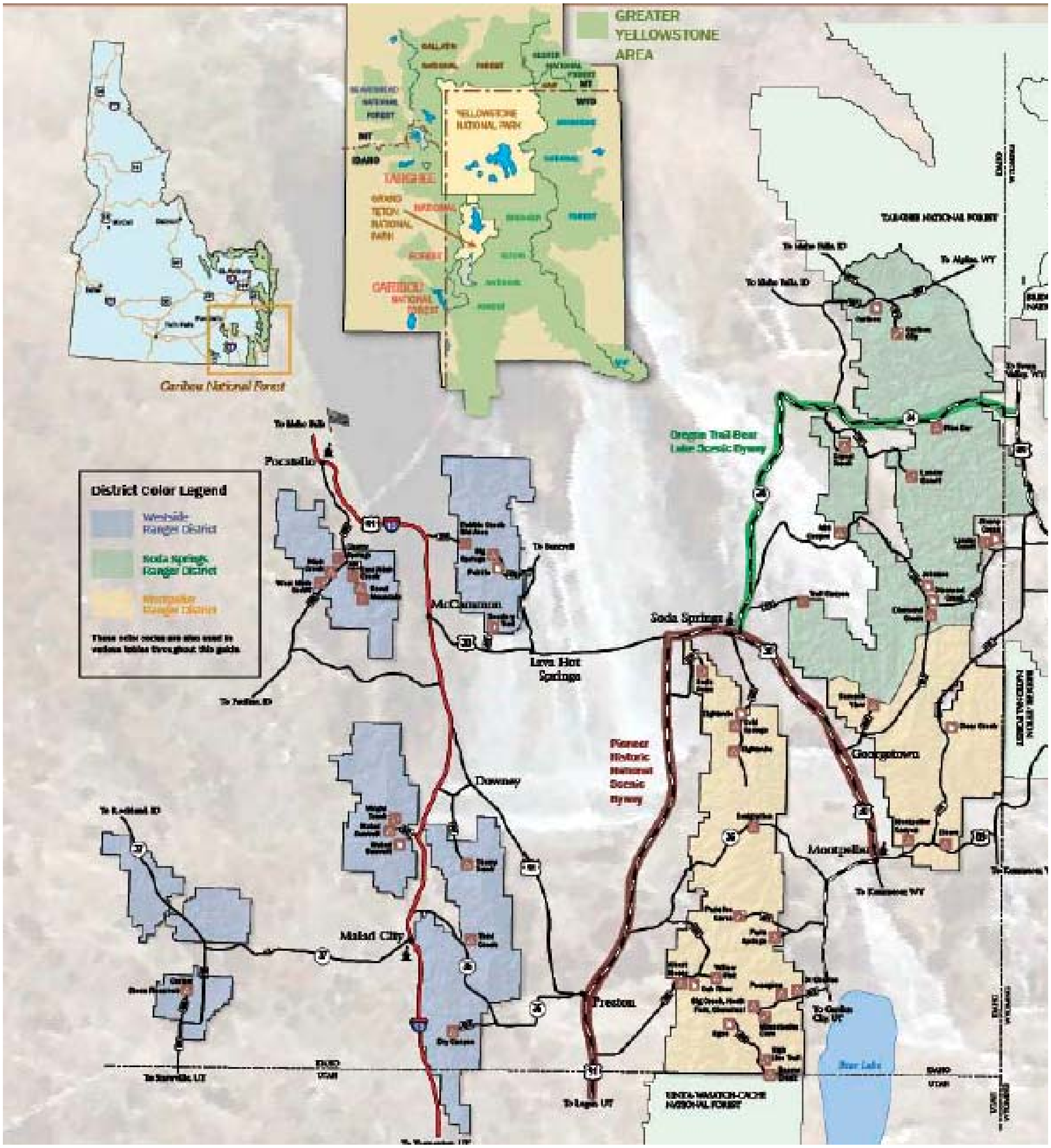


Figure 2. Caribou portion of Caribou-Targhee National Forest.

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.[8]

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

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 the 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/Idaho National Laboratory and the U.S. Department of Energy. The aggregated results for all agencies' fleets will provide an overview of federal fleets, vehicle missions, vehicle uses, and agency 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 annual mileage driven. This information was collected using the vehicle information form shown in Appendix A.

CTNF identified 132 fleet vehicles (as shown in Table 1). (Note that Section 4 provides descriptions of the vehicle mission types.) ITSNA coordinated with the CTNF fleet manager to identify the specific vehicles for data collection for inclusion in the study. The fleet manager assessed their wide range of light-duty vehicles and made selections of high-interest 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. ITSNA received no reports of depleted batteries during the study at CTNF. Twelve vehicles were selected, with two of them being pool vehicles and ten being support vehicles.

Table 1. Fleet evaluation.

Vehicle Mission	Study Vehicles	Total Fleet Reported	Percentage Studied
Pool Vehicles	2	7	28.5%
Enforcement Vehicles	—	10	0%
Support Vehicles	10	82	12.2%
Transport Vehicles	—	16	0%
Specialty Vehicles	—	17	0%
Shuttle/Bus	—	0	0%
Low-Speed Vehicles	—	0	0%
Total Fleet Vehicles	12	132	9.1%

3.2 Data Collection

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

3.2.1 Data Logger

Non-intrusive data loggers, produced by InTouchMVC[9] and depicted in Figure 3, were inserted into the vehicle's onboard diagnostic port to collect and transmit the relevant data. Installation of the data logger and 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 every 1 minute during vehicle operation and transmit by cellular communication to the data center.

Figure 3. InTouchMVC data logger.

ITSNA 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 reception, logger device removal, or extended periods in regions with insufficient cellular reception. ITSNA filters the

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

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.

CTNF requested and installed twelve data loggers into their fleet vehicles (i.e., two pool vehicles and 10 support vehicles).

The agency removed and shipped the data loggers to ITSNA 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 1 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*: A null value is a data record unusable for analysis for various reasons.

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 extrapolation occurred to provide the overall fleet usage and benefit analysis when fleet information was provided. Section 6 presents these benefits. ITSNA observations are included in Section 7.

Statistical data analysis uses Python 2.7 with the MATLAB Plotting Library graphics environment (Matplotlib) and spatial display with ESRI ArcGIS.[10] Frequency distributions summarize the travel behavior of each vehicle and vehicle mission during the study period. Rounding of the tables and figures are to three significant digits.

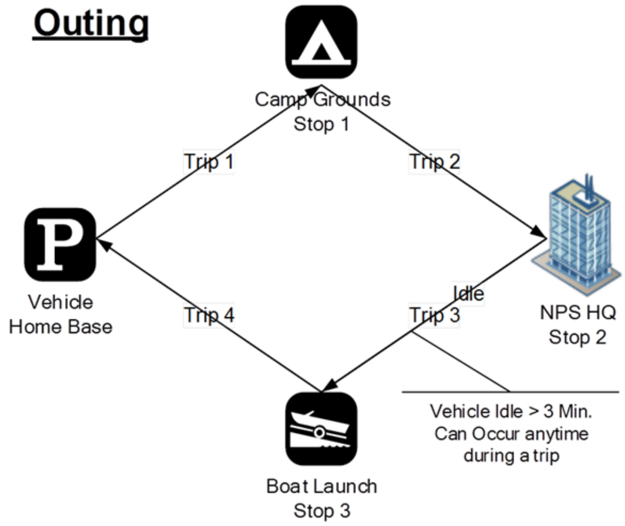


Figure 4. Vehicle outing.

4. VEHICLES

4.1 Vehicle Missions

The vehicle mission's 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, the participating agency use, and general vehicle use. Based on fleet information gathered, ITSNA has established the following seven mission/vehicle categories for analysis (shown 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.

[10] www.esri.com [accessed January 10, 2014].

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:** 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, CTNF has a unique opportunity to plan for the adoption of BEVs and PHEVs, along with planning for supporting infrastructure. The adoption of PHEVs and BEVs is a primary goal of 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.

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 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, although all have a charge-depleting mode in which the battery is depleted of its stored energy to propel the vehicle, and a charge-sustaining mode (or extended range mode) in which the battery assists the ICE but the latter provides the majority of the propulsion power and the state of charge is maintained between set limits. Some PHEVs exhibit completely all-electric charge-depleting modes, while others have a blended charge-depleting mode in which both the battery and the ICE provide propulsion power while the battery depletes.

Table 2. General Services Administration vehicle replacement requirements.

GSA Vehicle Replacement Requirements[11]			
	Fuel Type	Years	Miles
Passenger vehicles	Gasoline or alternative fuel vehicle	3 and 4 and 5 and Any year and	36,000 24,000 Any miles 75,000
	Hybrid	5 and	Any miles
	Low-speed BEV	6 and	Any miles
Light trucks 4 x 2	Non-diesel	7 or	65,000
	Diesel	8 or	150,000
	Hybrid	7 and	Any miles
Light trucks 4 x 4	Non-diesel	7 or	60,000
	Diesel	8 or	150,000
	Hybrid	7 and	Any miles

4.3.1 Battery Electric Vehicle/Electric Vehicle Benefits/Challenges[12]

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

- **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.
- **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.

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

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

4.3.2 Plug-in Hybrid Electric Vehicle Benefits/Challenges[13]

- **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 GHG 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 uses 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 have offered incentives to encourage the use and adoption of BEVs and PHEVs. Some original equipment manufacturers 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[14], 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 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. The Nissan Leaf, Ford Transit Connect, 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, and need should be completed.

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

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

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

Table 3.General Services Administration-certified battery electric vehicles/plug-in electric vehicles.

Make/Model	GSA Class	Type	City/Highway	GSA Incremental Price
Chevrolet Volt	Sedan, subcompact	PHEV	101/93 MPGe	$17,087.18
Ford C-MAX Energi	Sedan, subcompact	PHEV	108/92 MPGe	$14,899.52
Ford Focus Electric	Sedan, subcompact	BEV	110/99 MPGe	$16,573.09
Ford Fusion Energi	Sedan, compact	PHEV	108/92 MPGe	$19,289.99

Table 4. Original equipment manufacturer plug-in hybrid electric vehicle cars and availability.

Make	Model	Model Year
Audi	A3 eTron PHEV	2015 (estimate)
Chevrolet	Volt	2011
Honda	Accord PHEV	2013
Toyota	Prius PHEV	2012
Volvo	V60 Plug-in	2016 (estimate)
BMW	i3 with range extender	2015 (estimate)

Table 5. Original equipment manufacturer battery electric vehicle cars and availability.

Make	Model	Model Year
BMW	i3	2014
Chevrolet	Spark	2015
Fiat	500e	2014
Ford	Focus Electric	2012
Honda	Fit EV	2013
Kia	Soul EV	2015 (estimate)
Mercedes	B-Class E-Cell	2015 (estimate)
Nissan	LEAF	2011
smart	ED	2014
Tesla	Model S	2012
Tesla	Model X	2017 (estimate)
Volkswagen	Golf Blue-e-Motion	2015 (estimate)
Volvo	C30 Electric	2016 (estimate)

Table 6. Original equipment manufacturer plug-in hybrid electric vehicle trucks, vans, and availability.

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

Table 7. Original equipment manufacturer battery electric vehicle trucks, vans, and availability.

Make	Model	Model Year
Nissan	eNV200	2015 (estimate)
Toyota	RAV4 EV	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, which is an alternating current (AC) Level 2.

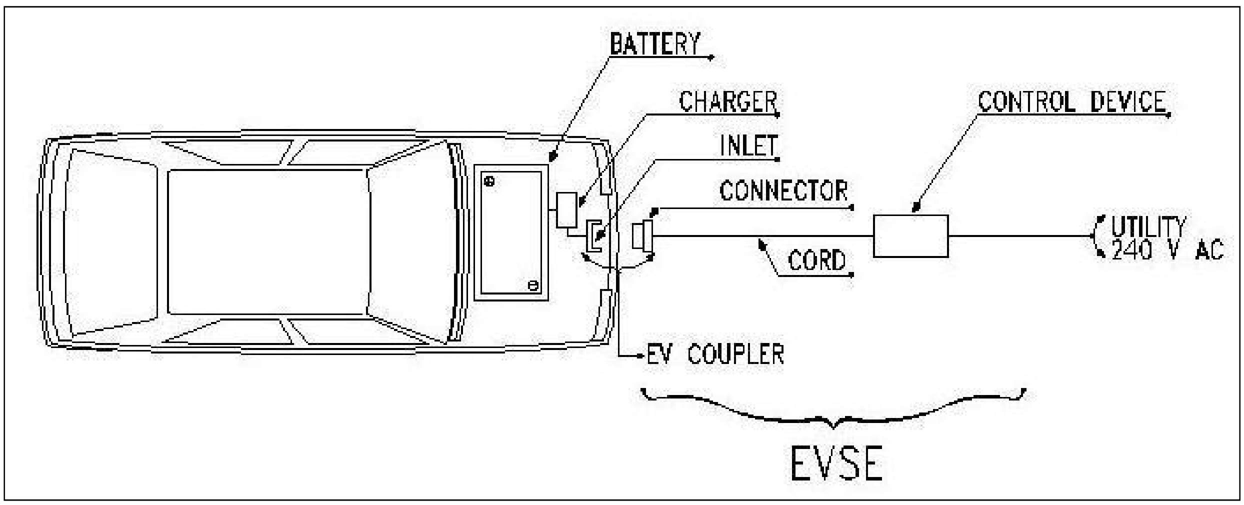


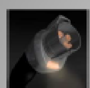
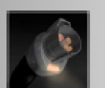
Figure 6. Alternating current Level 2 charging diagram.[15]

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 onboard or off-board the vehicle. Section 4.5.1.2 provides further explanation of the different EVSE configurations. For onboard conversion, AC current flows through the PEV inlet to the onboard 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 onboard the vehicle controls the battery rate of charge, among other functions. All current PEVs have an onboard charger; some BEVs (but no PHEVs currently) accommodate DC charging.

4.5.1.2 Charging Configurations and Ratings. The Society of Automotive Engineers standardized the requirements, configurations, and equipment followed by most PEV suppliers in the

[15]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].

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.

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.[16]

Most PEV manufacturers supply an AC Level 1 cordset 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 identifies a typical J1772-compliant inlet and connector for both AC Levels 1 and 2.

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 called the J1772 combo connector.

Some PEVs delivered in the United States prior to the approval of the J1772 standard for DC charging employed the CHAdeMO (designed in Japan) standard for connector and inlet design. Figure 10 shows this connector.

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 more typically provide DC inlets than PHEV suppliers do, because the rapid recharging provides opportunities for expanded vehicle range with

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

minimal operator wait times. PHEV operators can rely on the gasoline drive in the event they deplete the vehicle's 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 8. J1772 connector and inlet.[17]

Figure 9. J1772-compliant combo connector.[18]

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

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

Figure 10. CHAdeMO-compliant connector.[19]

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 Support 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 DC fast chargers 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[20].

Figure 11. Alternating current Level 2 electric vehicle support equipment.

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

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

DC fast chargers also are available from several manufacturers. Figure 12 illustrates one such charger.[21] This particular charger uses the CHAdeMO connector standard.

Figure 12. Direct current fast charger.

In general, installation costs are higher for the DC fast charger because of the higher voltage requirements and the inclusion of the AC to DC charger and other safety and design features. Costs for both types are 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 allow agency fleet vehicle use without direct payment. These systems also allow for accurate record keeping of vehicle charging requirements.

5. CARIBOU-TARGHEE NATIONAL FOREST ANALYSIS

5.1 Survey Results

Twelve vehicles were included in the study at CTNF. Two vehicles are pool vehicles (i.e., one sport utility vehicle [SUV] and one sedan) and ten are support vehicles (nine pickup trucks and one SUV). Table 8 presents a summary of these vehicles.

Table 8. Vehicle survey summary.

Mission	SUV	Truck	Sedans	Total
Pool	1	—	1	2
Support Vehicle	—	10	—	10
Other Vehicles	—	—	—	—
Total	1	10	1	12

Appendix D 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

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

PEV replacement. The missions of these two categories vary considerably; therefore, these two missions will be evaluated separately, because fleet-wide operations provide little useful information.

5.2 Data Validity

CTNF data collection took place from August 26, 2011, through June 7, 2012, in three separate stages. Vehicle data sheets (presented in Appendix D) detail the collected data for each vehicle.

Of the data collected, validation occurred for 98.5% of the data, while null values exist for the balance. Table 9 shows this information by mission type.

Table 9. Vehicle data logger reporting summary.

Vehicle Data Logger Reporting Summary			
Mission	% Collected	% Null Values	Total
Pool	99.3	0.7	100%
Support Vehicles	97.7	2.3	100%
All Vehicles	98.5	1.5	100%

5.3 Pool Vehicles Evaluation

5.3.1 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, vans, or small pickup trucks and typically do not carry specific cargo or equipment.

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.

5.3.2 Summary for Pool Vehicles

Appendix D provides the vehicle data sheets for each of the eight pool vehicles monitored. This section aggregates data for all pool vehicles. Table 10 summarizes pool travel during the study period for those days in which the vehicle was driven. Vehicle use occurred primarily between 0900 and 1900 hours daily. They traveled 5,362 miles, logged 111 hours, and idled for 3.9 hours during the 149-day study period.

Table 10. Pool vehicles travel summary.

Pool Vehicles Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	103.1/374.8	111.7/390.5	17.6/177.5	5,362.4
Travel Time (Minutes)	128.4/510.0	139.1/532.0	22.0/200.0	6,678.0
Idle Time (Minutes)	4.5/NA	4.9/NA	0.8/NA	235.0

5.3.3 Pool Vehicles Daily Summary

Figure 13 includes data for both pool vehicles and shows daily distance traveled by each vehicle, while Figure 14 provides the same for daily travel time. In Figure 13, the green line indicates typical electric range on a single charge for a PHEV, while the blue line indicates the same for a BEV. Figure 15 shows the composite history for both pool vehicles: that with fleet identification number 0427 and that numbered 0794.

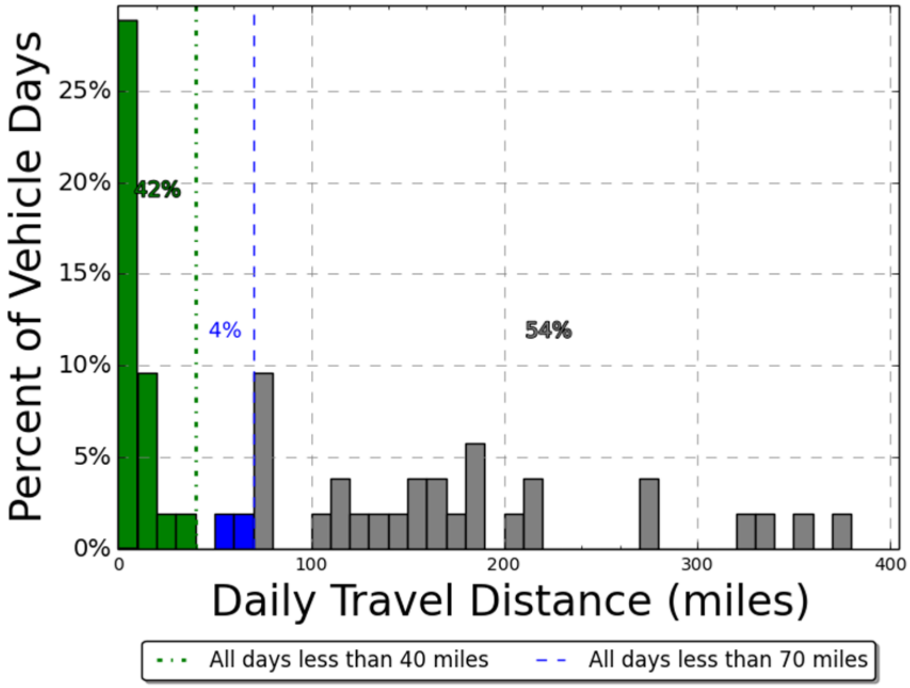


Figure 13. Pool vehicle daily travel miles (both vehicles).

