Tahoe-Truckee Plug-in Electric Vehicle Toolkit for Fleet Managers

May 2017

Submitted to:
Tahoe Regional Planning Agency

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1. Introduction

This toolkit was developed as part of the Tahoe-Truckee Plug-in Electric Vehicle (PEV) Readiness Project led by the Tahoe Regional Planning Agency. It provides an overview of the key considerations for fleet managers who are seeking to incorporate PEVs and charging infrastructure into their operations. This document is limited exclusively to light-duty vehicles and the charging infrastructure required to support these vehicles. There are many reasons why fleet managers might deploy PEVs–to reduce operating costs, enhance energy security, reduce exposure to volatile fuel prices, reduce regional greenhouse gas and air pollutant emissions, or outwardly demonstrate their commitment to environmental sustainability. Furthermore, government mandates and regulations increasingly require fleets to consider incorporating alternative fuel vehicles, like electric vehicles into their fleet. For instance, Governor Brown issued an Executive Order in 2012 ordering that the state's vehicle fleet increase the number of its zero-emission vehicles (including electric vehicles) so that at least 10 percent of fleet purchases of light-duty vehicles be zero-emission by 2015 and at least 25 percent of fleet purchases of light-duty vehicles be zero-emission by 2020.[1]

With the introduction of any new technology, there are questions and concerns that need to be addressed. This toolkit aims to help fleet managers address these questions by providing tips, resources, and best practices where applicable. To the extent feasible, the information presented in this toolkit is specific to the Tahoe-Truckee region, with recommendations and information tailored to local conditions based on research and stakeholder outreach.

The toolkit is structured as follows:

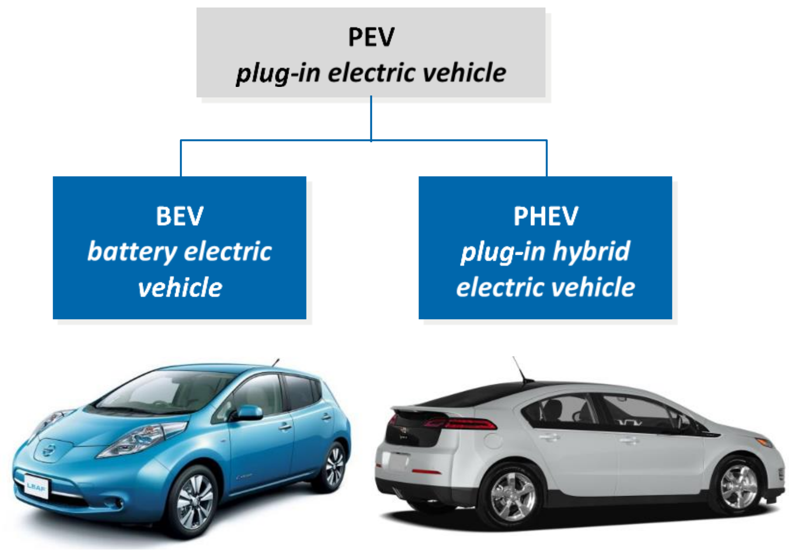
- **Technology overview:** Introduces the various PEV and charging infrastructure technologies available on the market today that are referenced throughout this toolkit.
- **Deploying PEVs:** Provides key considerations managers should think about when deciding if and what type of PEV is right for their fleet. This includes typical driving patterns, factors that affect the range of PEVs, total cost of ownership comparisons, and on-going maintenance.
- **Choosing the right charging infrastructure:** Discusses fleet manager considerations for choosing and siting charging infrastructure. This includes estimates for charging infrastructure costs and guidance on accessibility and signage.
- **Funding opportunities:** Lists incentive and grant programs available to help off-set or fund the cost of deploying of PEVs and charging infrastructure in fleet applications.
- **Best practices:** Includes information on minimizing the cost of installing new charging infrastructure, driver training, tracking vehicle performance, and using charging schedules.
- **Resources:** Outlines websites and publications that fleet managers can use for additional guidance.

[1] Executive Order B-16-12, available online at www.gov.ca.gov/news.php?id=17472

2. Technology Overview

2.1. Current Offerings and Market Outlook

PEVs include both plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs). PHEVs have both a battery-powered motor and an internal combustion engine (that uses gasoline) capable of powering the wheels. BEVs are powered exclusively by a battery-powered motor and do not use gasoline. The figure below shows the Nissan LEAF, a BEV, and a Chevrolet Volt, a PHEV.



Today, there are upwards of 30 light-duty PEV offerings to choose from, and the market continues to expand as automobile manufacturers roll out additional models. Table 1 below lists most of the currently available light duty PEVs, as well as several that are expected to be available within the next 12-18 months. The table also includes the expected all-electric range in miles for each vehicle. Over the past several years, technological advancements (largely in batteries) have extended the electric range significantly.

Table 1. Available PEV Models and Corresponding Electric Range

PEV Architecture	Light Duty Vehicle Make & Mode	Est. Electric Range (miles)
BEV	Tesla Model S, Tesla Model X, Tesla Model 3[1]	230-260
BEV	Chevrolet Bolt	200
BEV	Nissan Leaf, Kia Soul, Mercedes Benz B-Class, Fiat 500e	84-107
BEV	BMW i3, Chevy Spark, VW eGolf, Ford Focus, Honda Fit, Mitsubishi iMiev, Smart ForTwo	62-83
PHEV	Chevy Volt	53
PHEV	Cadillac ELR, Audi A3e, Hyundai Sonata	27-37
PHEV	BMW X5 & i8, Porsche Cayenne, Volvo XC90	13-20
PHEV	Ford C-Max Energi, Ford Fusion Energi, Toyota Prius Prime, Mitsubishi Outlander[2]	20-22

[1] Tesla reports that the Model 3 will start to ship in 2017.
[2] Mitsubishi reports that the Outlander SUV will start to ship in mid-2017.

In the Tahoe-Truckee region, most fleet managers consider all-wheel drive (AWD) or four-wheel drive (4WD) capability a necessary vehicle specification due to the need to drive in snowy or off-road conditions. Currently there are very limited PEV offerings with AWD, and for those that do have it - such as the Tesla Model X and other luxury PHEVs from BMW and Volvo – the price point is simply too high for fleet managers to justify. The good news is that over the next few years, we will see greater diversification in PEV offerings at more affordable price points. Tesla's Models 3 will be priced around $35,000—$$40,000 before incentives and will get more than 200 miles of range. Mitsubishi is planning to roll out their Outlander PHEV in mid-2017, a cross-over SUV that gets around 20-30 miles of all-electric range (with a back-up gas engine). This model has been very successful in Europe, where it has been the best-selling PHEVs on the market.

Figure 1. Mitsubishi Outlander PHEV with AWD, scheduled to be available in the U.S. in mid-2017 (Photo credit: insideevs.com)

Although this toolkit is focused on light-duty PEVs, the electric vehicle market is expanding rapidly and within a few years there will be a larger selection of vehicles, presumably including more AWD vehicles and even pick-up trucks. Ford announced in December that it has big plans to build over ten new hybrids, PHEVs, and BEVs by 2020.[2] Ford executives have also noted that they are working on a plug-in hybrid F-150 for 2020. Tesla has hinted at an electric pick-up truck but has not released any firm details. Workhorse, an Ohio-based manufacturer, just recently announced their first plug-in hybrid pick-up truck offering called the W-15. They are promising an all-electric range of 80 miles (with back up gasoline engine), a price point less than $50,000 before incentives, and production starting no later than 2018. Duke Energy, the city of Orlando and the city of Portland have all signed nonbinding letters of interest to purchase the W-15.[3]

2.2. Charging Infrastructure Types

Electric vehicle charging infrastructure is typically differentiated by the maximum amount of power that can be delivered to the vehicle's battery. This determines the time that it takes to charge the vehicle's battery. **Table 2** below provides a summary of the three types of charging that will be discussed in this toolkit. The charging equipment is referred to as electric vehicle supply equipment (EVSE), and each EVSE has at least

Keeping up to date on the latest PEVs:

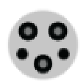
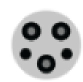
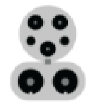
- Alternative Fuels Data Center: Availability of Hybrid and Plug-in Electric Vehicles, and Plug-in America
- For news and technology updates: Green Car Reports and Hybrid Car News

[2] http://www.businessinsider.com/15-electric-cars-that-will-be-here-by-2020-2016-6/#mercedes-benz-is-aiming-to-launch-at-least-one-new-electric-car-by-2018-11

[3] http://www.hybridcars.com/workhorse-group-plans-a-phev-pickup-truck-with-80-mile-electric-range/

one (but often more than one) charge port or plug.

Table 2. Electric Vehicle Supply Equipment Types

	Level 1 AC	Level 2 AC	DC Fast Charging		
Description	Uses a standard plug - 120 volt (V), single phase service with a three-prong electrical outlet at 15-20 amperage (A)	• Used specifically for PEV charging • ~ 240 V AC split phase service that is less than or equal to 80 A.	• Used specifically for BEV charging • Typically requires a dedicated circuit of 20-100 A, with a 480 V service connection.		
Connector type(s)					
	J1772 charge port	J1772 charge port	J1772 combo	CHAdeMO	Tesla combo
Limitations	Low power delivery lengthens charging time	Requires additional infrastructure and wiring	Can only be used by BEVs currently. Provides power much faster than the AC counterparts, but are more expensive to build and operate due to the necessary equipment and electrical upgrades		
Time to charge	2—5 miles of range per hr. of charging. Depending on the vehicle battery size, PHEVs can be fully charged in 2-7 h and BEVs in 14-20+ h.	10—25 miles of range per hr. of charging. Depending on the vehicle battery size, PHEVs can be fully charged in 1-3 h and BEVs in 4-8 h	50—70 mi of range per 20 min of charging Depending on the vehicle battery size, BEVs can be fully charged in 30-60 mins		
Infrastructure required	• Charging outlets should have ground fault interrupters installed and a 15 minimum branch circuit protection. • Requires no new electrical service for a building operating on an existing circuit.	• Requires additional grounding, personal protection system features, a no-load make/break interlock connection, and a safety breakaway for the cable and connector. • If 240 V service is not already installed at the charging site, a new service drop will be required from the utility.	• Requires a three phase DC power supply with 480 V service. • Requires additional grounding, personal protection system features, a no-load make/break interlock connection, and a safety breakaway for the cable and connector.		

3. Deploying PEVs

The first step in deploying PEVs is to map out how current fleet vehicles are being used to see if PEVs would be suitable replacements. It is important to understand vehicle use patterns such as daily mileage, typical terrain, weather, and where the vehicle is housed or parked when it’s not in use. The following section provides key considerations that fleet managers should think about when deciding if and what type of light-duty PEVs are well suited for their fleet.

As cost effectiveness is often the highest priority of fleet managers, we have included information on the cost differential of owning a PEV compared to a conventional gasoline powered vehicle. Although the initial purchase price of a PEV is higher, savings on fuel and maintenance can make them financially attractive over a vehicle's lifetime. Our analysis takes a total cost of ownership approach that is tailored to the Tahoe-Truckee region.