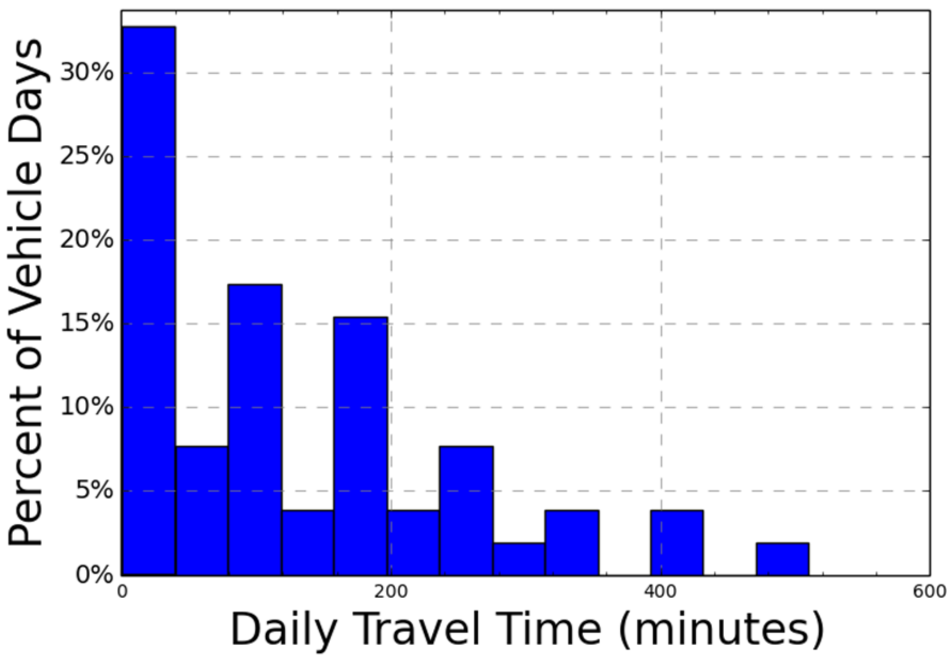


Figure 14. Pool vehicle daily travel time (both vehicles).

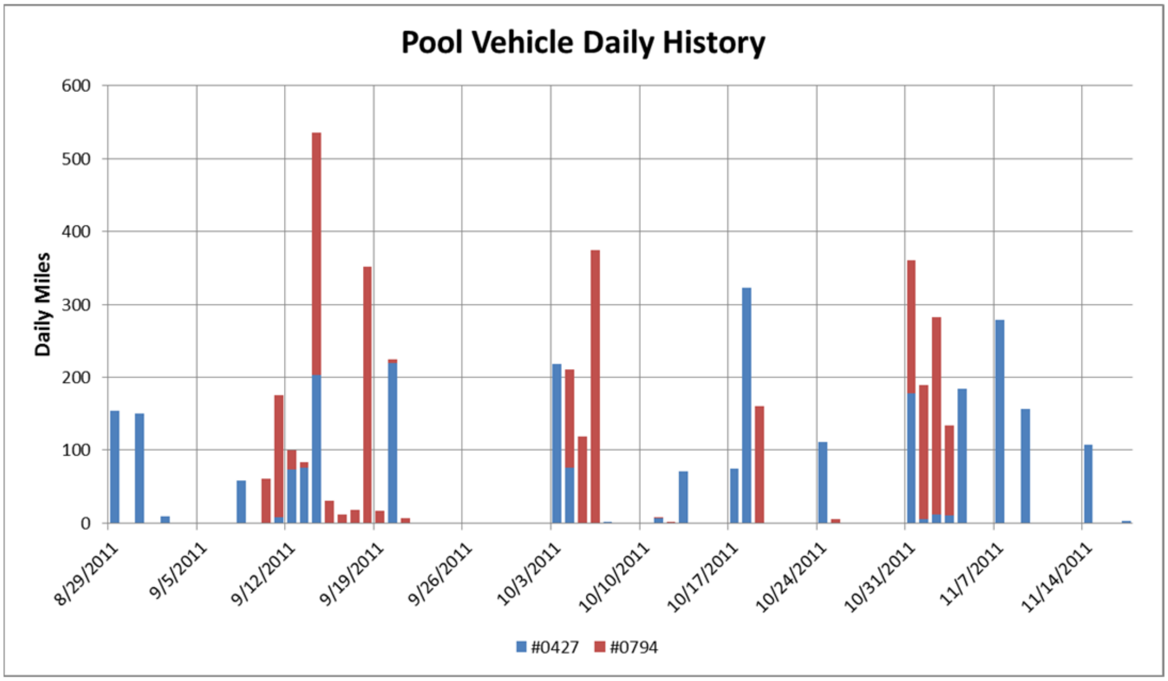


Figure 15. Pool vehicles travel history (all vehicles).

The average travel distance per day, when driven, for pool vehicles is 103.1 miles. On 46% 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. Fifty-four percent of pool daily travel is greater than 70 miles and 42% of vehicle travel days are less than 40 miles, which is considered to be within the battery-only range of a PHEV.

Figure 15 shows that the vehicles are not used every day. Vehicle 0427 was not driven 33% of the days monitored and Vehicle 0794 was not used 35% of the days. However, there are many periods where both vehicles operated several days in a row and there were days that both vehicles were in use. Figure 16 displays the summary of use by time of day for both pool vehicles.

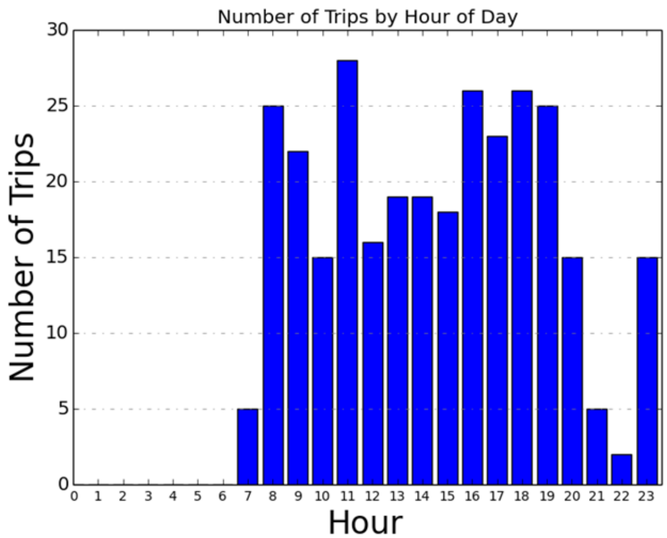


Figure 16. Pool vehicles hourly usage.

Figure 17 shows the outing distance traveled by each of the pool vehicles, including data for both vehicles.

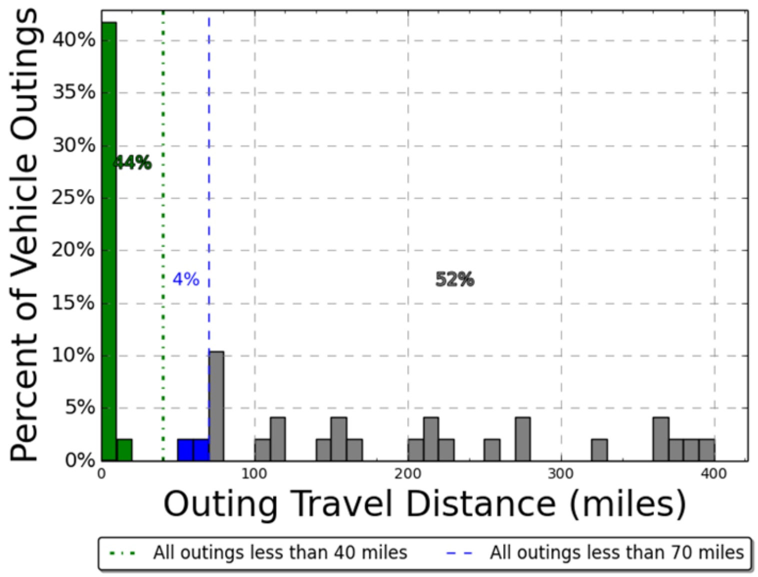


Figure 17. Pool vehicle outings.

Appendix D provides the details of each of the pool vehicle's daily travel. Both pool vehicles exceeded 70 miles of daily travel on a substantial percentage of all travel days. Appendix D also shows that vehicle 0427 had an outing that was greater than the daily travel, meaning it did not return to its home base within the same day.

The average travel outing for pool vehicles is 111.7 miles. On 48% of these vehicle outings, the distance traveled is less than the 70 miles considered to be within the BEV safe range. Fifty-two percent of pool outing travel is greater than 70 miles and 44% of vehicle travel outings are less than 40 miles, which is considered to be within the battery only range of a PHEV.

5.3.4 Pool Vehicle Observations/Summary

There appears to be three choices for CTNF in implementing PEVs into the pool fleet. Keep in mind that the optimum goal would be to incorporate as many BEVs as possible to realize the advantages of reduced petroleum usage and reduced emissions of GHG.

1. All BEV fleet: While some BEV manufacturers report vehicle range exceeding 70 miles, ITSNA 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 some of the daily outings.

   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. The data reveal that on 42% of all vehicle travel days, the total daily travel is less than 40 miles, which typically is the maximum distance a PHEV will travel on battery power only. This represents a significant operating cost savings opportunity, while retaining the ability to go longer distances when needed. Forty-four percent of the outings are less than 40 miles and could be completed on battery power if the battery is fully charged prior to the outing; 48% of the outings are within the typical capability of a BEV; therefore, 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.

2. 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. Data show that for a significant number of days, the PHEV will operate in a pure-electric mode. The first 40 miles of longer travel days also would be powered by electricity; therefore, 42% of all pool vehicle travel would be 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 pure-electric mode. Data show significant charging opportunities throughout the day during stop times.

While it would appear that PEVs are suitable replacements for some pool vehicles, additional mission analysis and management input is required. The missions of these vehicles likely include considerations other than mileage (such as cargo demands placed on the vehicle). Pool vehicles typically do not have such demands.

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. These stations also provide charging opportunities for the visiting public, whose fees may assist in offsetting operating costs.

ITSNA suggests further mission evaluation be given to pool vehicles when considering the adoption of BEVs and PHEVs. The fleet of pool vehicles in this study included one SUV and one sedan out of the seven total pool vehicles. Section 4.4 provides information on PEV SUVs and sedans currently or soon to be available in the automotive market. However, based on this travel information and providing a conservative approach to the pool fleet, ITSNA suggests that replacing these two vehicles with PHEVs would meet current mission requirements.

Considering the full complement of seven pool vehicles in the total fleet, ITSNA suggests that a mixed fleet may be possible. While the remaining vehicles were not monitored, approximately half the outings and daily travel are within the capability of the BEV. In addition, the vehicles monitored operated on about one-third of the days. A further analysis may be warranted, but ITSNA suggests that a fleet of two BEVs and five PHEVs would conservatively meet vehicle travel requirements. Typically, additional EVSE at frequent remote locations provides recharging for both the BEV and PHEV; however, there appear to be no consistent remote stop locations for either of these pool vehicles.

The types of vehicles monitored (i.e., sedan and SUV) are typical of pool vehicles. The above evaluation assumes the makeup of the balance of the pool fleet is similar.

5.3.5 Pool Vehicle Charging Needs

Upon review of these data, ITSNA suggests replacement of the pool fleet with two BEVs and five 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 DC fast charger at the home base will provide a more rapid recharge for BEVs, but it appears to be unnecessary if the fleet manager carefully assigns pool vehicles based on anticipated outing lengths.

As noted above, AC Level 2 overnight charging of BEVs is typical, whereas overnight charging of PHEVs uses the AC Level 1 outlet.

ITSNA’s experience suggests that each vehicle have an assigned charging location at their home base. Assigned stations require less management attention to ensure completion of overnight charging. BEVs and PHEVs not assigned to these locations also benefit during visits to the location as part of their normal operation. For the entire fleet of pool vehicles, two BEVs require two AC Level 2 EVSE units for overnight charging and five PHEVs require five AC Level 1 outlets for home base. ITSNA 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 electric vehicle mode.

At times, fleet vehicles obtain benefits from using public charging infrastructure. Figure 18 displays the availability of public charging at the time of this writing for the CTNF area. The green-colored sites are AC sites, indicating either AC Level 1 or Level 2 public locations.

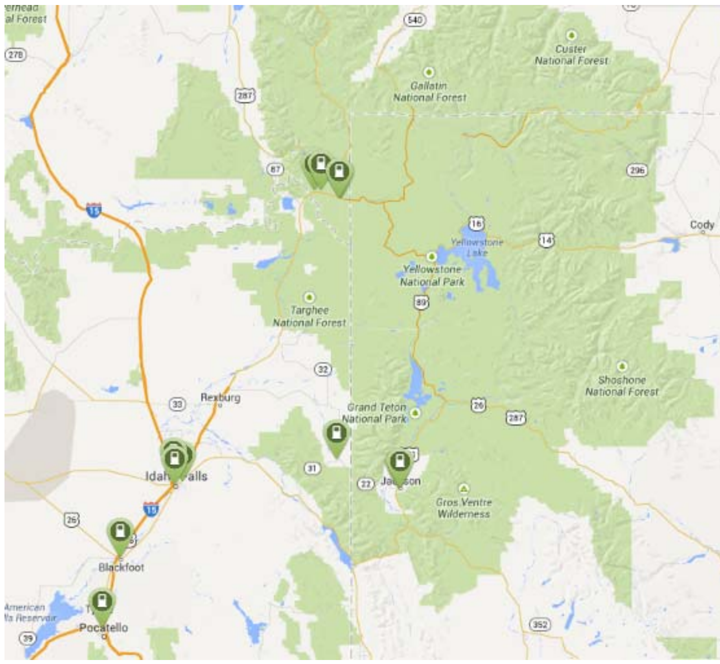


Figure 18. Public electric vehicle supply equipment in the Caribou-Targhee National Forest region.[22]

All stations in Figure 18 are AC Level 1, with the exception of AC Level 2 EVSE at the Nissan dealership, Idaho National Laboratory, and Idaho Falls Power. However, because these stations are not close to CTNF, they provide little benefit for additional charging.

5.4 Support Vehicles Evaluation

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.

5.4.1 Summary for Support Vehicles

Appendix D provides the vehicle data sheets for each of the 10 support vehicles monitored. Monitoring of these vehicles occurred over three separate date periods. This section aggregates the data for all support vehicles.

Table 11 summarizes support vehicle travel during the study period. Vehicle use occurred primarily between 0900 and 1900 hours daily. Support vehicles traveled over 25,300 miles, logged 803 hours, and idled for 196 hours during the study period.

[22] http://www.plugshare.com/ [accessed April 17, 2014].

Table 11. Support vehicle travel summary.

Support Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	87.8/696.8	44.5/1,562.4	14.7/191.4	25,307
Travel Time (Minutes)	167.4/796.0	84.7/3,132.0	28.0/458.0	48,198
Idle Time (Minutes)	40.7/NA	20.6/NA	6.8/NA	11,733

5.4.2 Support Vehicle Daily Summary

Figure 19 includes data for all of the support vehicles and shows daily distance traveled by each vehicle, while Figure 20 provides the same for the daily travel time. In Figure 19, the green line indicates the typical electric range on a single charge for a PHEV, while the blue line indicates the same for a BEV. Figures 21, 22, and 23 show the composite history for all support vehicles, identifying the daily distance traveled by each vehicle.

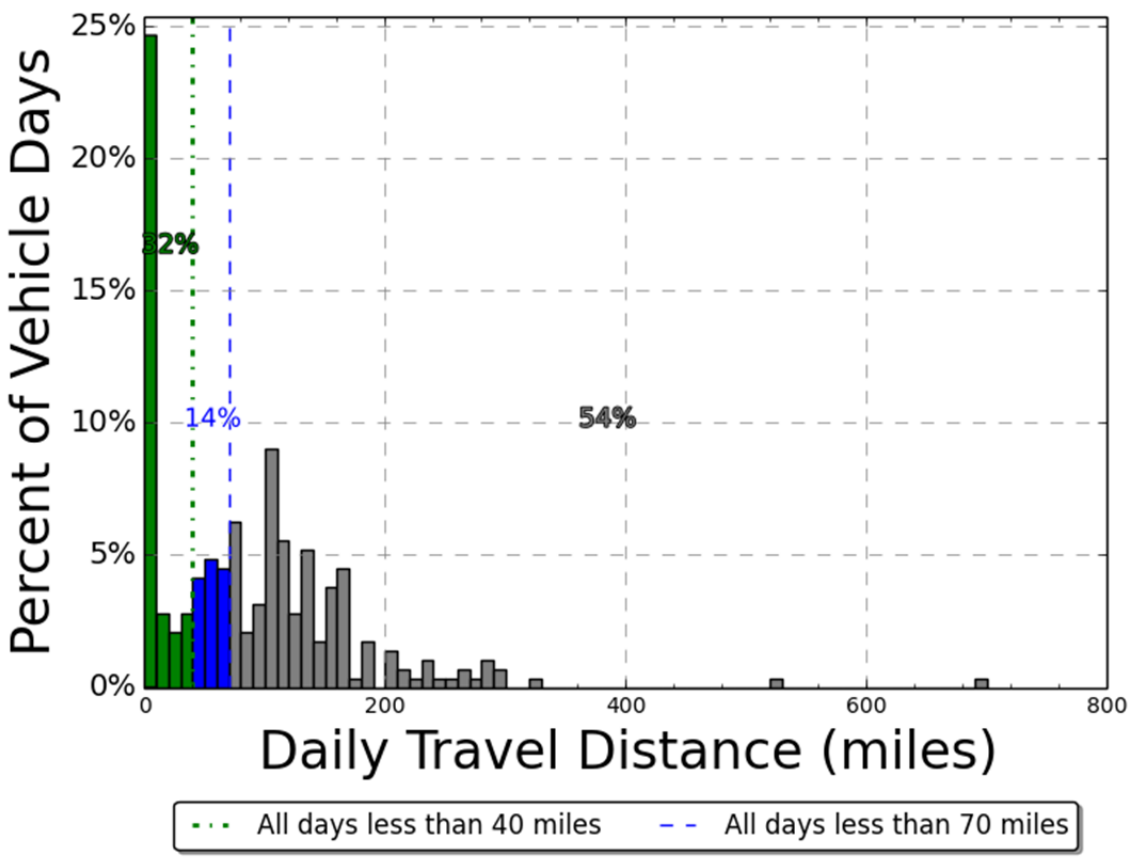


Figure 19. Support vehicle daily travel miles (all vehicles).

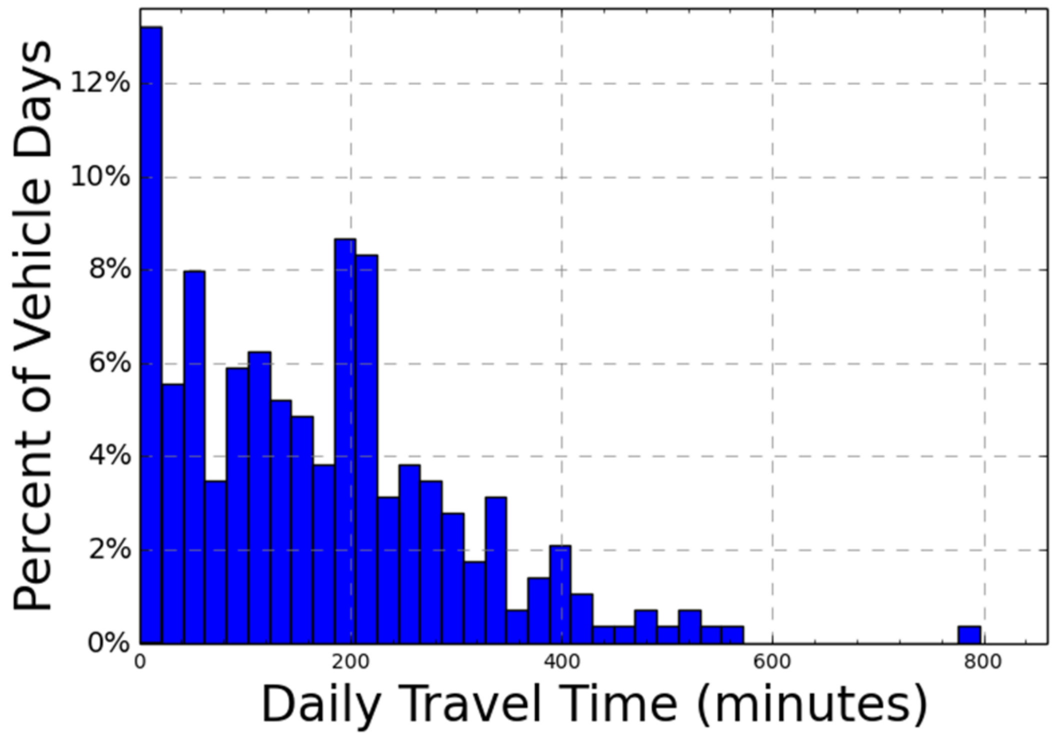


Figure 20. Support vehicle daily usage time (all vehicles).