3.1. Typical driving patterns

Understanding the duty-cycle of vehicles targeted for replacement is an important first step in determining the suitability of PEVs. Fleet managers should consider the following questions pertaining to typical vehicle use patterns:

- **How many miles are driven per day?** If the vehicle has a low daily mileage then an all-electric BEV will be a suitable replacement. For vehicles that are typically driven longer distances or have unpredictable mileage patterns, a PHEV with a back-up gasoline engine may be a better option.
- **How many trips are taken per day?** The number and frequency of daily trips may impact the ability to recharge a vehicle's battery. This may be less of a concern with extended range vehicles such as the Chevrolet Bolt, which can travel around 200 miles when fully charged. For PHEVs, maximizing the use of the electric engine by keeping the battery charged up before the next trip ensures that the on-going cost savings of driving electric are realized.

3.2. Factors that affect electric vehicle range

Similar to gasoline powered vehicles, there are many factors that can affect the fuel efficiency of PEVs. The distance a vehicle can be driven using only an electric motor (i.e., all-electric range) can vary significantly based on driving conditions and driver habits. Of particular importance in the Tahoe-Truckee region is weather and terrain.

- **Weather:** Extreme cold temperatures can reduce PEV range capability by 20-40 percent.[4] Heating the cabin of the vehicle draws more auxiliary power from the battery so it has less energy to devote to propulsion. When batteries are cold, they also don't provide as much power as warm ones. Many PEVs have thermal management systems to keep the battery at an optimal temperature, however warming the battery uses power that reduces range.

  Like conventional vehicles, precautions will need to be taken to allow the vehicles to start and function normally. This may include keeping vehicles in garages and using good battery thermal management systems. Allowing the battery to remain plugged in to even a Level 1 charger will

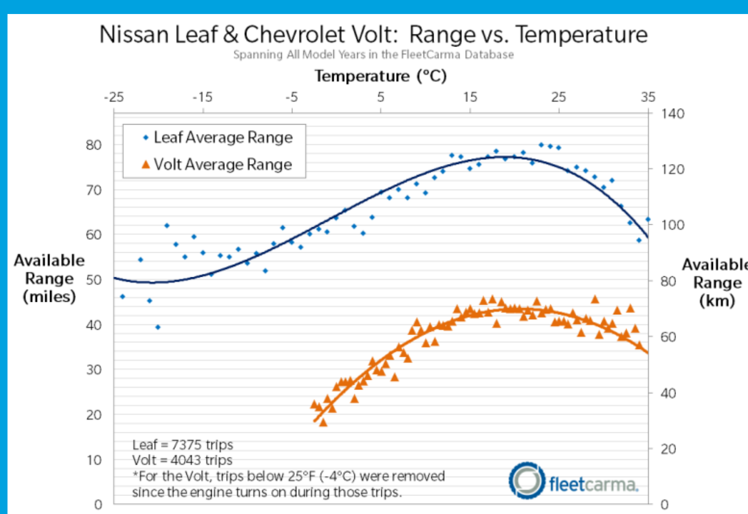
[4] FleetCarma, 2013, 'Electric Vehicle Range for the Nissan Leaf and Chevrolet Volt in Cold Weather,' http://www.fleetcarma.com/nissan-leaf-chevrolet-volt-cold-weather-range-loss-electric-vehicle/. The Chevrolet Volt turns on the gasoline engine intermittently at temperatures below 25°F (-4°C), so trips with ambient temperatures below that threshold were excluded.

keep the battery warm and will be critical to normal function. Further, fleets may want to consider alternative options to increase the cabin temperature, such as the use of seat heaters. Direct seat heating helps mitigate the losses of battery life, as it is more efficient than heating the entire vehicle's cabin. However, this too will draw power from the battery and decrease battery range depending on the driver and/or passenger settings. By pre-starting these vehicles while attached to a charger, drivers can allow the vehicle cabin to warm and the windshield to defog before operating the vehicle on a reduced range.

Cold Weather Performance of Electric Vehicles

Two things happen when a vehicle system is cold: 1) it will lead to an increase in auxiliary power consumption as drivers increase energy demand to heat the passenger cabin and to operate the defogger, and 2) vehicle components will become less efficient from increases in internal friction as an engine or battery gets colder. The greatest impact on range in cold weather usually comes from auxiliary loads, such as cabin heaters and fans and component heaters (i.e., battery heaters). Conventional vehicles use waste heat to help warm the cabin, but because all-electric vehicles do not generate sufficient waste heat, an electric heater must be used. Cabin heating therefore reduces the battery charge and potential range of a PEV. For some PEVs, a pre-heating setting is available to allow the battery and cabin heaters to run while still plugged in, preventing any initial loss in range to heat the vehicle. PHEVs can heat the cabin from engine rather than battery thereby minimizing battery efficiency loses at the expense of gasoline.

Based on findings of the AAA Automotive Research Center, PEV battery range on a limited number of sample vehicles was reduced by nearly 60% at -7°C (20°F), largely due to the vehicles auxiliary loads. Another report by researchers at Carnegie Mellon University found similar results. FleetCarma, a vehicle monitoring service for major auto manufacturers, aggregated data from Chevrolet Volt and Nissan Leaf drivers to assess the range impact at temperatures between -25°C (-15°F) and 35°C (100°F).



- **Terrain:** Driving up hills requires more energy and therefore draws more power from the battery than driving on flat terrain. PEVs do have regenerative braking that recovers some of the energy used to climb hills, but there is still an effect on range.

  Fleet managers will have to consider over-sizing the battery in the case of purchasing battery electric vehicle (BEV). In the case of PHEVs, fleet managers will not have to worry about range, as they have a gasoline engine. However, they can seek to maximize electricity consumption by identifying and maximizes the opportunities to charge the battery.

- **Driving habits**: Speeding on highways, accelerating too fast, and abruptly braking can also affect the range of PEVs. Range is maximized when drivers maintain constant speeds and brake slowly to take advantage of the full energy saving capability of the regenerative braking system.

Another important aspect to consider is where the vehicle is typically parked, as this will impact the type of charging equipment needed and the frequency of charging sessions. This will be addressed in Section 4—Choosing the Right Infrastructure.

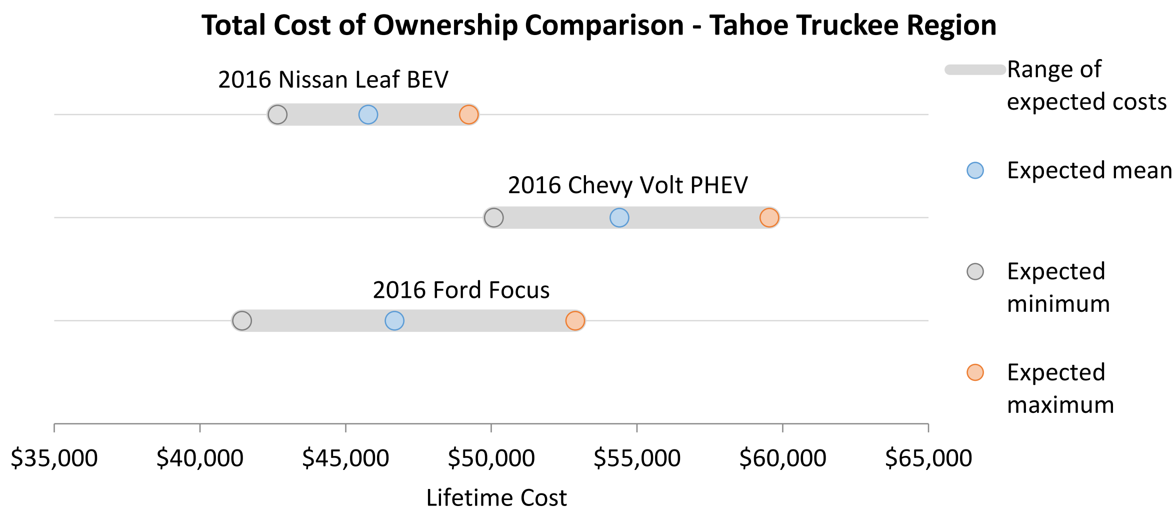
3.2.1. Total Cost of Vehicle Ownership

Fleet purchasing decisions are often based on the upfront cost of vehicles. Although the purchase price of PEVs are more expensive than conventional vehicles, they often have a lower total cost of ownership (TCO) when looking at the costs incurred throughout a vehicle's useful life. Conducting TCO analyses that compare PEVs and conventional vehicles is a valuable exercise that can help fleet managers understand if PEVs are a cost-effective solution for their fleet application and help influence procurement decisions.

To demonstrate the cost-effectiveness of PEVs, we conducted some illustrative analyses that compare the lifetime vehicle costs of a Nissan LEAF (BEV), a Chevrolet Volt (PHEV), and a Ford Focus (conventional gasoline vehicle). We ran different scenarios, varying by annual vehicle mileage, the general or time-of-use electricity rates from local utilities (Liberty Utilities, NV Energy, and Tahoe-Truckee Public Utility District), gasoline prices, and electric miles traveled for PHEVs.

ICF notes that we did **not** consider the cost of charging infrastructure in this analysis because this introduces another variable with a broad range of potential costs. These include the level of charging (Level 1 vs Level 2 vs DC fast charging), location of charging, potential electrical upgrades, type of equipment installed, networking fees, accessibility, etc. The number of variables yields too many combinations to consider for an illustrative analysis. Fleets, however, will have to consider the costs of vehicle charging infrastructure, as outlined elsewhere in this document.

The results of each of these scenarios are summarized in the figure below. The TCO assumptions are included after the figure.



ICF used the following assumptions in our TCO estimates:

- Vehicle miles traveled: 8,000—12,000 miles annually
- Gasoline price: $2.50—$4.00/gallon
- For the Volt PHEV, we assumed 40—80% of miles are traveled using electricity.
- Annual insurance costs:[5] Conventional vehicle—$1,294, PHEV—$1,273, and BEV—$1,165
- Maintenance costs[6]: Conventional vehicle—5.99¢/mi, PHEV—4.93¢/mi, and BEV—4.45¢/mi
- Electricity rates are shown in the table below.

Table 3. Electricity Rates

Utility	Electricity Rate	Electricity Price ($/kWh)	Source
Liberty	A-1 Small General Service	$0.14056	Liberty utilities
Liberty	TOU A-1 Small General Service - Off-peak	$0.11373	Liberty Utilities
NV Energy	General Service Standard Rate	$0.07525	NV Energy
NV Energy	Optional General Service EV TOU Rate	$0.03962	NV Energy
TDPUD	Small Commercial Rate	$0.15900	Truckee Donner Public Utility District

There are many TCO calculators available for fleet managers to use to conduct their own analysis, including:

- The Department of Energy (DOE) Alternative Fuels Data Center website provides a Vehicle Cost Calculator. This tool uses basic information about driving habits to calculate total cost of ownership

[5] Insurance rates based on zip code look up at Edmunds.com. A 10% discount to BEVs was applied based on a Farmers Insurance discount.
[6] Raustad and Fairey, Electric Vehicle Life Cycle Cost Assessment, 2014. Available online at: http://fsec.ucf.edu/en/publications/pdf/FSEC-CR-1984-14.pdf

and emissions for makes and models of most vehicles, including BEVs and PHEVs. Users can modify assumptions such as the price of gasoline. However, it is not possible to modify the price of electricity so this tool is not useful if you want to take time-of-use rates into considerations.