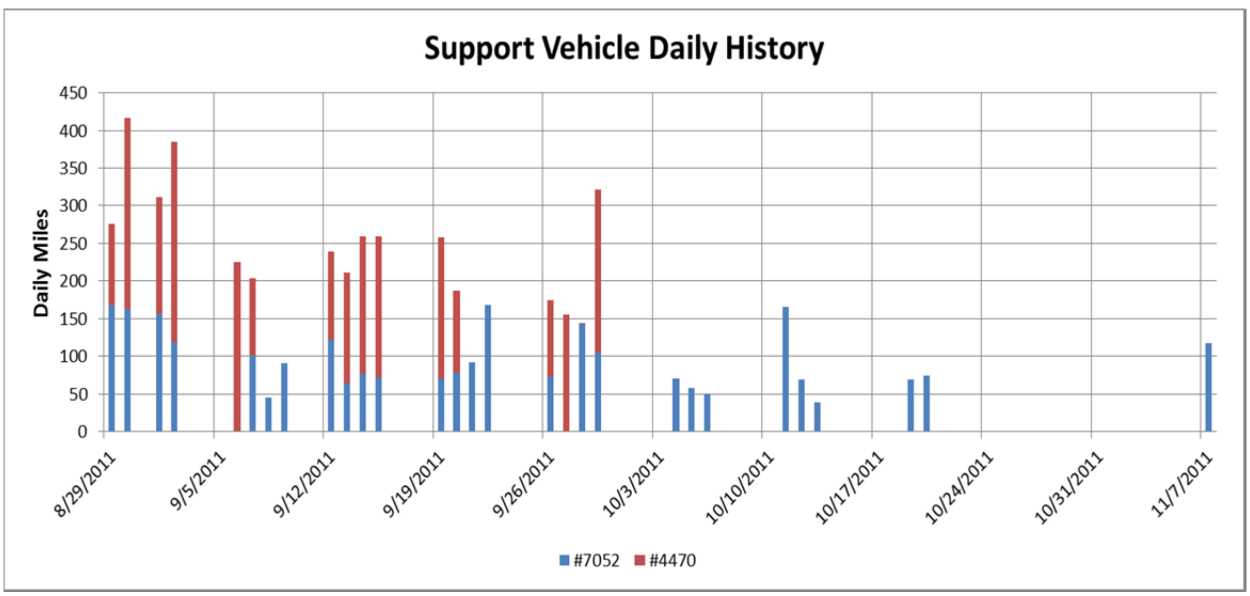


Figure 21. Support vehicle history (Vehicles 7052 and 0427).

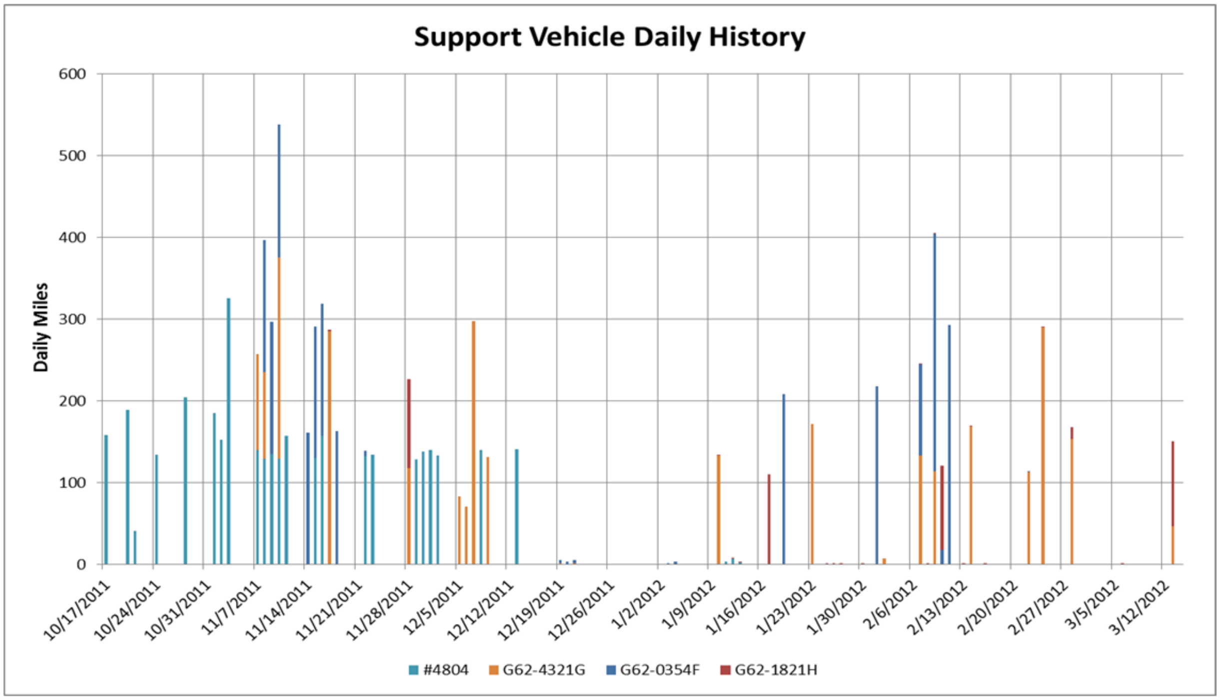


Figure 22. Support vehicle history (four vehicles).

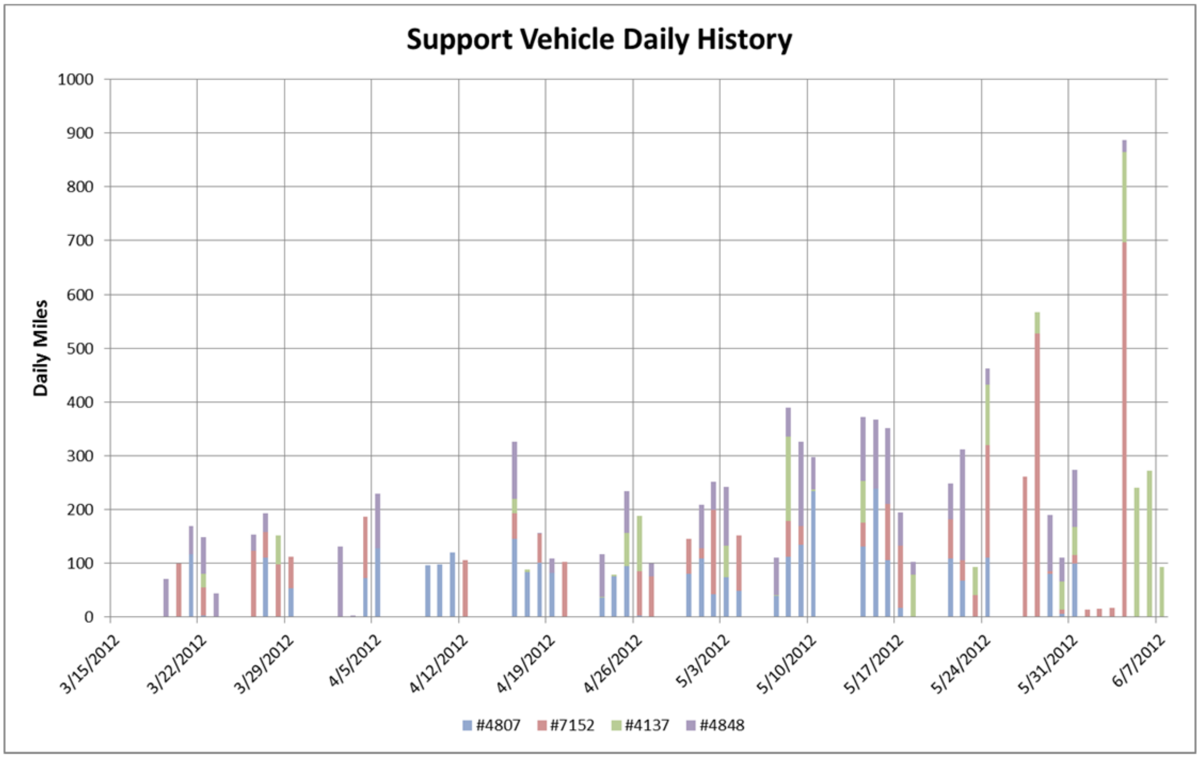


Figure 23. Support vehicle history (four vehicles).

The history graphs identify when several support vehicles may be in use at the same time and the total miles driven.

The average travel distance per day, when driven, by a support vehicle is 87.9 miles. On 46% of these vehicle days, the daily travel is less than the 70 miles considered to be within the BEV safe range. Fifty-four percent of support vehicle daily travel is greater than 70 miles and 32% of vehicle travel days are less than 40 miles, which is considered to be within the battery only range of a PHEV.

Figures 21, 22, and 23 show that the vehicles are not used every day. For example, Vehicles #4804, G62-4321G, G62-0354, and G62-1821H are unused 80% of the days monitored. The rest are unused between 40 and 67% of the days. However, there are many periods where several vehicles operated several days in a row and days that several vehicles are in use at the same time.

Figure 24 displays the summary of use by time of day for all support vehicles combined.

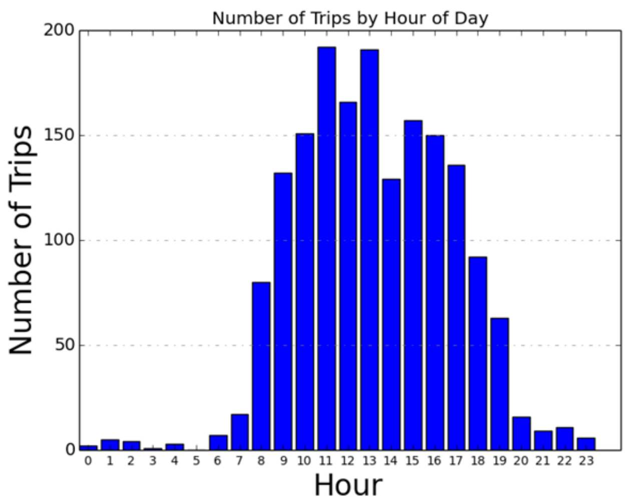


Figure 24. Support vehicles hourly usage.

Figure 25 shows the individual outing distances for all support vehicles. The distance scale allows identification of the longest single outing of 1,562 miles by Vehicle #7152.

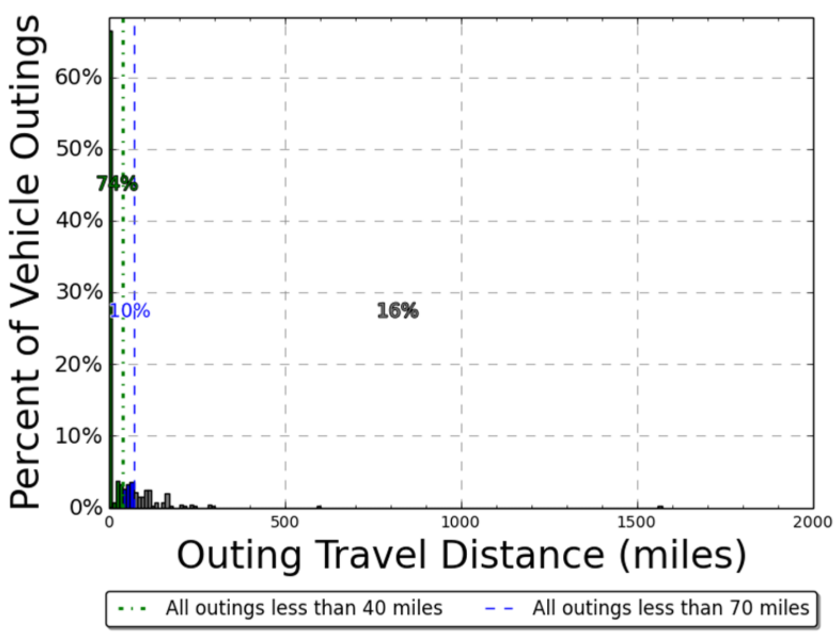


Figure 25. Support vehicle outings.

Appendix D provides the details of each of the support vehicle's daily travel. At some point during the evaluation period, all support vehicles exceeded 70 miles of daily travel on a substantial percentage of all travel days. Appendix D also shows that several vehicles had outings that were significantly beyond the 70-mile range of a BEV.

The average travel outing for support vehicles is 44.5 miles. On 84% of these vehicle outings, the distance traveled was less than the 70 miles considered to be within the BEV safe range. Sixteen percent of support travel is greater than 70 miles. However, some of these outings are significantly longer than this range, with the longest outing being 1,562 miles. Seventy-four percent of vehicle travel outings are less than 40 miles, which is considered to be within the battery-only range of a PHEV.

5.4.3 Support Vehicle Observations/Summary

As a group, the support vehicles have frequent daily travel distances exceeding 70 miles. Each vehicle exceeded the 70-mile range on some days. Several vehicles had average outings exceeding 70 miles, including Vehicles #7052, #4470, #4804, G62-4321G, and G62-0354F. The rest had average outings within the 70-mile range. Certainly, the unusual high outing distances added considerably to the average value for these five vehicles.

All of the support vehicles are pickup trucks, with the exception of one SUV. Two of the pickup trucks are heavier-duty diesel trucks. Pickup trucks are a popular choice for a support vehicle because they are versatile to the various types of support needed (e.g., special cargo or equipment transport). In some cases, as seen here, SUVs or mini-vans can perform the same mission. Section 4.4 provides information on PEV trucks and vans currently or soon to be available.[23]

As before, there appears to be three choices for CTNF in implementing PEVs into the support vehicle fleet. Keep in mind that the optimum goal would be to incorporate as many BEVs as possible to realize the advantages of reduced petroleum usage and reduced emissions of GHG.

1. All BEV fleet: While some BEV manufacturers report vehicle range exceeding 70 miles, ITSNA 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 is not possible for support vehicles due to the long distances experienced by several vehicles. The addition of remote-charging locations to support the BEV still would not allow an all-BEV fleet.

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 PEV's gasoline engine can provide motive power when the battery has been depleted. The data reveal that on 32% of all vehicle travel days, the total travel per vehicle is less than 40 miles, which typically is the maximum distance a PHEV will travel on battery power only. The first 40 miles of longer travel days would also be powered by electricity; therefore, 32% of support vehicle travel would be battery powered with only one charge per day. Thus, the PHEV would be of benefit for this travel.

   It is noted that 46% of all travel days and 84% of all outings are less than 70 miles. This would support travel by BEVs. For the days where the 70 miles are exceeded, intermediate charging locations typically provide the recharge necessary to increase the all-electric drive. However, no common remote sites were identified in the stop information for the location of remote EVSE. Thus, consideration should be given to home base charging only. Additional charging during the day at the home base between outings would add daily range. Incorporation of BEVs into the fleet will require management attention to ensure appropriate deployment based on the need and expected distance to be driven.

[23] Note that Via Motors has recently added PEV pickup trucks to the Pacific Gas and Electric Company in the San Francisco Bay Area: http://www.viamotors.com/blog/national-plugin-day-2012-cupertino/ [accessed July 19, 2013].

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 capabilities of currently available PHEVs to meet current support vehicle requirements.

While it would appear that BEVs are suitable replacements for some support vehicles, additional mission analysis and management input is required. The missions of these vehicles likely include considerations other than mileage (such as power demands and load-carrying capabilities placed on the vehicle). Two of the support vehicles are heavy-duty pickups and, currently, there are no PEV replacements for heavy-duty pickups.

The vehicle summary shows sufficient time for charging at the base location during the course of the day. These stations also provide charging opportunities for the visiting public, whose fees may assist in offsetting operating costs.

ITSNA suggests that further mission evaluation be given to support vehicles when considering the adoption of BEVs and PHEVs. However, aside from the heavy-duty capabilities of two of the vehicles, based on this travel information, a conservative approach to the support vehicle fleet suggests the potential for replacement by four BEVs and six PHEVs. Additional BEVs may be possible with further management or fleet software attention; however, fleet managers typically desire vehicles that support longer trips.

The current fleet contains 82 total support vehicles. Currently, there are no replacement vehicles for heavy-duty pickup trucks; therefore, it is assumed that the fleet consists of 20% heavy-duty trucks. Of the remaining balance of 66 vehicles, ITSNA suggests that 26 BEVs and 40 PHEVs could replace the current fleet and continue to carry out the same mission.

5.4.4 Support Vehicle Charging Needs

Upon review of these data, ITSNA suggests replacement of most of the support vehicle fleet with 26 BEVs and 40 PHEVs. No available PHEVs at the time of this writing provide for DC fast charging nor do the data suggest that this would be a significant benefit for PHEVs in the support vehicle fleet. Additional charging of BEVs during the day is not a requirement nor would DC fast chargers be required. The majority of the support vehicle activity occurs during daytime hours, which leaves significant time during the nighttime hours for recharging.

As noted above, AC Level 2 overnight charging of BEVs is typical, whereas overnight charging of PHEVs often uses AC Level 1 outlets. Opportunity charging at intermediate stops obtains greater benefits from AC Level 2 EVSE. However, remote intermediate stop locations were not identified in the data. Most vehicles returned to their home base daily, with the exception of long trips lasting several days.

For the entire fleet of support vehicles, 26 BEVs require 26 AC Level 2 EVSE for overnight charging and 40 PHEVs require 40 AC Level 1 outlets for home base charging. Of the support vehicles monitored, two were home based in Dubois, one in Island Park, one is Ashton, and six in Idaho Falls. The home base of the remaining fleet vehicles is unknown. ITSNA recommends a minimum of two EVSE at each location to maximize charge capability without a significant increase in installation costs. As noted above, there are no publicly accessible EVSE in the vicinity to provide significant backup charging resources.

Greater management attention provides the possibility of reducing the overall number of AC Level 2 EVSE. A ratio of two AC Level 2 charging stations to three vehicles typically sustains a normal fleet operation. Fleet managers rotate vehicles on the charger to complete charging of all vehicles in the allotted time. This analysis does assume a fully recharged battery at the start of each day. CTNF will gain experience in management as the PEV fleet grows.

5.5 Balance of Fleet Vehicles

The balance of the CTNF fleet consists of enforcement, specialty, and transport vehicles. Certain select PEVs are being demonstrated for various specialty applications, but none are listed in the GSA schedule. The same exists for transport vehicles. Analysis for other sites suggests that some enforcement vehicles can appropriately be replaced with PHEVs. Certain applications may also allow the use of BEVs. Further analysis would be required to provide specific observations.

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. Cost reduction also occurs because the cost of electricity is comparable to the cost of gasoline on a unit of energy basis; however, PEVs are more efficient than conventional ICE vehicles. Because fuel logs were not kept, the mileage accumulated by each vehicle provides the source of fuel consumption estimates for the study vehicles.

In order to perform the analysis, EPA fuel economy ratings are used.[24] Tables 12 and 13 provide these ratings. Ratings for the PHEVs in Table 13 include electric-only operation. Because these data are estimates, assumptions include the following:

1. PHEVs operate in electric mode only for the percentage of travel less than 40 miles per outing. This is reasonable for most daily operations (as described in Section 5). This assumption results in savings calculations slightly higher than those realized through the expected operation of combined electric and gasoline motive operations.
2. The fuel economy for the Mitsubishi Outlander is the same as the RAV4, because EPA has not yet created ratings for the former vehicle.
3. The Chevrolet Volt replaces the pool sedan and the Nissan Leaf or RAV4 electric vehicle replaces the pool SUV, which is reasonable (as described in Section 5). The following analysis utilizes the Leaf data.
4. The Mitsubishi Outlander replaces the support SUV and several of the lighter-duty pickups and the Toyota RAV4 replaces other support vehicles pickups[25].
5. The two heavy-duty pickups are not replaced.