- BeFrugal.com's Electric Car Calculator is similar to DOE's tool, as it allows you to compare multiple vehicles in terms of annual and lifetime vehicle costs and environmental impact. You can modify the price of gasoline and electricity in this tool, which allows for a more regionally-specific analysis and the benefit of charging on a time-of-use rate.
- To analyze the impact of a whole fleet, Argonne National Laboratory's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool may be a good choice. This tool that estimates petroleum use, greenhouse gas emissions, air pollutant emissions, and cost of ownership of light-duty and heavy-duty vehicles, including PEVs, using simple spreadsheet inputs.

3.2.2. Ongoing maintenance

Compared to conventional vehicles, BEVs (and PHEVs, but to a lesser extent) have fewer on-going maintenance concerns and expenses. Electric motors have fewer moving parts - there is no oil that needs be changed, transmissions to repair, and brake pads don't need to be replaced as often because of regenerative braking. The battery, motor, and associated electronics of electric vehicles require little to no regular maintenance. Studies suggest the total maintenance costs of BEVs may be one third less than a conventional gasoline vehicle of similar size and use pattern.

Like all vehicles and other fleet assets, PEVs should be on a preventative maintenance schedule tailored to their needs, as directed by the vehicle manufacturer. They will need periodic inspections to ensure that brakes, tires, suspension, and overall safety of the vehicle meet applicable standards. Any problems should be reported to vehicle dealership for maintenance and repair—this is a barrier in the Tahoe-Truckee region with no dedicated PEV dealerships. Fleet managers will have to consider carefully maintenance considerations during the procurement process and work with dealers or vendors to ensure they have a strategy for preventative maintenance in place. Currently, it is unclear if vehicle manufacturers are offering training to fleet mechanics to diagnose or repair electric drive systems. If this changes, then fleet managers will need to provide appropriate electric vehicle training to their mechanics or outsource the services to dealerships.

Long-term battery performance is often a concern of fleet managers. Batteries can lose capacity over time. To alleviate these concerns, the majority of manufacturers are offering vehicle warranties. Nissan has a 96-month/100,000-mile battery warranty standard with the purchase of a new LEAF. Chevrolet has a similar program for their new Bolt BEV, offering an eight year or 100,000 mile battery warranty. These warranties will likely cover the expected lifetime of a PEV in a fleet application.

4. Choosing the Right Charging Infrastructure

There is a variety of electric vehicle charging equipment available today and costs can vary depending on the charging level required, desired amenities and installation location. The following section discusses fleet manager considerations for choosing charging infrastructure and presents a range of cost estimates.

4.1. What type of charging equipment is needed

Most fleets use either Level 1 or Level 2 charging equipment, as the more powerful DC fast chargers are typically not needed and are much more expensive to install.

Level 1 chargers use a standard 120 volt three-prong plug with a single phase service at 15-20 amperage. The low power delivery lengthens the time required to charge – typically an hour of charging on a Level 1 will give vehicles 2 to 5 miles of electric range. Therefore, Level 1 chargers are most suitable for PHEVs that have smaller batteries or BEVs that are routinely parked overnight or for at least four or more consecutive hours each day.

Level 2 chargers use a 240 volt plug with a split phase service at less than or equal to 80 amperage. They provide more charging power to vehicles in a shorter time then Level 1 chargers, delivering between 10 and 25 hours of electric range per hour plugged in. Level 2 chargers are needed for BEVs who are routinely parked for only a few hours at a time, and for BEVs with larger batteries (like the 200 mile Chevy Bolt, which would take over 30 hours to get a full charge on a Level 1).

The costs of both Level 1 and Level 2 charging equipment can vary widely based on the service and networking capabilities. The most basic chargers are usually adequate for fleet charging applications and employee parking where fee collection is not required. These units are essentially just plugs that connect the vehicle to charger. However, some types of basic chargers come with keypads to allow for access control.

More sophisticated charging equipment, often called “smart chargers”, is more expensive than basic chargers because they allow for data capture and analytics and the option to collect fees for charging. Commonly available features in smart charging equipment includes: verification of the user by RFID card, point-of-sale using credit cards, display of fee rates, text or email notification of a completed session, plug-out notification, internet location of charging unit with rates, in-use status, and reservation capabilities. Data capture and analytics commonly include: date, location, electricity used for each charging session, monthly reports, and fee totals.

4.2. Determining the right location

The location of charging equipment can impact utilization and installation costs. Placing chargers in locations convenient to drivers is important. While BEVs have to be charged to be driven, PHEVs do not, since their gasoline engines can be used. If chargers are burdensome to access, PHEVs drivers might not charge as often, which limits the emissions benefits and cost savings associated with driving electric.

The most cost-effective charging installations are those in close proximity to an existing electrical panel that has the capacity to handle the additional load required for vehicle charging. The California Department of General Services recommends that the following factors should be accounted for when choosing a location for charging equipment:[7]

- Existing electrical panel distribution voltage – Does the existing voltage meet the requirement of the desired charging station? If not, can transformers be added to obtain the desired voltage?
- Existing panel capacity evaluation – The sum of the proposed charging equipment full load amperage and existing loads may overload the existing electrical distribution equipment. Load testing can potentially determine if the panel will exceed the capacity.
- Distance between the electrical panel and charger location – the length of the conductors will affect installation design and material costs. Factors such as conduit size, conductor sizing, trenching, circuit voltage drop and other requirements will need to be assessed, especially if additional future charging equipment is planned.
- Networking access – If "smart" chargers are planned, strong reception of cellular phone signals or wired phone lines are needed.
- Lighting – charging locations should have illumination levels that meet or exceed the minimum necessary for operation of the equipment.