Table 14 provides a pictorial view of the replacements involved.

[24] http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=33558 [accessed February 2, 2014].

[25] Although an SUV replaces the support vehicle pickup due to current market availability, PEV pickup trucks will be increasingly available in the near future. One example is the Via Motors VTRUX (http://www.viamotors.com/wp-content/uploads/VIA-Small-Brochure.pdf). Note that Via Motors has recently provided fleet pickup trucks to Pacific Gas and Electric in the San Francisco Bay Area (http://www.viamotors.com/blog/national-plugin-day-2012-cupertino/). [accessed July 19, 2013].

Table 12. U.S. Environmental Protection Agency's internal combustion engine fuel economy ratings.

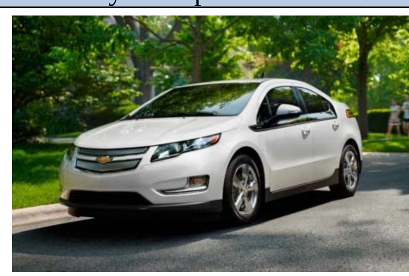
Vehicle	Logger	Mission	Make and Model	Model Year	Fuel Economy-Combined (miles/gallon)
7052	1	Support	GMC Sierra	2006	17
0427	2	Pool	Dodge Charger	2009	21
7094	3	Pool	Chevrolet Trailblazer	2006	16
4470	4	Support	Chevrolet Silverado	2009	16
4804	33	Support	Dodge Dakota	2011	16
G62-4321G	34	Support	Dodge Ram 1500	2010	16
G62-0354F	35	Support	Dodge Durango	2011	16
G62-1821H	36	Support	Chevrolet Silverado 1500	2009	16
4807	55	Support	Dodge Ram 1500	2011	19
7152	56	Support	Dodge Ram 2500	2006	16*
4137	57	Support	Ford Ranger	2007	17
4846	58	Support	Ford F350	2011	14*

*Diesel fuel economy is not available. Value listed is for lighter weight gasoline model.

Table 13. U.S. Environmental Protection Agency's plug-in electric vehicle fuel economy ratings.

Mission	Make and Model	Model Year	Fuel Economy-Combined (Wh/mile)	MPGe
Pool	Chevrolet Volt	2014	350	98
Pool	Nissan Leaf	2014	300	114
Support	Toyota RAV4	2014	440	76
Support	Mitsubishi Outlander	2014	440	76

Table 14. Current vehicle replacement plug-in electric vehicles.

	Current Vehicle	Analysis Replacement PEV
Pool Large Sedan	 Dodge Charger	 Chevrolet Volt PHEV
Pool SUV	 Chevrolet Trailblazer	 Nissan Leaf BEV

	Current Vehicle	Analysis Replacement PEV
Support SUV and some lighter-duty pickups	 Dodge Durango	 Mitsubishi Outlander PHEV
Support Pickup (lighter duty)	 GMC Sierra 1500 Pickup	 Toyota RAV4 BEV

Calculations provided for GHG emissions and fuel savings include both a total United States 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 Idaho Falls 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 United States from ITSNA to Idaho National Laboratory, primarily will consider the national figures.

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.[26] The United States and Idaho Falls area averages for GHG emissions for the production of electricity are 1.53 lb-CO_2e/kWh[27] and 0.166 lb-CO_2/kWh[28], respectively. Idaho Falls relies heavily on hydroelectric power and, thus, emissions are much lower than the national average.

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 PHEVs, the percentages of outings less than 40 miles are counted for the annual miles saved in charge-depleting mode, with the balance of the miles accounted for as fueled with gasoline.

Table 15 shows the calculation of annual miles based on the recorded miles in this study. In addition, a 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.

---

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

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

[28] http://www.idahofallsidaho.gov/city/city-departments/idaho-falls-power/power-portfolio/carbon-footprint.html [accessed April 25, 2014].

Table 15. Charge-depleting mode miles calculations.

Vehicle	Replacement Vehicle	Calculated Annual Miles	Percent of Miles CD Mode	CD Mode Miles
7052	Outlander	13,103.50	28%	3,668.98
0427	Volt	12,181.33	36%	4,385.28
7094	Leaf	13,713.42	100%	13,713.42
4470	Outlander	26,983.16	17%	4,587.14
4804	Outlander	9,878.95	15%	1,481.84
G62-4321G	RAV4	8,624.83	100%	8,624.83
G62-0354F	Outlander	6,529.79	45%	2,938.41
G62-1821H	RAV4	1,087.65	100%	1,087.65
4807	Outlander	14,700.49	86%	12,642.42
7152	Not replaced	16,658.87	NA	NA
4137	Outlander	8,139.97	67%	5,453.78
4846	Not replaced	11,073.30	NA	NA

For the cost-avoided piece of the analysis, fuel cost assumptions are $3.75/gallon of gasoline for the United States and $3.475/gallon for the Idaho Falls area. Electrical cost assumptions are 0.098 $/kWh[29] for the United States and 0.0425 $/kWh for the Idaho Falls area[30]. 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 charge-depleting mode yields estimates for yearly GHG emissions avoided and fuel cost reductions. The results of this analysis (shown in Table 16) 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 of reduction in GHG emissions and fuel costs for ease of comparison. For example, if the Outlander replaces Vehicle #7052, a 94% reduction in GHG emissions in Idaho occurs. The Sierra produces 4,338 lb-CO2e/year for the distance avoided, whereas the Outlander produces 268 lb-CO2e/year for that same distance for a reduction of 4,070 lb-CO2e/year.

Table 16 shows the high potential benefit in the reduction of GHG emissions in the local Idaho Falls area due to the very low utility production emissions. In addition, the fuel cost reduction potential benefit is also significant due to the low local cost of power.

As presented in Section 5, the pool fleet of seven vehicles could be replaced by two BEVs and five PHEVs. The support fleet of 82 vehicles would retain 16 heavy-duty pickups and replace the balance with 26 BEVs and 40 PHEVs. Using an average savings per vehicle, Table 17 provides the avoided GHG and fuel cost savings should these replacements occur. Additional savings result if CTNF includes the portions of their fleet with other missions. The table also shows the percentage reduction in GHG emissions and fuel costs for ease of comparison.

[29] http://www.eia.gov/electricity/state/ [accessed May 12, 2014].

[30] http://www.idahofallsidaho.gov/city/city-departments/idaho-falls-power/rates-policies-payment-programs.html [accessed April 25, 2014].

Table 16. Greenhouse gas emissions avoidance and fuel cost reduction analysis summary

	Mission	Make and Model	Extrapolated U.S. Yearly CO_2e Avoided ($lb\text{-}CO_2e$/year)/ **% reduction**	Extrapolated Local Yearly CO_2e Avoided ($lb\text{-}CO_2e$/year)/ **% reduction**	Extrapolated U.S. Yearly Fuel Cost Reduction/ **% reduction**	Extrapolated Local Yearly Fuel Cost Reduction/ **% reduction**
7052	Support	GMC Sierra	1,868/**43%**	4,070/**94%**	$665/**82%**	$681/**91%**
0427	Pool	Dodge Charger	1,849/**44%**	3,943/**94%**	$646/**82%**	$660/**91%**
7094	Pool	Chevrolet Trailblazer	10,933/**63%**	16,545/**96%**	$2,846/**89%**	$2,804/**94%**
4470	Support	Chevrolet Silverado	2,675/**46%**	5,428/**94%**	$895/**83%**	$910/**91%**
4804	Support	Dodge Dakota	864/**46%**	1,753/**94%**	$289/**83%**	$294/**91%**
G62-4321G	Support	Dodge Ram 1500	5,029/**46%**	10,205/**94%**	$1,682/**83%**	$1,712/**91%**
G62-0354F	Support	Dodge Durango	1,713/**46%**	3,477/**94%**	$573/**83%**	$583/**91%**
G62-1821H	Support	Chevrolet Silverado 1500	634/**46%**	1,287/**94%**	$212/**83%**	$216/**91%**
4807	Support	Dodge Ram 1500	4,863/**36%**	12,451/**93%**	$1,998/**80%**	$2,076/**90%**
7152	Support	Dodge Ram 2500	NA	NA	NA	NA
4137	Support	Ford Ranger	2,777/**43%**	6,050/**94%**	$989/**82%**	$1,013/**90%**
4846	Support	Ford F350	NA	NA	NA	NA
		Total Pool	12,782/**60%**	20,487/**96%**	$3,492/**87%**	$3,464/**94%**
		Total Support	20,423/**43%**	44,720/**94%**	$7,303/**82%**	$7,486/**91%**

Table 17. Extrapolated greenhouse gas emissions avoided and fuel cost savings for the entire fleet.

Mission	Extrapolated U.S. Yearly CO_2e Avoided ($lb\text{-}CO_2e$/year)/ **% reduction**	Extrapolated Local Yearly CO_2e Avoided ($lb\text{-}CO_2e$/year)/ **% reduction**	Extrapolated U.S. Yearly Fuel Cost Reduction ($/year)/ **% reduction**	Extrapolated Local Yearly Fuel Cost Reduction ($/year)/ **% reduction**
Pool	31,111/**56%**	52,802/**95%**	$8,922/**86%**	$8,909/**93%**
Support	172,018/**44%**	370,919/**94%**	$60,681/**82%**	$62,114/**91%**

7. OBSERVATIONS

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

Observation #1:

Implementation: CTNF 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, most 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 ITSNA 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 enforcement, specialty, transport vehicles, and shuttles/buses.

Observation #3:

Vehicle Replacement Plan: The development of a detailed vehicle replacement plan could be beneficial. This 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. The savings in 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 CTNF sites for the placement of PEV charging infrastructure could be beneficial. ITSNA 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 located at various destination points may provide additional infrastructure for PEV charging of the CTNF fleet. Charging stations at CTNF may also provide an opportunity for charging by the public. CTNF can benefit through collection of charging fees during times when these stations are not required for the overnight charging of fleet vehicles. The fees avoid the questions associated with a federal agency providing fuel for privately owned vehicles and support the costs for installation and operation of the EVSE.

Appendix A
Fleet Survey Form

Fleet Survey Sample	
Project Name:	BEA-FEMP Fleet II
Agency Name:	National Park Service
Location:	Caribou-Targhee National Forest
Date Requested:	2/2/2013

The following survey questions are used to lead the discussion concerning the mission of the current fleet of vehicles. If responding by e-mail, please use one form for each vehicle.

Please submit the data sheets to Ian Nienhueser at ian.nienhueser@intertek.com by fax at (602) 443-9007. If you have questions, please contact Ian at the email above or by phone at (702) 738-2706.

Vehicle Information			
Today's Date:	2/17/2013	Odometer Reading:	17,589
Make:	Chevrolet	Data Logger ID:	64
Model:	Tahoe	Data Logger Installed:	2/17/2013
Year:	2012	Fuel Type:	Gasoline
Vehicle Identification Number:	1GNSK2E01CR301102	Miles per Gallon:	23/31
Agency Fleet ID:	NA	Miles per Year:	10,000

1.	Vehicle Mission:	
	☐	Pool Vehicle
	☐	Enforcement Vehicle
	☐	Support Vehicle
	☐	Transport Vehicle
	☐	Specialty Vehicle
	☐	Shuttle/Bus
	☐	Low Speed Vehicle
2.	Vehicle Typical Parking Location: (parking lot name/designation, nearest building number)	

Appendix B
Vehicle Characterization

Table B-1. Caribou-Targhee National Forest vehicle index.

Vehicle Index					
Logger	**Make**	**Model**	**Year**	**Fleet Vehicle Id**	**Mission**
1	GMC	Sierra 1500	2006	7052	Support
2	Dodge	Charger	2009	0427	Pool
3	Chevrolet	Trailblazer	2006	7094	Pool
4	Chevrolet	Silverado	2009	4470	Support
33	Dodge	Dakota	2011	4804	Support
34	Dodge	Ram 1500	2010	G62-4321G	Support
35	Dodge	Durango	2011	G62-0354F	Support
36	Chevrolet	Silverado 1500	2009	G62-1821H	Support
55	Dodge	Ram 1500	2011	4807	Support
56	Dodge	Ram 2500	2006	7152	Support
57	Ford	Ranger	2007	4137	Support
58	Ford	F350	2011	4846	Support

Appendix C
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. It is issued annually by the GSA Vehicle Acquisition and Leasing Service's Automotive Division.
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 time period the vehicle, within the study, has been equipped with a data logger.

Appendix D
Vehicle Data Sheets

Vehicle 7052

www.edmunds.com

Make/Model/Year	GMC Sierra 1500/2006
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Parking Location	Hollipark Drive
Fleet Vehicle ID	7052
Fuel Type	Gas
EPA Label/MPG (City/Hwy/Combined)	15/20/17
EPA GHG Emissions (Grams CO_2/Mi)	523
Study Vehicle ID	1
Total Vehicle Days/Total Study Days	27/73

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	97.1/167.7	72.8/167.7	16.6/94.1	2,621
Travel Time (Minutes)	261/470	195.5/470	44.6/292	7,039
Idle Time (Minutes)	67.3/NA	50.4/NA	11.5/NA	1,816

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	62	48.8%	Less than 2	95
10 to 20	0	0%	2 to 4	3
20 to 40	42	33.1%	4 to 8	1
40 to 60	23	18.1%	Greater than 8	28

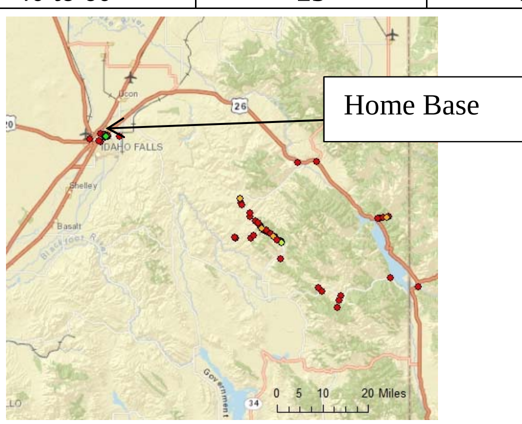


Figure D-1. Vehicle 7052 stops.

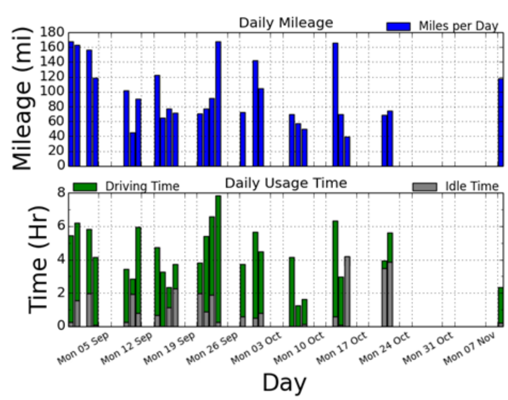


Figure D-2. Vehicle 7052 history.

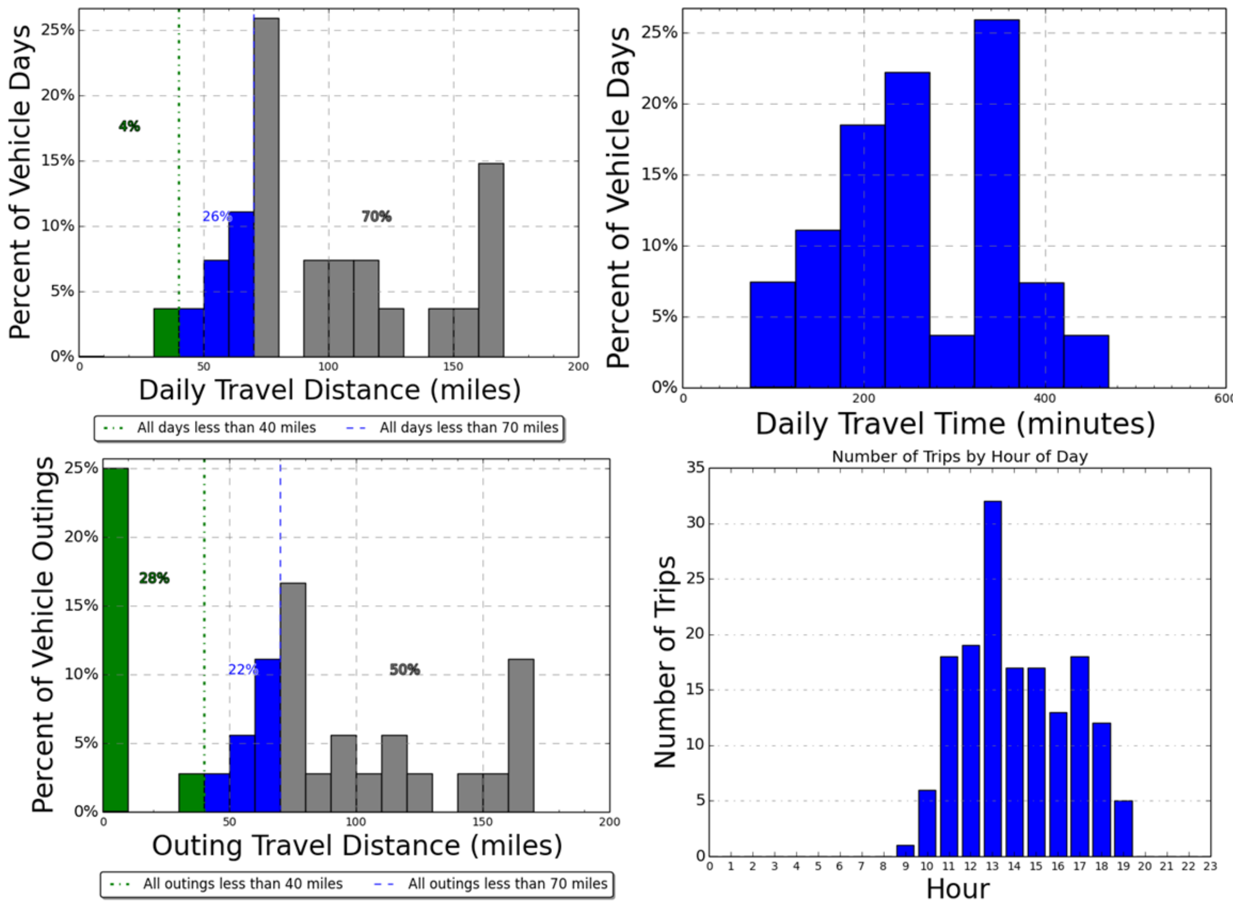


Figure D-3. Vehicle 7052 travel graphs.

Vehicle 7052 Observations

Logger 1 collected data on Vehicle 7052 for 27 days of the 73-day study period. Data validation occurred on 97.3% of the vehicle data. The vehicle's primary home base is located at Hollipark Drive in Idaho Falls. This vehicle supports engineering in monitoring projects. It averages about 10,000 miles per year. The odometer read 50,061 during the study.

As shown on the history graph (Figure D-2), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 30% were within the 70-mile BEV safe range (the green bars on Figure D-3) and 4% were within the battery-only range of a typical PHEV.

For outings, the longest single outing of 168 miles occurred on October 11, 2011, involving a trip to Alpine, Wyoming. Half the outings were within the 70-mile BEV range and 28% were within the battery-only range of a typical PHEV.

It appears a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 0427

www.indexusedcars.com

Make/Model/Year	Dodge Charger/2009
EPA Class Size	Large Car
Mission	Pool
Contact	Ms. Woods
Parking Location	Hollipark Drive
Fleet Vehicle ID	0427
Fuel Type	Gas
EPA Label/MPG (City/Hwy/Combined)	18/26/21
EPA GHG Emissions (Grams CO_2/Mi)	423
Study Logger ID	2
Total Vehicle Days/Total Study Days	28/83

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	98.9/323.2	86.6/390.5	22.9/177.5	2,770
Travel Time (Minutes)	114/328.0	100.0/390	26.4/150	3,200
Idle Time (Minutes)	3.1/NA	2.8/NA	0.7/NA	88

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	44	39.3%	Less than 2	63
10 to 20	0	0%	2 to 4	15
20 to 40	15	13.4%	4 to 8	5
>40	53	47.4%	Greater than 8	29

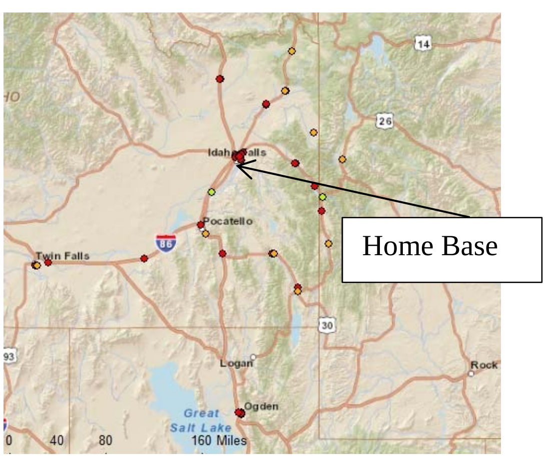


Figure D-4. Vehicle 0427 stops.

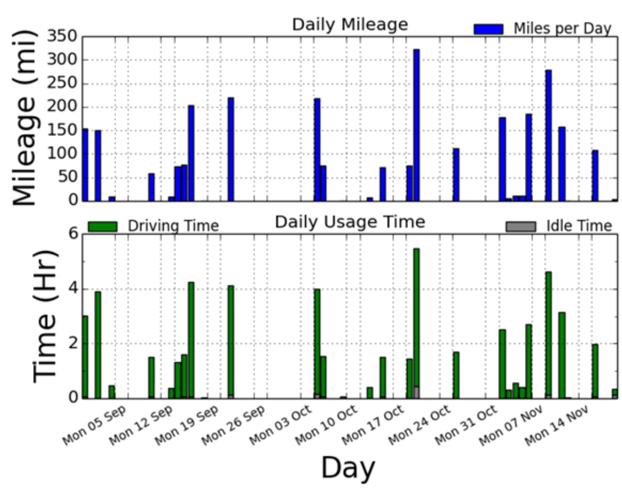


Figure D-5. Vehicle 0427 history.

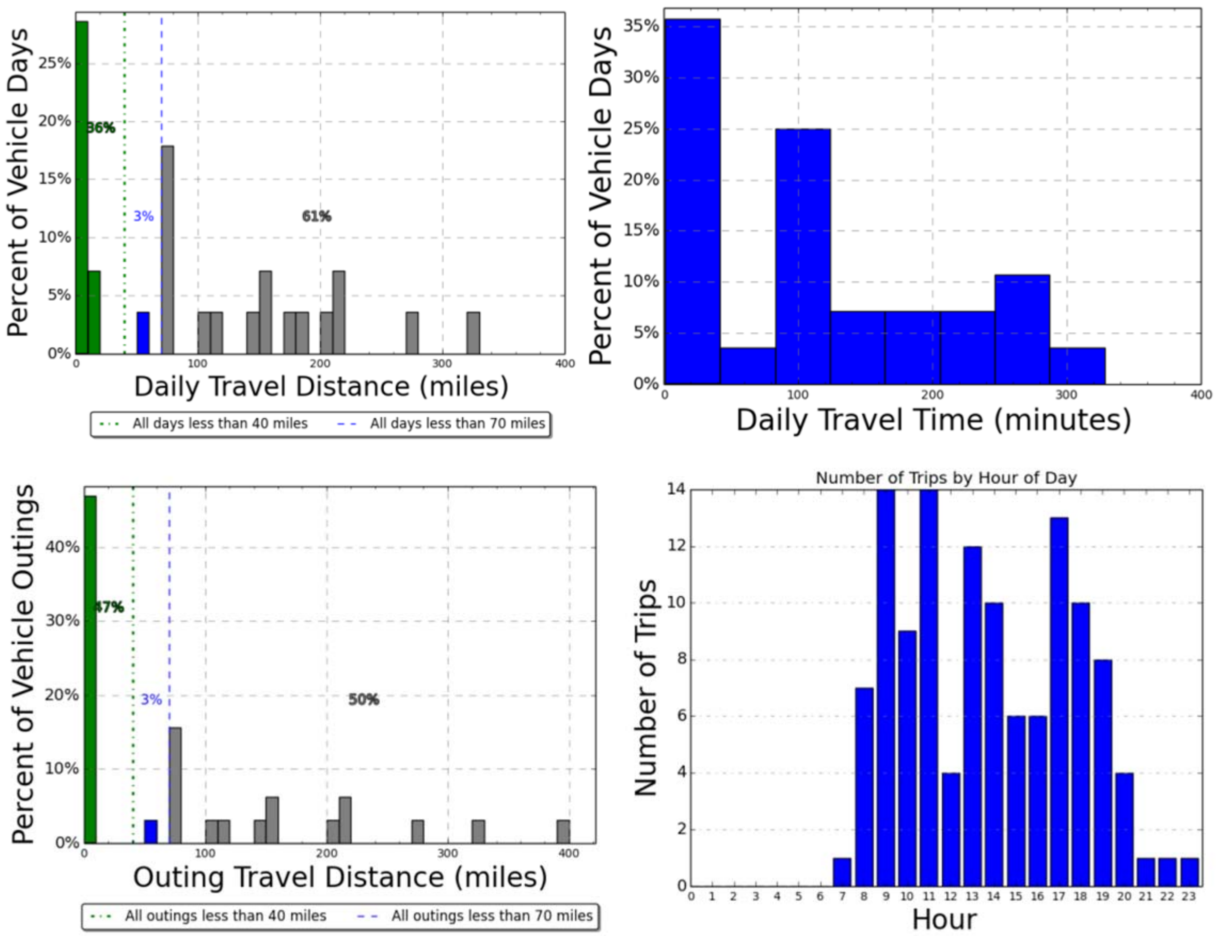


Figure D-6. Vehicle 0427 travel graphs.

Vehicle 0427 Observations

Logger 2 collected data on Vehicle 0427 for 28 days of the 83-day study period. Data validation occurred on 100% of the vehicle data. Vehicle 0427 is a pool vehicle supporting highway trips and meetings averaging 15,000 miles per year. The odometer read 35,295 during the study. The vehicle's primary home base is located at Hollipark Drive in Idaho Falls.

As shown on the history graph (Figure D-5), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 39% were within the 70- mile BEV safe range (the green bars on Figure D-6) and 36% were within the battery-only range of a typical PHEV.

The longest single outing of 390 miles occurred on November 2, 2011, involving a trip to Utah. The outing was over a several day period, explaining why the outing number exceeds the daily travel number. In general, half the outings are within the 70-mile BEV range and 47% are within the battery-only range of a typical PHEV.

It appears a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle7094

www.edmunds.com

Make/Model/Year	Chevrolet Trailblazer/2006
EPA Class Size	SUV
Mission	Pool
Contact	Ms. Woods
Home Base	Hollipark Dr. Idaho Falls/ Salmon, Idaho
Fleet Vehicle ID	7094
Fuel Type	Gas
EPA Label/MPG (City/Hwy/Combined)	14/19/16
EPA GHG Emissions (Grams CO_2/Mi)	555
Study logger ID	3
Total Vehicle Days/Total Study Days	24/69

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	108.0/374.8	162/374.8	14.2/160.8	2,592
Travel Time (Minutes)	145/510	217.4/510	19.0/200.0	3,478
Idle Time (Minutes)	6.1/NA	9.2/NA	0.8/NA	147

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	48	29.6%	Less than 2	110
10 to 20	1	0.6%	2 to 4	6
20 to 40	2	1.2%	4 to 8	18
>40	112	69.1%	Greater than 8	28

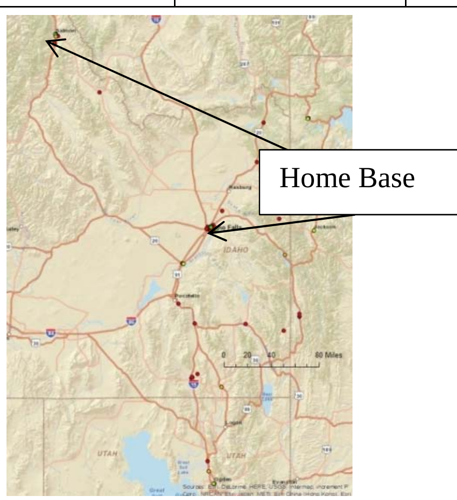


Figure D-7. Vehicle 7094 stops.

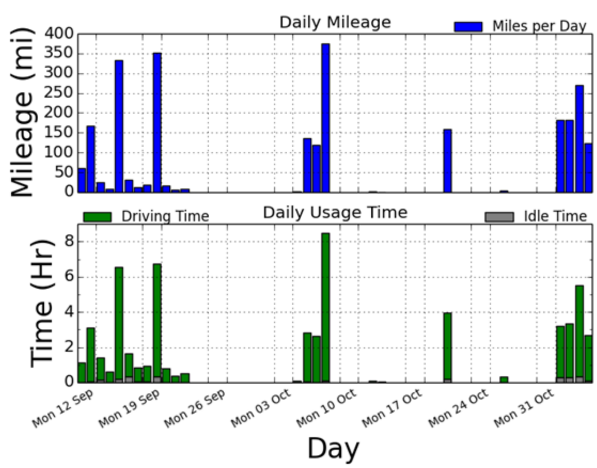


Figure D-8. Vehicle 7094 history.

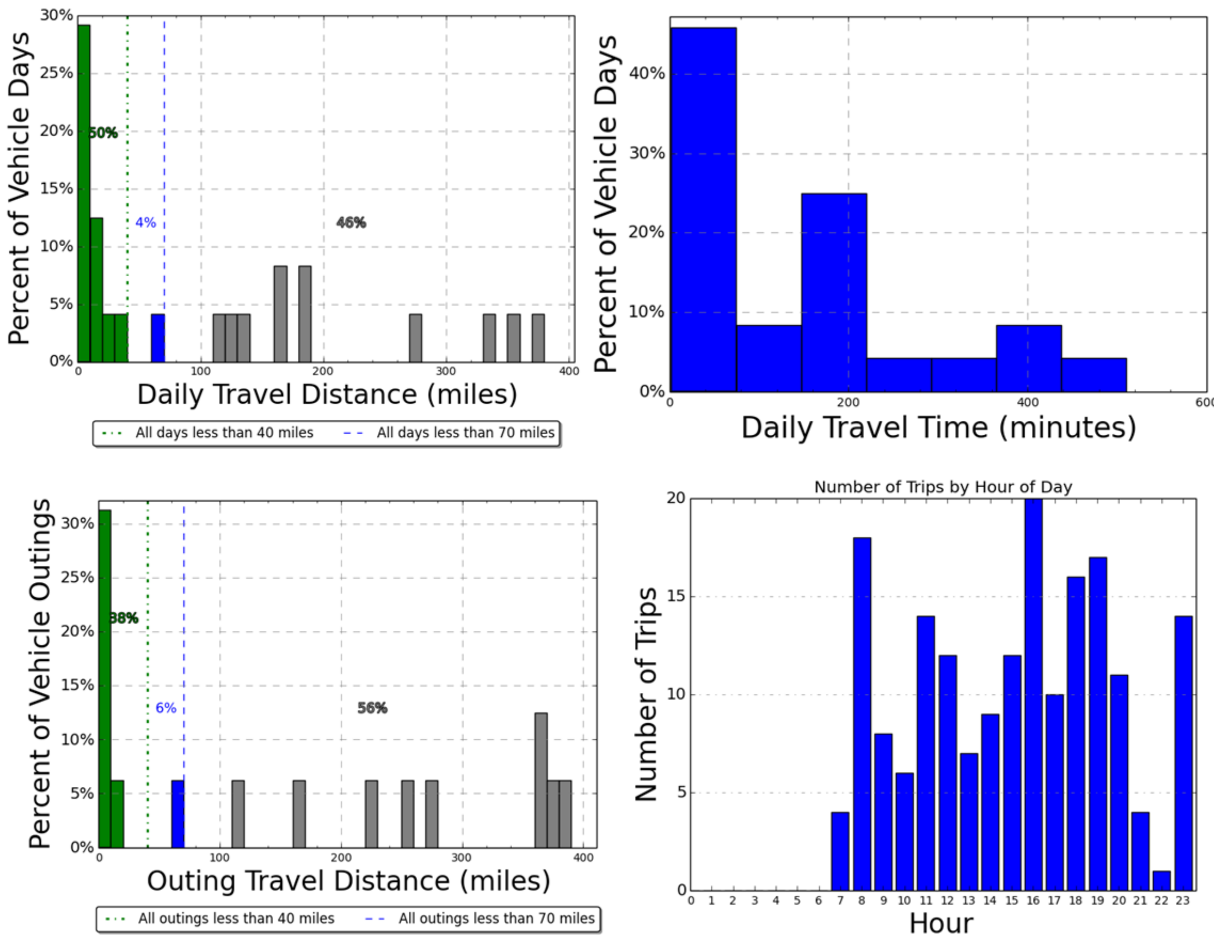


Figure D-7. Vehicle 7094 vehicle travel graphs.

Vehicle 7094 Observations

Logger 3 collected data on Vehicle 7094 for a period of 24 days of the 69-day study period. Validation occurred on 98.7% of the vehicle data. This vehicle appeared to be home based at the office in Idaho Falls, but also parked several nights in Salmon, Idaho. According to the site survey, this is a pool vehicle supporting highway trips and meetings averaging 15,000 miles per year. The odometer read 35,295 during the study.

As shown on the history graph (Figure D-8), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 54% were within the 70-mile BEV safe range (the green bars on Figure D-9) and 50% were within the battery-only range of a typical PHEV. The longest single daily travel of 375 miles occurred on October 6 on an outing to Wyoming. Forty-four percent of the vehicle outings are within the 70-mile BEV safe range (the green bars on Figure D-9) and 38% were within the battery-only range of a typical PHEV. This vehicle also made an extended outing to Ogden, Utah.

It appears that a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 4470

www.edmunds.com

Make/Model/Year	Chevrolet Silverado K1500/2009
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Parking Location	Office, Hollipark Drive
Fleet Vehicle ID	4470
Fuel Type	Gas
EPA Label/MPG (City/Hwy/Combined)	14/20/16
EPA GHG Emissions (Grams CO_2/Mi)	555
Study Logger ID	4
Total Vehicle Days/Total Study Days	16/34

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	157.1/266.1	139.6/266.1	25.1/106.2	2,514
Travel Time (Minutes)	226/342.0	200.9/342.0	36.2/144	3,616
Idle Time (Minutes)	1.3/NA	1.1/NA	0.2/NA	20

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	28	31.8%	Less than 2	66
10 to 20	1	1.1%	2 to 4	5
20 to 40	13	14.8%	4 to 8	1
>40	48	52.3%	Greater than 8	16

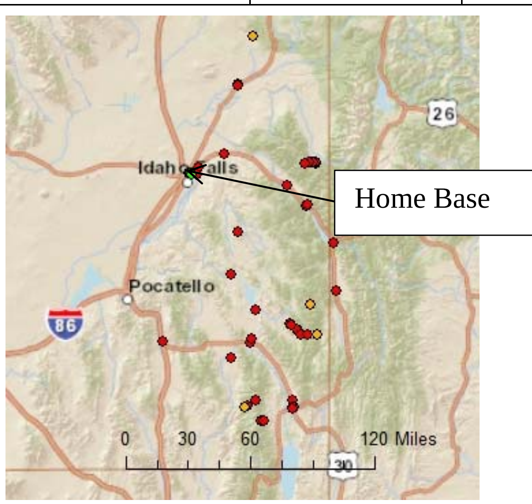


Figure D-10. Vehicle 4470 stops.

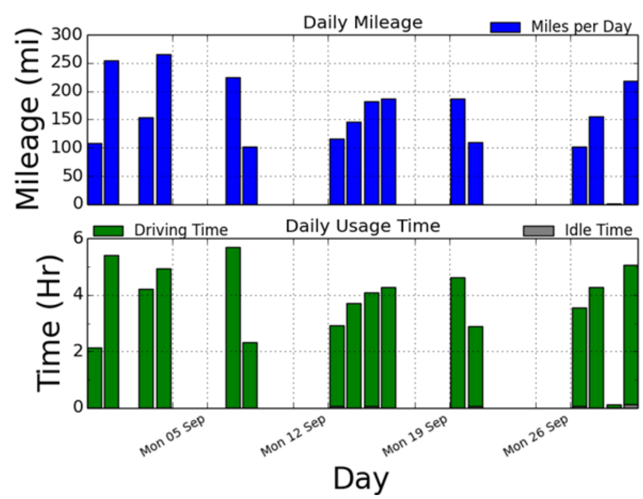


Figure D-11. Vehicle 4470 history.

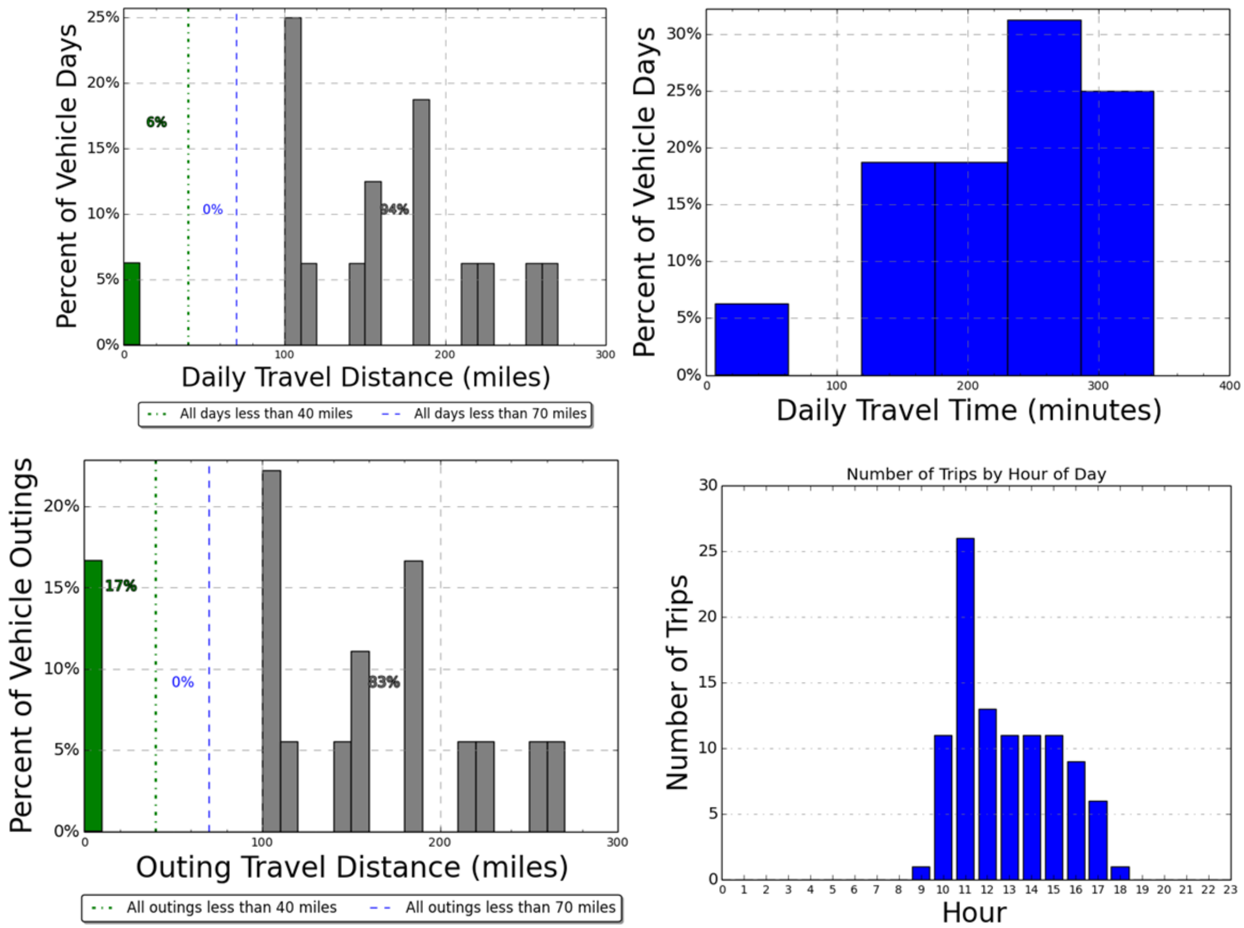


Figure D-8. Vehicle 4470 travel graphs.