4.3. Charging infrastructure cost estimates

Charging infrastructure costs are primarily comprised of hardware, permitting, and installation. As noted previously, the costs vary by charging level, site characteristics, and equipment features.

Table 4 below summarizes the expected costs of Level 1 and Level 2 charging installations in non-residential applications.

[7] California Department of General Services. 2014. Electric Vehicle Supply Equipment Guidance Document. Retrieved from https://www.documents.dgs.ca.gov/green/EVSE.pdf.

Table 4. Cost ranges for single port electric vehicle charging stations in non-residential applications[8]

Cost Element	Level 1		Level 2	
	Low	High	Low	High
Hardware	$300	$1,500	$400	$6,500
Permitting	$100	$500	$100	$1,000
Installation	$0*	$3,000	$600	$12,700
Total	**$400**	**$5,000**	**$1,100**	**$20,200**

* The $0 installation cost assumes a standard outlet for PEV users to plug in their Level 1

The values presented in the table above are based on single charge ports being installed at each location. It is worth noting that the marginal cost of the next charger installations—for each level of charging infrastructure shown in the table above–is a fraction of the total installed cost listed. The charging equipment hardware is the only cost element that does not yield some benefit with increased number of installations. This is particularly relevant because the hardware represents a small fraction of the overall cost for both Level 1 and Level 2 equipment.

4.4. Considerations for Charging Available to the Public

If fleets opt to make charging equipment in a parking lot or other location that will be available for use by the general public, then fleets will need to make arrangements for ADA accessibility and consider signage. These issues are covered in the sub-sections below.

4.4.1. Accessibility Requirements

If the charging equipment is <u>installed in a parking lot and will be made available for use by the public</u>, then it will need to be designed so that it meets the California requirements for ADA accessibility.

Table 5 shows the number of each type of accessible space that is required based on the total number of chargers at a location, according to the 2016 California Building Code. These new requirements go into effect on January 1st, 2017 and encompass three types of ADA access:

- <u>Ambulatory</u> parking spaces designed for people with disabilities who do not require wheelchairs, but may use other mobility aids;
- <u>Standard accessible</u> spaces designed for people who use wheelchairs but can operate vehicles; and
- <u>Van accessible</u> spaces for vehicles carrying people who use wheelchairs who cannot operate their own vehicles.

[8] Cost ranges are based on data from U.S. Department of Energy. 2015. Costs Associated with Non-Residential Electric Vehicle Supply Equipment and EPRI. 2013. Electric Vehicle Supply Equipment Installed Cost Analysis.

Table 5. Number of accessible chargers required at installations of new public charging spaces[9]

Total chargers	Minimum required van accessible chargers	Minimum required standard accessible chargers	Minimum required ambulatory chargers
1-4	1	0	0
5-25	1*	1	0
26-50	1*	1*	1
51-75	1*	2*	2
76-100	1*	3*	3
101+	1, plus 1 for each 300 over 100*	3, plus 1 for each 60 over 100*	3, plus 1 for each 50 over 100

* Indicates a case where at least one charger is required to be identified with an international symbol of accessibility and restricted to vehicles with an ADA accessible parking placard.

4.4.2. Signage

If charging stations will be made available for use by the public or are located at facilities open to public travel, then appropriate signage needs to be installed. The California Vehicle Code (CVC) requires that an off-street PEV charging spot be properly identified with signage,[10] and the California Manual on Uniform Traffic Control Devices (MUTCD), which creates consistent standards for signage on public roads, contains several signs and markings to designate spaces for EV chargers.[11] These include:

- General service signs to indicate the location of chargers (Figure 2), which can be combined with directional arrows to guide drivers to chargers;
- Parking signs to designate restrictions or time limits on charging spaces (Figure 3); and
- Pavement markings to designate restrictions on charging spaces (Figure 4).

None of these signs are required by the MUTCD, but they should be used wherever applicable to provide consistency for drivers in search of charging. General service signs should be used at all charging stations, and parking signs and pavement markings should be used where applicable (see the following section for a discussion of time limits and enforcement).

[9] California Building Standards Commission, 2016 California Building Standards Code; Section 11B-228.3 describes the number of accessible chargers required and Section 11B-812 describes spatial requirements for accessible chargers.
[10] California Vehicle Code §22511.1(a).
[11] California Department of Transportation (Caltrans), California Manual on Uniform Traffic Control Devices, Section 2I.03; summarized in Caltrans Policy Directive 13-01.

Figure 2. General service sign for chargers and additional signage to indicate DC fast chargers

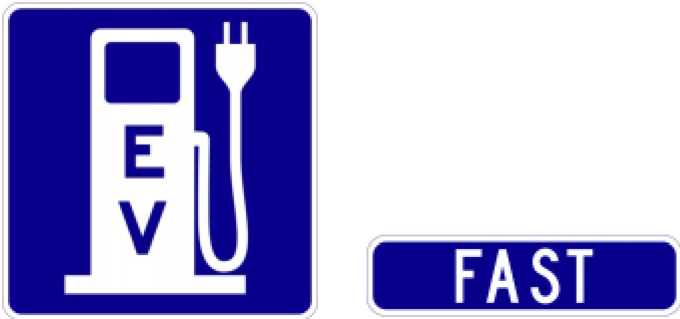
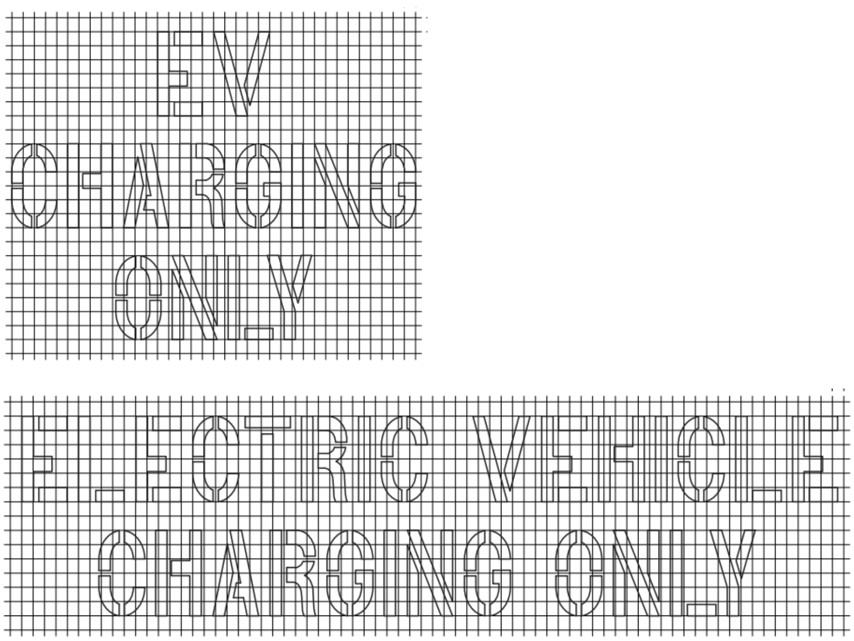


Figure 3. Parking signs to place restrictions or time limits on charging spaces

Figure 4. Pavement markings indicating restrictions on charging spaces



5. Incentives and Funding Opportunities

There are various government sponsored incentive and grant programs available to help off-set or fund the cost of deploying PEVs and charging infrastructure in fleet applications.

- At the federal level, tax liable entities can receive a **Plug-In Electric Drive Vehicle Tax Credit** for the purchase or lease of new PEV for $2,500-$7,500, depending upon battery capacity.
- Fleets in California can also apply for the **Clean Vehicle Rebate Program (CVRP)** incentive**,** administered by the California Air Resourced Board (CARB). CVRP provides rebates of $1,500-$2,500[12] for the lease or purchase of new, ARB-certified PEVs. Public fleets are limited to 30 rebates per calendar year; traditional rental car fleets and car sharing fleets are restricted to 20 rebates per calendar year. Private fleets are limited to two rebates per year.
- Over the lifetime of the vehicle, California fleets who own PEVs can save on **insurance discounts**. Farmers Insurance provides a discount of up to 10% on all major insurance coverage for PEV owners. AAA offers up to a 5% discount.
- In Nevada, PEVs are **exempted from Nevada's emissions testing requirements**, which can provide additional savings.
- Liberty Utilities and NV Energy provide **reduced electricity prices for charging that occurs during off-peak hours** through Time-of-Use and EV specific rates. Compared to general service rates, these reduced rates can provide a 19 to 47 percent savings for each kWh consumed during off-peak hours.
- Local government fleets can leverage federal funding to deploy PEVs and charging infrastructure via the **Congestion Mitigation and Air Quality Program (CMAQ)**, which can be granted through regional metropolitan or transportation planning organizations. This is an annual grant funding process, with selection based on the cost effectiveness on reducing emissions.
- In some California counties such as El Dorado and Nevada, funding for PEVs and charging infrastructure may be available through **local air quality districts via funds generated from DMV fees**. These programs typically have an annual grant funding process and selection based on the cost effectiveness of reducing emissions.

Case Study: El Dorado County

El Dorado County has successfully leveraged multiple funding streams to support their PEV program. By working with the local air district and transportation planning agency, the County could obtain $250,000 in CMAQ funds to cover the incremental cost of purchasing PEVs (compared to their gasoline-powered equivalent) and for the installation of charging infrastructure. The El Dorado County Air Quality Management has also leveraged State funding through the CEC's ARFVTP program. For this grant, they were awarded $60,450 to install 15 charging stations along the highway 50 corridor.

[12] Except for rental, public and car share fleets, no single entity is eligible to receive more than two CVRP rebates either via direct purchase and/or lease as of January 1, 2015. All rebates issued prior to this date do not count toward the two rebate limit. Public fleets are limited to 30 rebates per calendar year.

- The **Nevada State Energy Program (SEP) Formula Grant** is an annual source of federal funds from the U.S. Department of Energy that is used to fund and promote a variety of energy efficiency and renewable energy projects throughout Nevada. SEP formula grants funded the purchase and installation of a charging station at the Carson City Community Center in 2013, and is currently being used to help finance the Nevada Electric Highway Joint Initiative.

Case Study: Nevada County

Nevada County was able to fund the installation of two new charging stations at their office building by applying for the Northern Sierra Air Quality Management District's emissions reduction funding opportunity. The district is actively seeking more applicants for their annual grant funding process.

- The California Energy Commission's **Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)** is a competitive grant program that provides funding for charging infrastructure, light duty PEV deployment, workforce training and development, and regional PEV readiness plans. ARFVTP has funded the installation of over 6,000 charging stations in California to date, with another 1,433 planned.
- By opting-in to California's **Low Carbon Fuel Standard (LCFS),** entities, including fleets, providing electricity as a vehicle fuel can earn LCFS credits. These credits can then be sold on the LCFS market to generate revenue that can help fund PEV programs. The amount of revenue earned per LCFS credit depends on the carbon intensity of the electricity used and the market price of credits at the time they are being sold. For example, electricity consumed at the California state average carbon intensity could generate between four and fifteen cents in revenue per kilowatt-hour, based on market prices ranges between $50 and $200 per LCFS credit.