Vehicle 4470 Observations

Logger 4 collected data on Vehicle 4470 for a period of 16 days of the 34-day study period. The logger was removed from the vehicle early. Validation occurred on 99.5% of the vehicle data. Vehicle 4470 a support vehicle that supports timber sales administration and preparation, averaging 15,000 miles per year. The odometer read 32,829 during the study. The vehicle's home base is in the Idaho Falls office area.

As shown on the history graph (Figure D-11), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 6% were within the 70-mile BEV safe range and the battery-only range of a typical PHEV (the green bars on Figure D-12). The longest single daily travel of 266 miles occurred on September 2 on an outing to South Bannock, Mink Creek, and Grace. Seventeen percent of the vehicle outings are within the 70-mile BEV safe range and the battery-only range of a typical PHEV (the green bars on Figure D-12).

It appears that a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 4804

www.edmunds.com

Make/Model/Year	Dodge Dakota/2011
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Parking Location	Office Hollipark Drive
Fleet Vehicle ID	4804
Fuel Type	Gas/E85
EPA Label/MPG (City/Hwy/Combined)	14/19/16 – 9/13/10
EPA GHG Emissions (Grams CO_2/Mi)	555/630
Study Logger ID	33
Total Vehicle Days/Total Study Days	26/128

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	133.2/325.4	133.2/325.4	30.93/124.8	3,464
Travel Time (Minutes)	206/541.0	206.2/541.0	47.9/228.0	5,361
Idle Time (Minutes)	15.6/NA	15.6/NA	3.6/NA	405

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	41	42.7%	Less than 2	57
10 to 20	7	7.3%	2 to 4	7
20 to 40	22	22.9%	4 to 8	7
>40	26	27.1%	Greater than 8	25

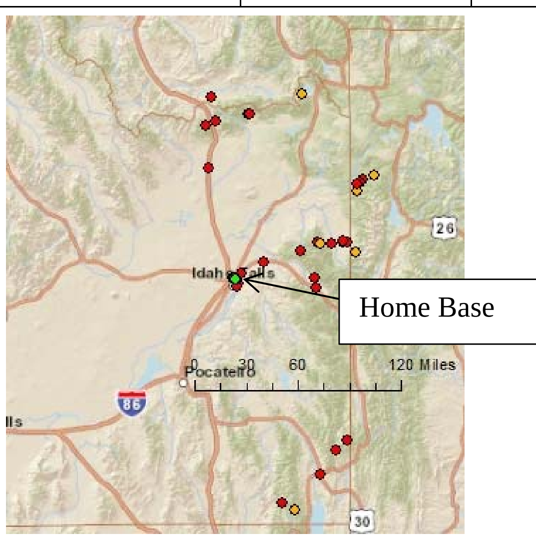


Figure D-13. Vehicle 4804 stops.

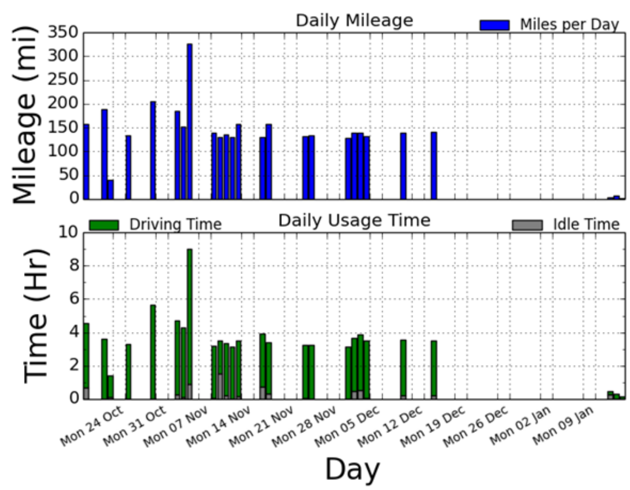


Figure D-14. Vehicle 4804 history.

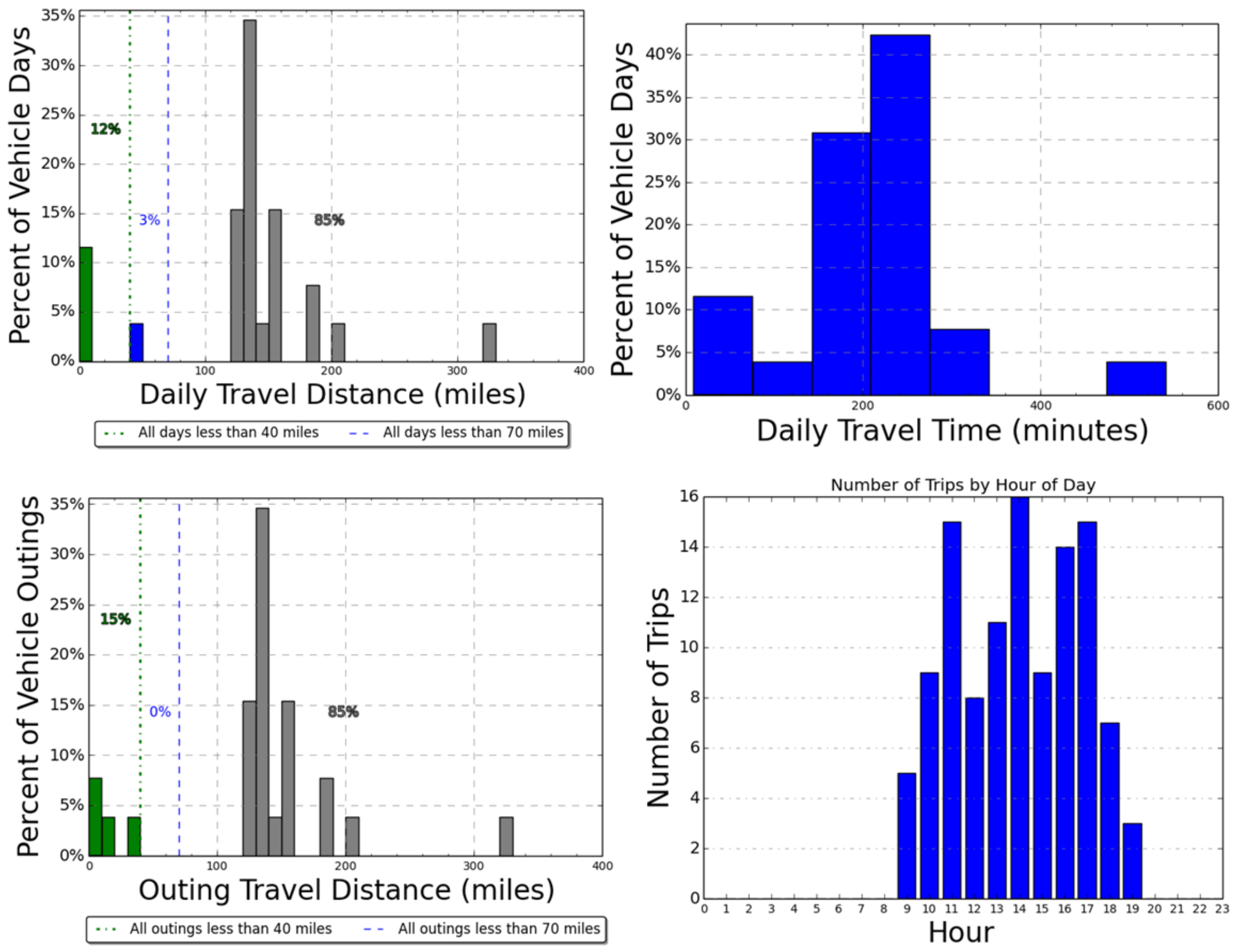


Figure D-9. Vehicle 4804 travel graphs.

Vehicle 4804 Observations

Logger 33 collected data on Vehicle 4804 for a period of 26 days of the 128-day study period. Validation occurred on 95.7% of the vehicle data. This vehicle appeared to be home based at the office in Idaho Falls. According to the site survey, Vehicle 4804 is a support vehicle supporting engineering in monitoring projects, averaging 10,000 miles per year. The odometer read 9,777 during the study.

As shown on the history graph (Figure D-14), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 15% were within the 70-mile BEV safe range (the green bars on Figure D-15) and 12% were within the battery-only range of a typical PHEV. The longest single daily travel of 325 miles occurred on November 3 on an outing to Wayan, Montpelier, Parris, and Preston. Fifteen percent of the vehicle outings are within the 70-mile BEV safe range and the battery-only range of a typical PHEV (the green bars on Figure D-9).

It appears that a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle G62-4321G

www.edmunds.com

Make/Model/Year	Dodge Ram 1500/2010
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Parking Location	Hollipark Drive
Fleet Vehicle ID	G62-4321G
Fuel Type	Gas
EPA Label/MPG (City/Hwy/Combined)	14/20/16
EPA GHG Emissions (Grams CO_2/Mi)	555
Study Logger ID	34
Total Vehicle Days/Total Study Days	22/118

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	126.7/297.7	121.2/297.7	19.8/109.3	2,788
Travel Time (Minutes)	164/395.0	157.0/395.0	25.6/108	3,611
Idle Time (Minutes)	17.6/NA	16.8/NA	2.7/NA	387

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	31	25.4%	Less than 2	88
10 to 20	0	0%	2 to 4	9
20 to 40	18	14.8%	4 to 8	3
>40	73	59.8%	Greater than 8	22

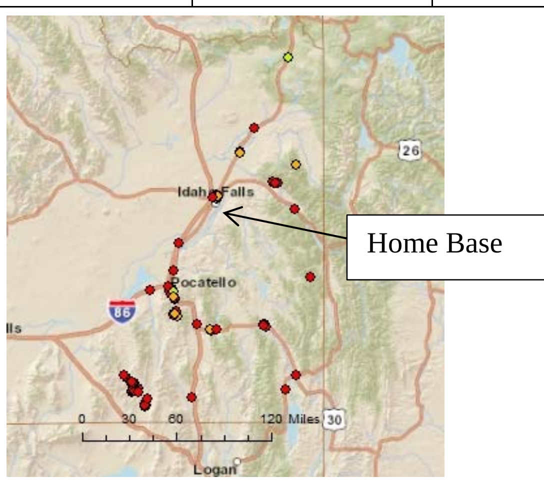


Figure D-16. Vehicle G62-4321G stops.

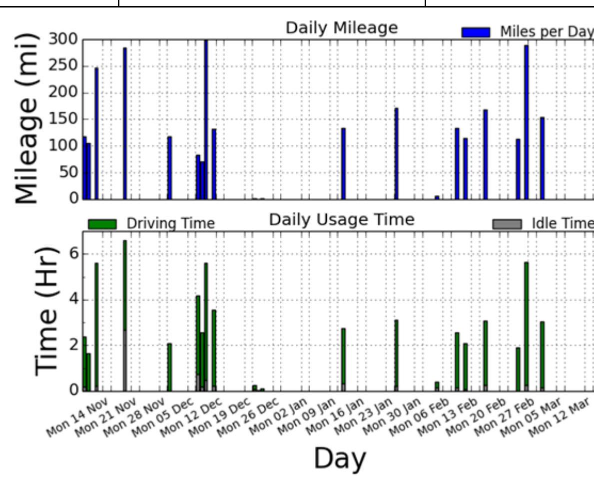


Figure D-17. Vehicle G62-4321G history.

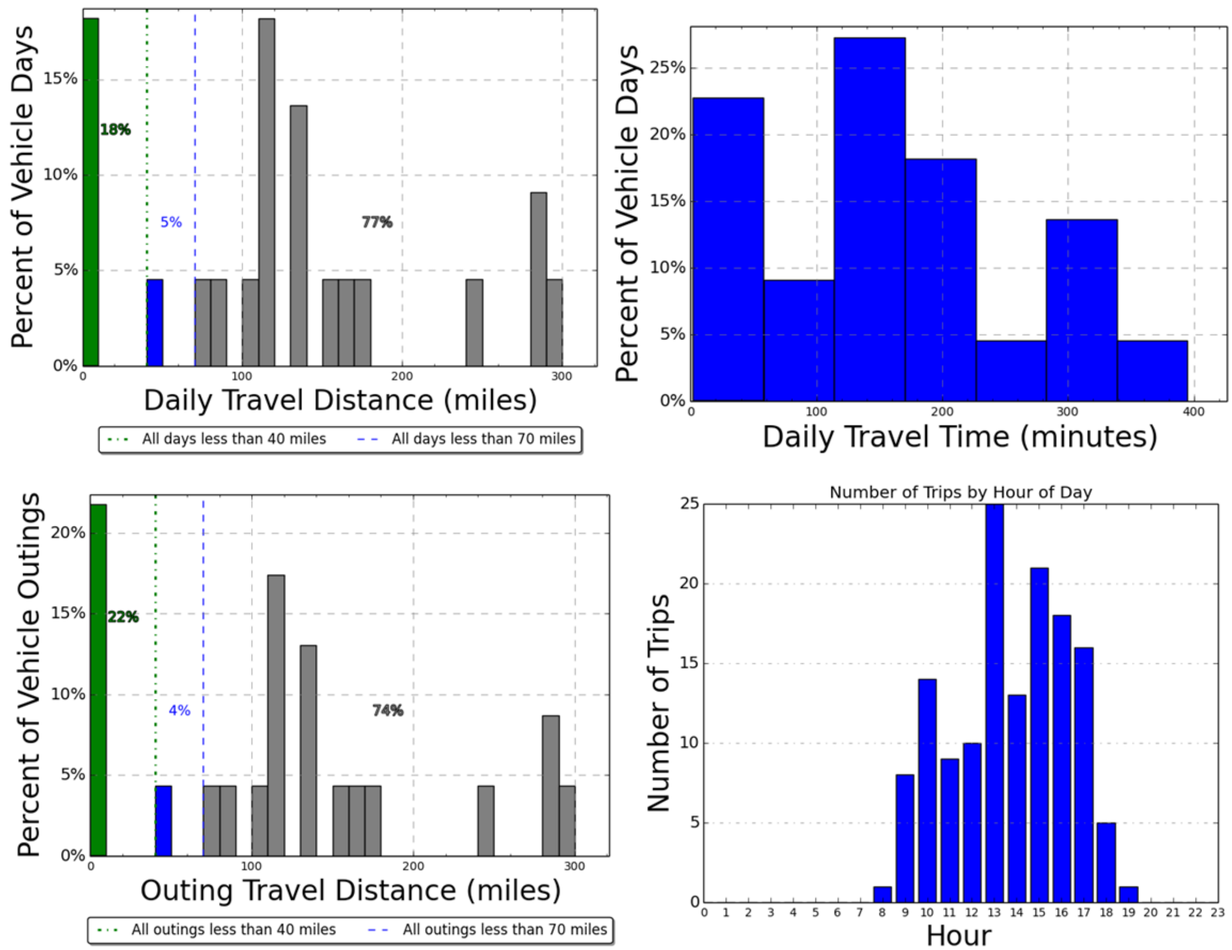


Figure D-10. Vehicle G62-4321G travel graphs.

Vehicle G62-4321G Observations

Logger 34 collected data on Vehicle G62-4321G for a period of 22 days of the 118-day study period. Validation occurred on 99.7% of the vehicle data. This vehicle appeared to be home based at the office in Idaho Falls. According to the site survey, Vehicle G62-4321G is a support vehicle for the hydrologist, averaging 18,000 miles per year. The odometer read 28,032 during the study.

As shown on the history graph (Figure D-17), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 23% were within the 70-mile BEV safe range (the green bars on Figure D-18) and 18% were within the battery-only range of a typical PHEV. The longest single daily travel of 298 miles occurred on December 7 on an outing to Soda Springs, Montpelier, Parris, and South Bannock. Twenty-six percent of the vehicle outings are within the 70-mile BEV safe range and 22% are within the battery-only range of a typical PHEV.

It appears that a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle G62-0354F

www.edmunds.com

Make/Model/Year	Dodge Durango/2011
EPA Class Size	SUV
Mission	Support
Contact	Ms. Woods
Home Base	Hollipark Drive
Fleet Vehicle ID	G62-0354F
Fuel Type	Gas
EPA Label/MPG (City/Hwy/Combined)	14/20/16
EPA GHG Emissions (Grams CO_2/Mi)	555
Study Logger ID	35
Total Vehicle Days/Total Study Days	21/128

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	109.0/292.3	114.5/599.6	34.7/165.8	2,290
Travel Time (Minutes)	139/292.0	145.7/604	44.1/135	2,913
Idle Time (Minutes)	18.5/NA	19.5/NA	5.9/NA	389

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	24	40.0%	Less than 2	28
10 to 20	0	0%	2 to 4	3
20 to 40	0	0%	4 to 8	8
40 to 60	36	60.0%	Greater than 8	21

Figure D-19. Vehicle G62-0354F stops.

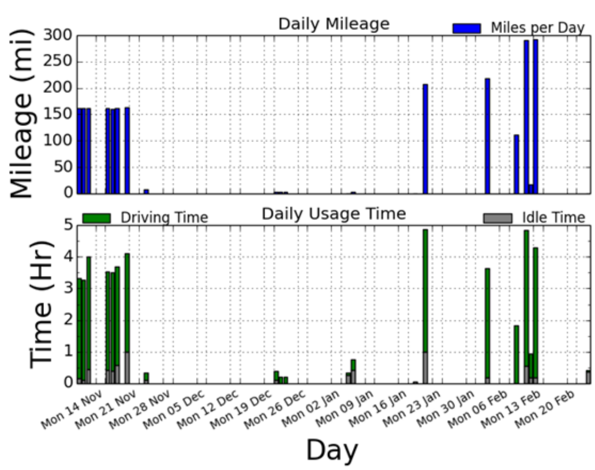


Figure D-20. Vehicle G62-0354F history.

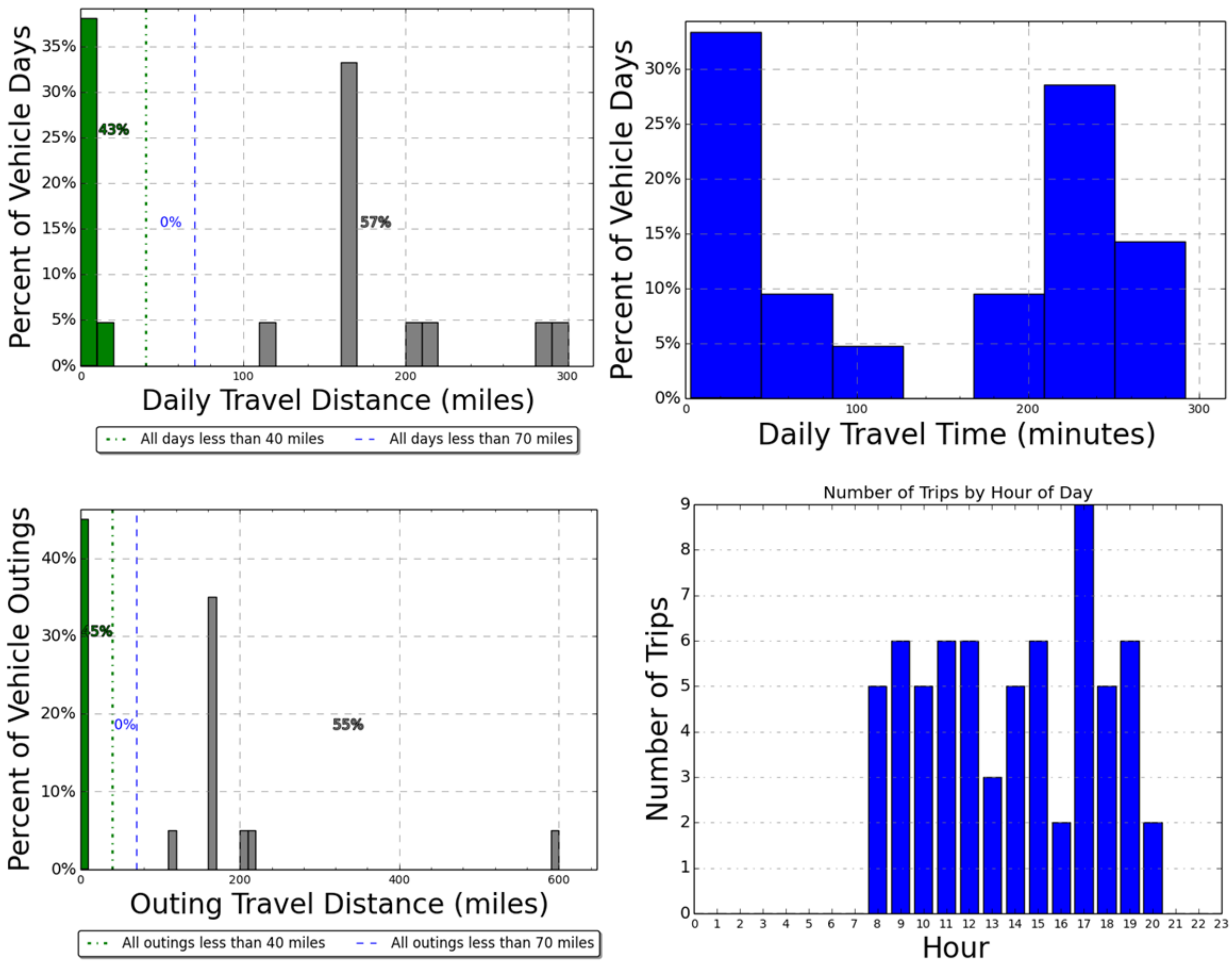


Figure D-11. Vehicle G62-0354F travel graphs.

Vehicle G62-0354F Observations

Logger 35 collected data on Vehicle G62-0354F for a period of 21 days of the 128-day study period. Validation occurred on 99.4% of the vehicle data. This vehicle is home based at the office in Idaho Falls. According to the site survey, Vehicle G62-0354F is a support vehicle for the hydrologist, averaging 11,000 miles per year. The odometer read 51,596 during the study.

As shown on the history graph (Figure D-20), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 43% were within the 70-mile BEV safe range and the 40-mile battery-only range of a typical PHEV (the green bars on Figure D-21). The longest single daily travel of 292 miles occurred on February 22, 2012. This was part of a several days outing from February 9 through 11 of 600 miles to Declo, Boise City, Mountain Home, Jerome, and Chubbuck. Forty-five percent of the vehicle outings are within the 70-mile BEV safe range and the battery-only range of a typical PHEV.

It appears that a BEV is not a suitable replacement for this vehicle. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle G62-1821H

www.edmunds.com

Make/Model/Year	Chevrolet Silverado 1500/2009
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Parking Location	Hollipark Drive
Fleet Vehicle ID	G62-1821H
Fuel Type	Gas/E85
EPA Label/MPG (City/Hwy/Combined)	14/20/16 11/15/13
EPA GHG Emissions (Grams CO_2/Mi)	555/484
Study Logger ID	36
Total Vehicle Days/Total Study Days	31/149

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	14.3/109.7	13.1/109.7	9.4/60.5	444
Travel Time (Minutes)	52/137.0	47.5/137	34.4/106	1,615
Idle Time (Minutes)	37.2/NA	33.9/NA	24.5/NA	1,152

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	13	68.4%	Less than 2	8
10 to 20	0	0%	2 to 4	4
20 to 40	0	0%	4 to 8	1
40 to 60	6	31.6%	Greater than 8	6

Figure D-22. Vehicle G62-1821H stops.

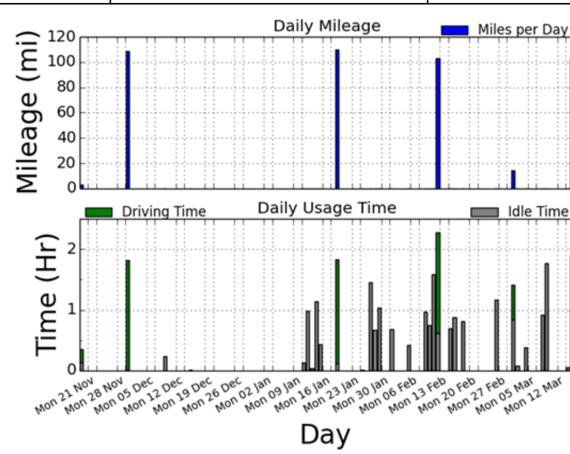


Figure D-23. Vehicle G62-1821H history.

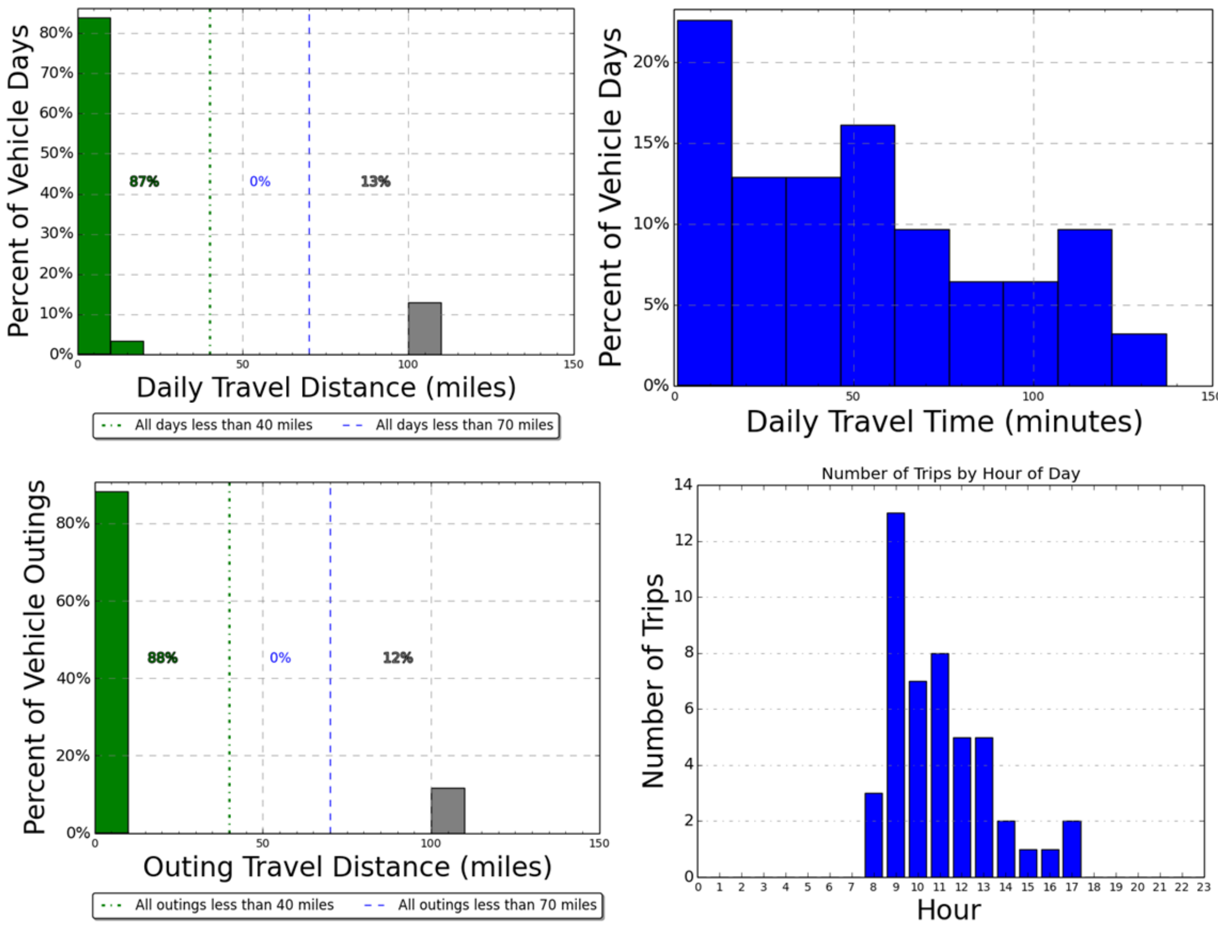


Figure D-12. Vehicle G62-1821H travel graphs.

Vehicle G62-1821H Observations

Logger 36 collected data on Vehicle G62-1821H for a period of 31 days of the 149-day study period. Validation occurred on 90.7% of the vehicle data. This vehicle is home based at the office in Idaho Falls. According to the site survey, Vehicle G62-1821H is a support vehicle supporting the archeologist, averaging 8,000 miles per year. The odometer read 22,523 during the study.

As shown on the history graph (Figure D-23), this vehicle frequently travels daily distances in excess of the advertised range of BEVs (i.e., 70 miles). However, most of the trips were to Dubois or Pocatello from Idaho Falls. The one-way trip distances of these are within the range of a BEV. In addition, there is sufficient recharge time at the destinations for battery charging for the return trip to Idaho Falls. Of all vehicle travel days, 87% were within the 70-mile BEV safe range and the 40-mile battery-only range of a typical PHEV (the green bars on Figure D-24). The longest single daily travel of 110 miles occurred on January 17, 2012. This was also the longest outing to Dubois. Eighty-eight percent of the vehicle outings are within the 70-mile BEV safe range and the battery-only range of a typical PHEV.

It appears that a BEV is a suitable replacement option for this vehicle. With sufficient recharge time and AC Level 2 EVSE placed at the typical locations in Dubois and Pocatello, a BEV can be fully recharged for the return trip. A PHEV is also a suitable option because most travel will be within the battery-only range and will maximize battery use. This assumes the BEV or PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 4807

www.edmunds.com

Make/Model/Year	Dodge Ram 1500/2011
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Home Base	Oakley Ave, Dubois
Fleet Vehicle ID	4807
Fuel Type	Gas/E85
EPA Label/MPG (City/Hwy/Combined)	14/19/25 – 9/13/10
EPA GHG Emissions (Grams CO_2/Mi)	592/630
Study Logger ID	55
Total Vehicle Days/Total Study Days	47/81

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	69.4/238.7	13.3/238.2	7.8/78.5	3,262
Travel Time (Minutes)	206/522	39.5/513	23.1/458	9,675
Idle Time (Minutes)	87.3/NA	16.7/NA	9.8/NA	4,101

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	277	62.5%	Less than 2	288
10 to 20	54	14.9%	2 to 4	15
20 to 40	62	17.1%	4 to 8	15
40 to 60	20	5.5%	Greater than 8	45

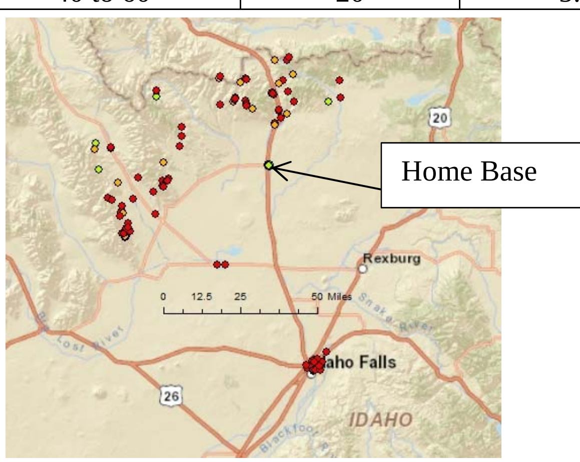


Figure D-25. Vehicle 4807 stops.

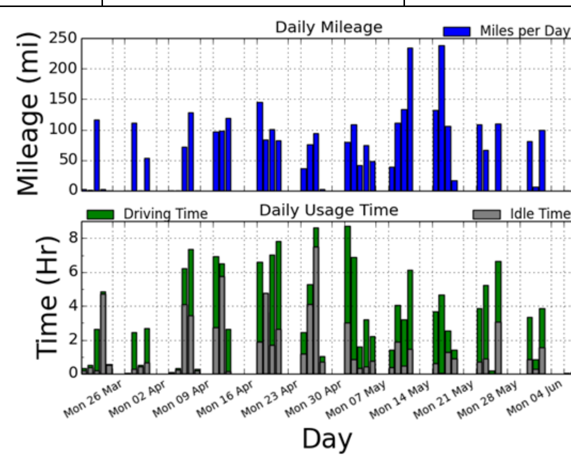


Figure D-26. Vehicle 4807 history.

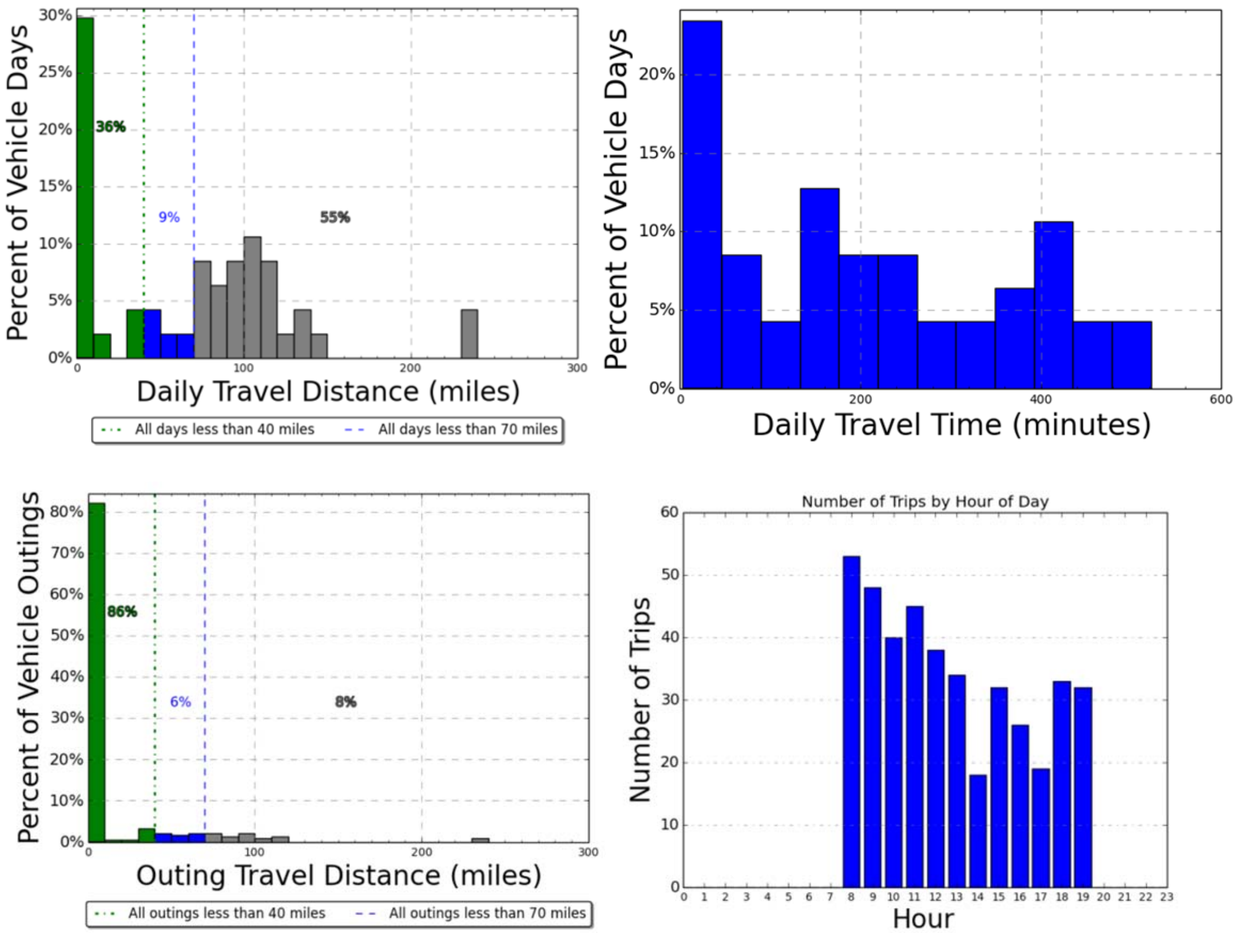


Figure D-13. Vehicle 4807 travel graphs.

Vehicle 4807 Observations

Logger 55 collected data on Vehicle 4807 for a period of 47 days of the 81-day study period. Validation occurred on 98.8% of the vehicle data. This vehicle is home based on Oakley Avenue in Dubois, Idaho. According to the site survey, Vehicle 4807 is a support vehicle supporting recreation, averaging 8,500 miles per year. The odometer read 12,630 during the study.

As shown on the history graph (Figure D-26), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 45% were within the 70-mile BEV safe range and 36% were within the 40-mile battery-only range of a typical PHEV (the green bars on Figure D-27). The longest single daily of travel of 239 miles occurred on a single outing on May 15, 2012, to Idaho Falls and West Clark. Ninety-two percent of the vehicle outings are within the 70-mile BEV safe range and 86% are within the battery-only range of a typical PHEV. A significant amount of idle time was recorded on this vehicle, with 51 idle events recorded of a length greater than 15 minutes and 17 of those were greater than an hour. The idle events occurred at many different locations.

It appears that a BEV is not a suitable replacement for this vehicle unless alternate vehicles are available for the trips to Idaho Falls. A PHEV is a suitable replacement and most of the trips would be on battery-only motive power. This assumes that a PEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 7152

www.edmunds.com

Make/Model/Year	Dodge Ram 2500/2006
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Home Base	Oakley Ave, Dubois
Fleet Vehicle ID	7152
Fuel Type	Diesel
EPA Label/MPG (City/Hwy/Combined)*	14/20/16
EPA GHG Emissions (Grams CO_2/Mi)*	555
Study Logger ID	56
Total Vehicle Days/Total Study Days	37/81

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	99.9/696.8	60.6/1562.4	12.2/191.4	3,697
Travel Time (Minutes)	192/796.0	116.6/3,132.0	23.6/181.0	7,114
Idle Time (Minutes)	66.6/NA	40.4/NA	8.2/NA	2,464

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	77	26.4%	Less than 2	239
10 to 20	31	10.6%	2 to 4	15
20 to 40	36	12.3%	4 to 8	6
>40	148	50.6%	Greater than 8	32

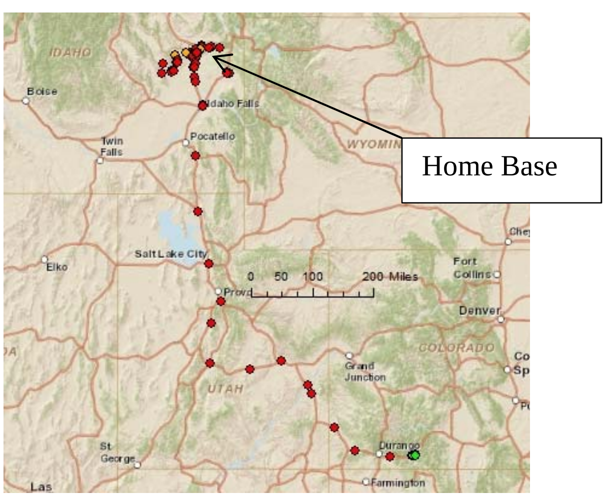


Figure D-28. Vehicle 7152 stops.

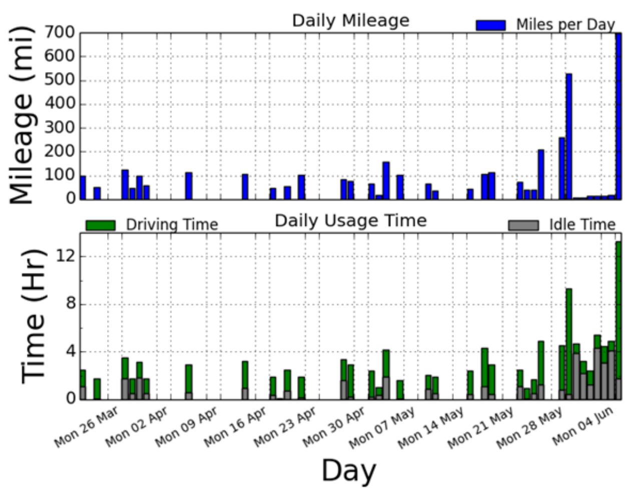


Figure D-29. Vehicle 7152 history.

*Gasoline version statistics provided. Diesel statistics are not available.