6. Best Practices

6.1. Minimizing the cost of installing new charging infrastructure

PEV charging infrastructure can be overly expensive if it is not sited optimally. Below is a list of tips for minimizing PEV charging station costs, as recommended by the Department of Energy (DOE) Clean Cities program.[13]

When choosing which type of charging equipment to purchase:

- Choose charging equipment with the minimum level of features that you will need.
- Choose a wall mounted unit, if possible, so that trenching or boring is not needed.
- Choose a dual port unit to minimize installation costs per charge port.
- Determine the electrical load available at your site and choose the quantity and level of equipment to fit within that available electrical capacity.

When looking at possible locations for charging equipment:

- Place the charging equipment close to the electrical service to minimize the need for trenching/boring and the costs of potential electrical upgrades.
- Instead of locating the charging station at a highly visible parking spot a great distance from the electrical panel, use signage to direct PEV drivers to the charger.
- If trenching is needed, minimize the trenching distance.
- Choose a location that already has space on the electrical panel with a dedicated circuit.

It is also important to consider long term PEV fleet planning. Fleet managers should consider the quantity and location of charging stations that they plan to install over the next 5—15 years before they install their first charging unit. Taking a “dig once” approach can help minimize the cost of installing future units–this includes upgrading the electrical service for the estimated future charging load and running conduit to the anticipated future charging locations.

[13] Department of Energy, Clean Cities. 2015. Costs Associated with Non-Residential Electric Vehicle Supply Equipment. http://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf

6.2. Driver training

Introducing a new technology that changes the way drivers typically behave can be challenging for fleet managers. Drivers who have had no previous experience with PEVs will have questions about how far they can travel and may express concerns over range anxiety. For PEVs to be successfully integrated, fleet managers will need to ensure that drivers are familiarized with vehicle features and charging infrastructure, as well as the driving habits for optimal PEV performance and safety. There are a variety of ways this can be accomplished. If the vehicle is being assigned to one or just a few people, then the fleet manager should review the vehicle and charger features with the driver before the keys are handed over. Keeping a frequently asked questions document in the vehicle with contact information is also a good back-up if any questions or issues arise after the initial orientation. For general pool vehicles, fleet managers should provide group workshops or training sessions. It should be required that new drivers attend training before reserving a vehicle for the first time. The City of Seattle developed a short training video in lieu of a mandatory workshop, which is also helpful for drivers if they need to refresh themselves on specific vehicle features.

PEV Driver Orientation Checklist
The Bay Area Climate Collaborative developed a PEV Orientation Checklist that fleet managers can use as a template. For more information, see Appendix C of the Ready, Set Charge Fleets Guidebook

Management can also adopt policies that encourage the use of PEVs over gasoline powered vehicle whenever possible. The City of Seattle established PEVs as the default choice and only when these vehicles are not suitable can users opt for a different vehicle. The City of Houston implemented a tracking process that tries to identify users that check out gasoline powered vehicles for trips that could have been completed with a PEV. They then conduct targeted education of drivers to encourage them to use the PEVs.

6.3. Tracking vehicle performance and charging behavior

Tracking vehicles and charging behavior can be a valuable tool for fleet managers to compare how PEVs are performing and also identify and remedy issues that may arise with introducing a new technology to drivers. For a simple tracking mechanism, drivers could record the mileage and energy use data provided by most PEVs at the end of each trip. This data can help fleet managers understand utilization and efficiency patterns of PEVs. More in-depth data collection can be accomplished through automated data collection systems offered by fleet management software or charging equipment suppliers. “Smart” charging units can report on many key variables of interest to fleet managers including the date, time, location, and electricity used for each charging sessions. Such data can provide valuable information on energy use and charging infrastructure utilization. Through gathering this type of data, it is also possible identify drivers who are not plugging in the vehicles properly and conduct follow-up education to ensure vehicles and equipment are being used correctly.

6.4. Implementing a charging schedule

Planning when and where PEVs will be charged can help substantially reduce the cost of fueling with electricity. Before installing charging infrastructure, contact the local utility to discuss the existing electricity consumption at the proposed sites, the estimated demand that will be added by charging PEVs, and how that might affect demand charges. Working closely with the utility on these matters will help fleet managers develop a charging schedule that balances PEV charging with other electricity usage.

Charging schedules can also ensure that vehicles are pulling electricity from the grid at times that are most cost effective, such as off-peak hours on a time-of-use rate. This can be accomplished easily through either charging equipment or vehicle that allow users to set pre-determined times for when they want the vehicles to start and end charging sessions. Most PEVs now have companion applications for smart phones that allow users to set charging schedules, even with the most basic charging equipment.

7. Resources

- U.S. Department of Energy (DOE) Clean Cities Plug-in Electric Vehicle Handbook for Fleet Managers: published in 2012, this guidebook describes the basics of PEV technology, PEV benefits for fleets, how to select the right PEV, charging a PEV, and PEV maintenance.
- The California Plug-In Electric Vehicle Collaborative' s Community Toolkit for Plug-In Electric Vehicle Readiness highlights actions communities can take to get ready for PEVs and offers tangible best practices examples and case studies from communities and stakeholders throughout California and abroad
- Ready, Set, Charge, Fleets! PEV Fleet Deployment Strategies (2015) provides details on PEV fleet deployment strategies for fleet managers that are interested in transitioning to electric vehicles. The Guide includes total cost of ownership assessment, duty-cycle considerations, infrastructure siting, and numerous other substantive and practical considerations for deployment of PEV in public and private fleets.
- The California Department of General Services published an Electric Vehicle Supply Equipment Guidance Document in 2014. It was developed to assist facility and fleet managers in the planning, budgeting, installation, and data collection of electric vehicle charging stations at state-owned buildings, parking garages and surface lots.
- The US Federal Highway Administration and the Oregon Department of Transportation developed an online toolkit to provide a library of curated resources related to innovative finance mechanisms for alternative fuel vehicles, along with case studies, plans, and guides.

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