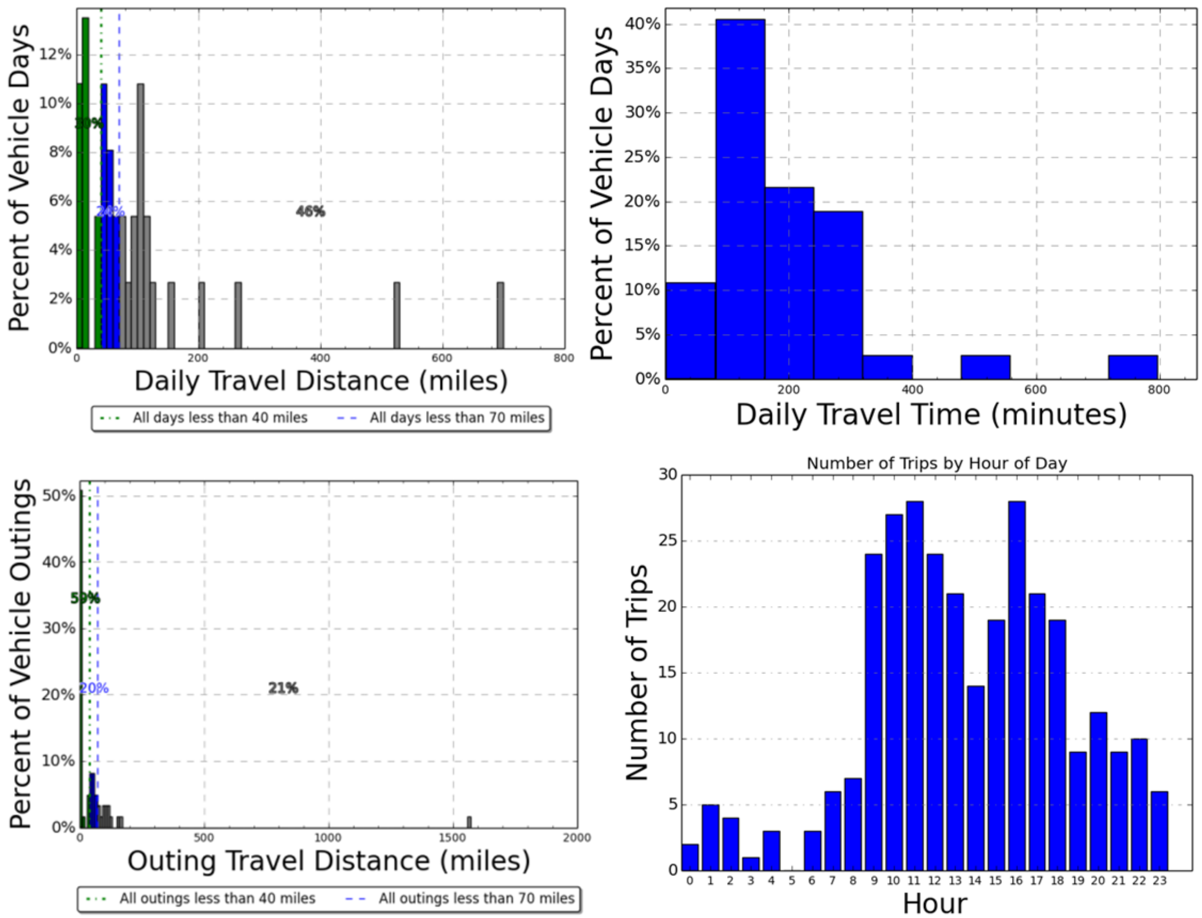


Figure D-14. Vehicle 7152 travel graphs.

Vehicle 7152 Observations

Logger 56 collected data on Vehicle 7152 for a period of 37 days of the 81-day study period. Validation occurred on 99.0% of the vehicle data. This vehicle is home based on Oakley Avenue in Dubois, Idaho. According to the site survey, Vehicle 7152 is a support vehicle for the range, averaging 9,000 miles per year. The odometer read 57,478 during the study.

As shown on the history graph (Figure D-29), this vehicle had a typical routine of travel between 100 and 150 miles per day until the end of the study period. The final data reports covered a several day outing involving a trip to Salt Lake City and other points in Utah and to Cortez and Pagosa Springs in Colorado. This outing was from May 27 to June 4, 2012. It also contained the longest travel days recorded. Of all vehicle travel days, 54% were within the 70-mile BEV safe range and 30% were within the 40-mile battery-only range of a typical PHEV (the green bars on Figure D-30). Seventy-nine percent of the vehicle outings are within the 70-mile BEV safe range and 59% are within the battery-only range of a typical PHEV. A significant amount of idle time was recorded on this vehicle, with 49 idle events recorded of a length greater than 15 minutes and 6 of those were greater than an hour. The idle events occurred at many different locations.

It appears that a BEV may be a suitable replacement option for this vehicle if an alternate vehicle is available for the especially long trips. A PHEV is also a suitable option because most travel will be within the battery-only range and will maximize battery use. This assumes that the BEV or PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 4137

www.edmunds.com

Make/Model/Year	Ford Ranger/2007
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Home Base	US Hwy 20, Island Park
Fleet Vehicle ID	4137
Fuel Type	Gas
EPA Label / MPG (City/Hwy/Combined)	15/20/17
EPA GHG Emissions (Grams CO_2/Mi)	523
Study Logger ID	57
Total Vehicle Days/Total Study Days	26/78

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	66.9/271.6	48.3/772.2	10.4/76.8	1,740
Travel Time (Minutes)	115/499.0	82.9/1,663.0	17.9/151.0	2,986
Idle Time (Minutes)	12.9/NA	9.3/NA	2/NA	335

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	77	39.3%	Less than 2	161
10 to 20	3	1.5%	2 to 4	5
20 to 40	18	9.2%	4 to 8	4
>40	98	50.0%	Greater than 8	26

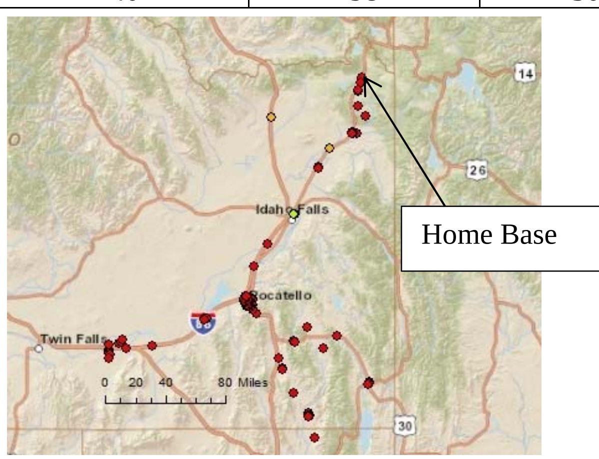


Figure D-31. Vehicle 4137 stops.

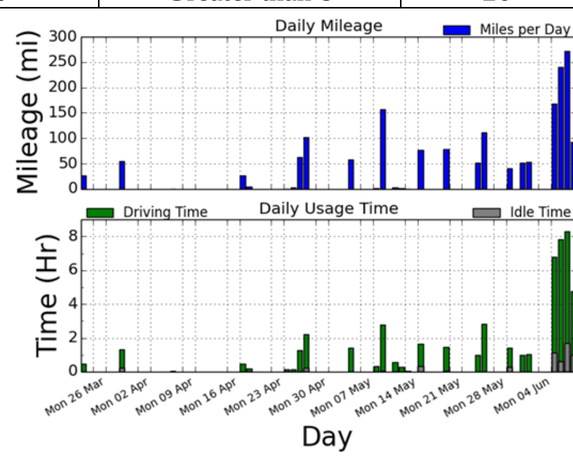


Figure D-32. Vehicle 4137 history.

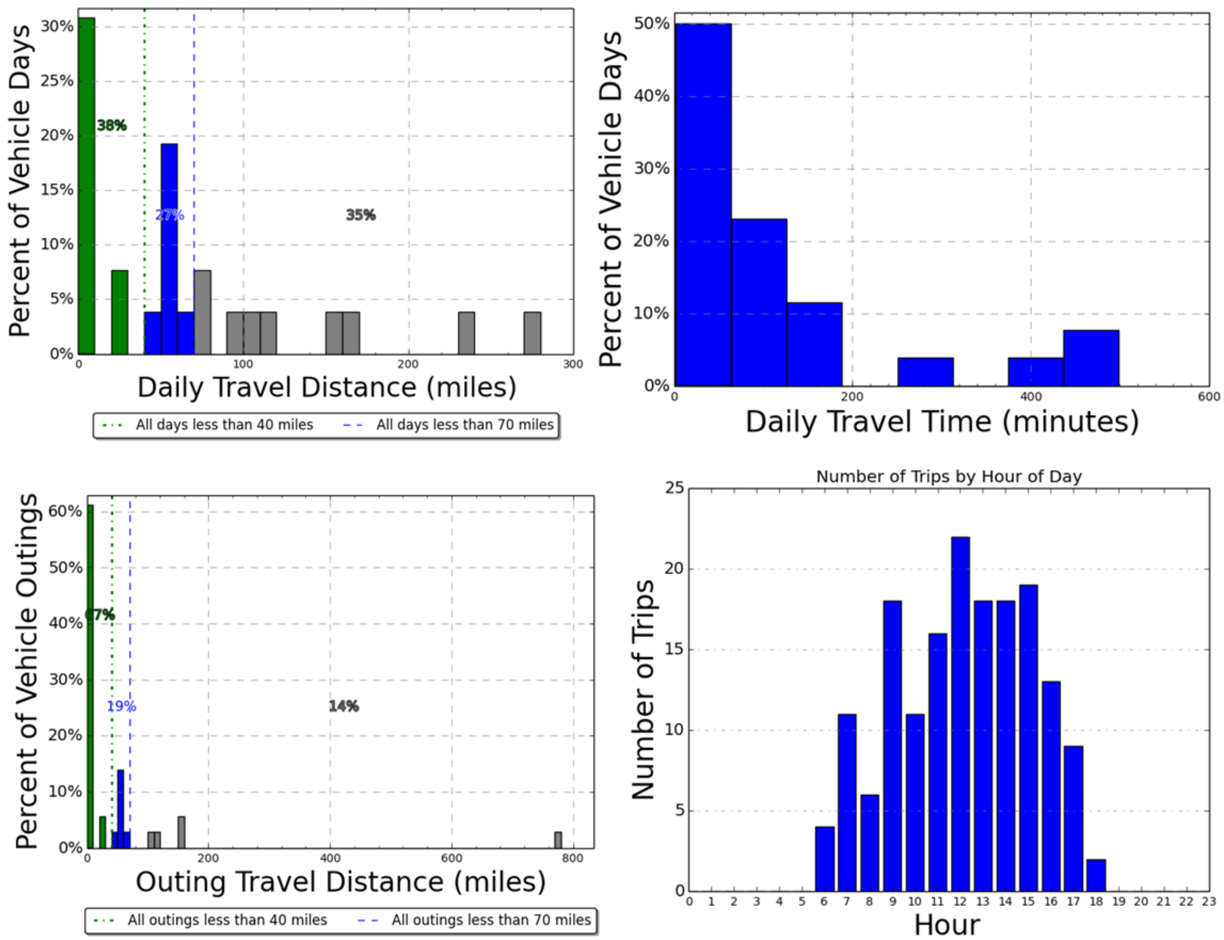


Figure D-15. Vehicle 4137 travel graphs.

Vehicle 4137 Observations

Logger 57 collected data on Vehicle 4137 for a period of 26 days of the 78-day study period. Validation occurred on 98.4% of the vehicle data. This vehicle is home based on U.S. Highway 20 or Chick Creek in Island Park. According to the site survey, Vehicle 4137 is a support vehicle for timber, averaging 11,000 miles per year. The odometer read 54,595 during the study.

As shown on the history graph (Figure D-32), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 65% were within the 70-mile BEV safe range and 38% were within the 40-mile battery-only range of a typical PHEV (the green bars on Figure D-33). The longest single daily travel of 272 miles occurred on June 6, 2012. This was part of a several days outing of 600 miles to Pocatello; Burley; American Falls; Richmond, Utah; and Idaho Falls. Eighty-six percent of the vehicle outings are within the 70-mile BEV safe range and 67% are within the battery-only range of a typical PHEV.

It appears that a BEV is not a suitable replacement for this vehicle unless another vehicle could be used for the extended outings. A PHEV is required for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.

Vehicle 4846

www.edmunds.com

Make/Model/Year	Ford F350/2011
EPA Class Size	Pickup
Mission	Support
Contact	Ms. Woods
Home Base	E 1300 N, Ashton, Idaho
Fleet Vehicle ID	4846
Fuel Type	Diesel
EPA Label/MPG (City/Hwy/Combined)*	13/18/14
EPA GHG Emissions (Grams CO_2/Mi)*	635
Study Logger ID	58
Total Vehicle Days/Total Study Days	35/82

Vehicle Travel Summary				
	Per Day Average/Peak	Per Outing Average/Peak	Per Trip Average/Peak	Total
Travel Distance (Miles)	71.1/206.1	35.5/206.1	11.9/78.6	2,488
Travel Time (Minutes)	122/339.0	61.0/339.0	20.4/106.0	4,268
Idle Time (Minutes)	19.0/NA	9.5/NA	3.2/NA	664

Total Stops			Stop Duration	
Distance From Home Base (Miles)	Stops	Percentages	Stop Duration (Hours)	Stops
Less than 10	146	60.3%	Less than 2	191
10 to 20	50	20.7%	2 to 4	14
20 to 40	39	16.1%	4 to 8	3
40 to 60	7	2.9%	Greater than 8	34

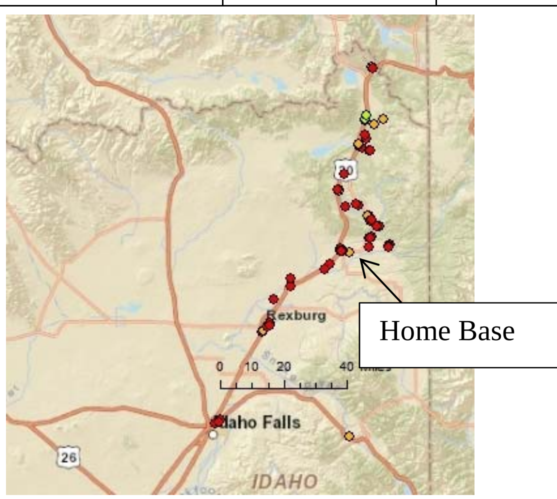


Figure D-34. Vehicle 4846 stops.

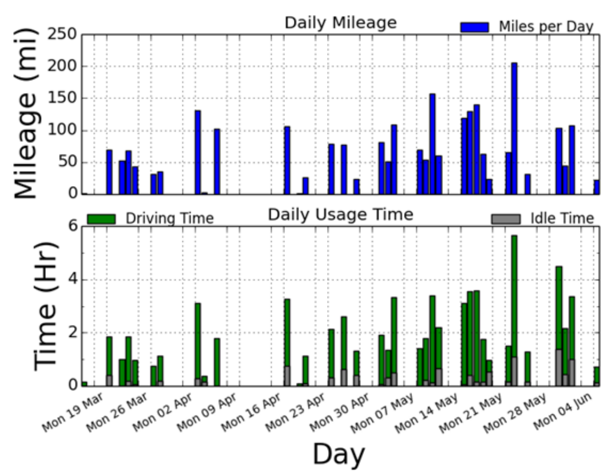


Figure D-35. Vehicle 4846 history.

*F350 diesel statistics are not available. F150 statistics identified.

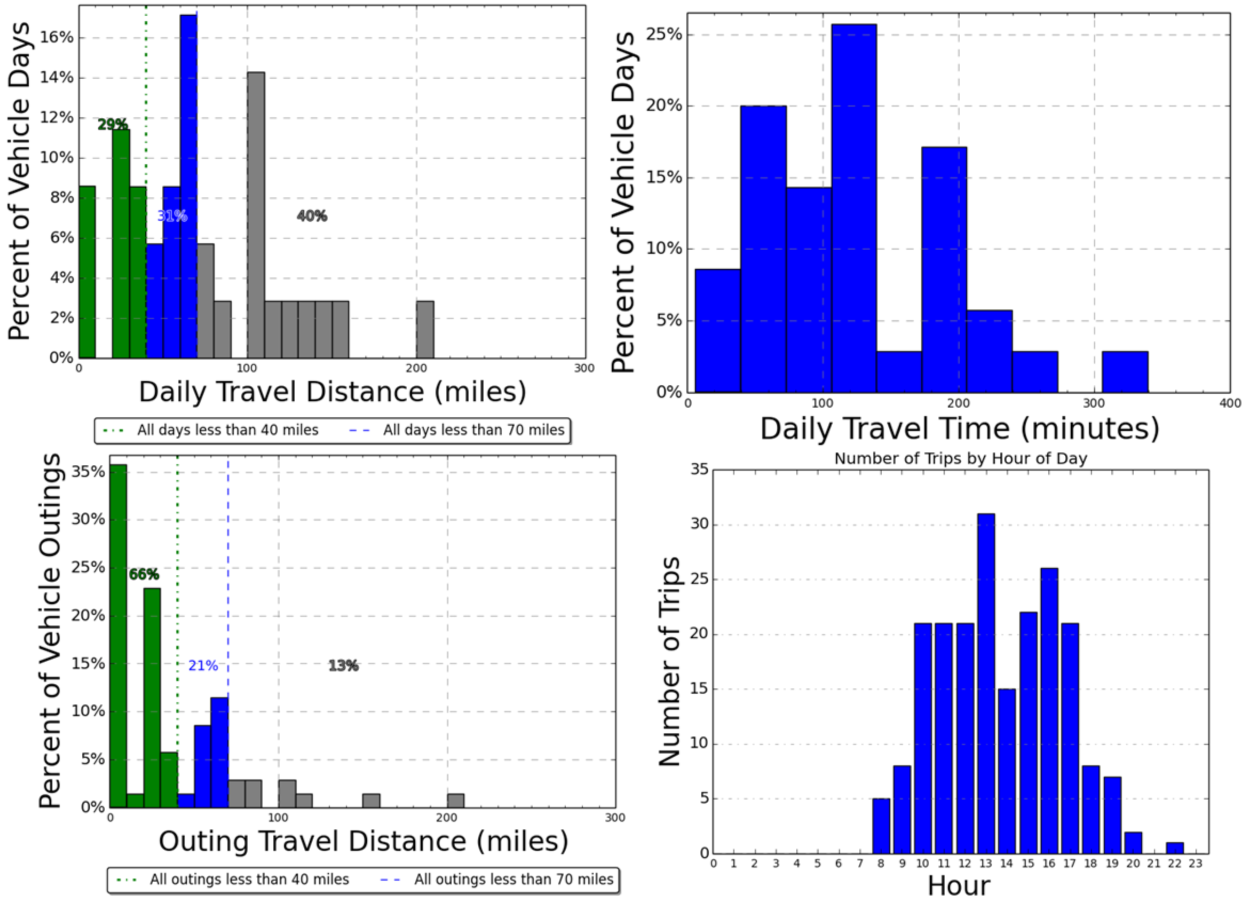


Figure D-16. Vehicle 4846 travel graphs.

Vehicle 4846 Observations

Logger 58 collected data on Vehicle 4846 for a period of 35 days of the 82-day study period. Validation occurred on 98.6% of the vehicle data. According to the site survey, Vehicle 4846 is a support vehicle for recreation, averaging 9,000 miles per year. The odometer read 1,907 during the study. The vehicle is home based at Ashton/Island Park Road.

As shown on the history graph (Figure D-35), this vehicle frequently travels distances in excess of the advertised range of BEVs (i.e., 70 miles). Of all vehicle travel days, 60% were within the 70-mile BEV safe range and 29% were within the 40-mile battery-only range of a typical PHEV (the green bars on Figure D-36). The longest single daily travel of 206 miles occurred on an outing on May 22, 2012, to Rexburg, Island Park, and back to Ashton. The trip both ways would have been within the range of a BEV if the vehicle had stopped at home base between each trip. Eighty-seven percent of the vehicle's outings are within the 70-mile BEV safe range and 66% are within the battery-only range of a typical PHEV.

It appears that a BEV may not be a suitable replacement for this vehicle unless another vehicle could be used for the extended outings. A PHEV could be used for the days that involve extended trips, assuming a PHEV can support the other mission requirements of this vehicle (such as cargo or other specifications). CTNF did not identify specific requirements at the time of the survey.