Tahoe-Truckee Local Government Plug-in Electric Vehicle Toolkit

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Submitted to:
Tahoe Regional Planning Agency

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1. Introduction

1.1 Purpose and Content of this Guide

This toolkit provides an overview of the key considerations for local governments who are seeking to support the deployment of plug-in electric vehicle (PEV) charging infrastructure. To the extent feasible, the information presented in this toolkit is specific to the Tahoe-Truckee region. Where appropriate, the recommendations and information has been tailored to local conditions based on research and stakeholder outreach. The document introduces the following concepts and provides guidance and best practices for local governments. The information presented is intended to serve multiple goals, including helping local governments initiate action to support the regional deployment of PEVs and charging infrastructure, and provide supporting information in areas where local governments seek to expand their reach.

The document is structured as follows:

- **Definitions:** Provides an introduction of the various PEV and charging infrastructure technologies available on the market today that are referenced throughout this toolkit.
- **Charging Infrastructure at New Developments:** Outlines how local governments can use incentives and policy to promote the deployment of charging infrastructure at new developments in their jurisdiction.
- **Installing Charging Stations**: Introduces the nuts-and-bolts of installing a station, including basic requirements, reviews sample configurations, installation costs ranges, and funding or financing opportunities.
- **Managing Charging Stations**: This section captures what to expect after the station has been installed and is operational; it explores ownership structures, fees, time limits, and enforcement protocols.
- **Permitting Considerations:** Local governments interact directly with installers and utilities through the permitting process. This section provides recommendation to streamline the permitting process while making sure installations are safe and consumer protections are robust.
- **Resources:** Provides a list of websites and publications that local governments can reference for guidance in addition to this toolkit.

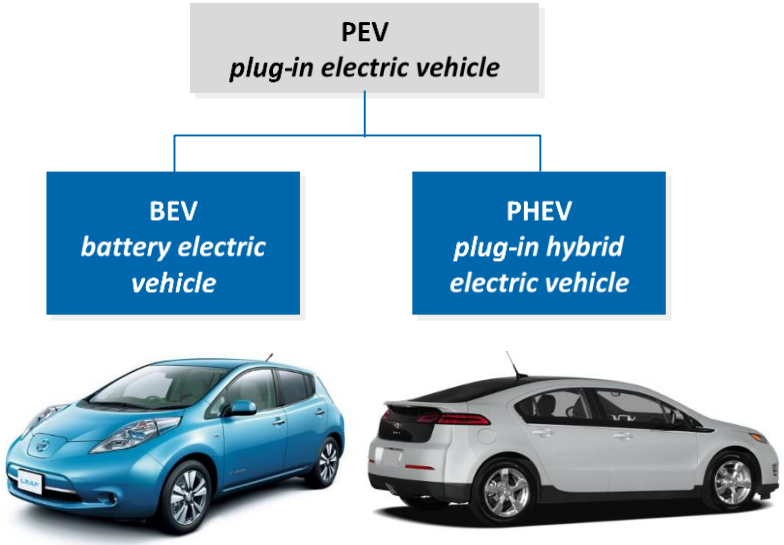
1.2 Benefits of Regional Charging Network

By supporting the development of a robust regional PEV charging network, local governments can help the Tahoe-Truckee region become a PEV destination and corridor. This is a great opportunity to demonstrate leadership in an emerging industry while also improving local air quality and reducing greenhouse gas emissions. Hosting charging stations or making it easier for others to do so will help support the deployment of more PEVs in the region by reducing driver range anxiety. Making it easier and more convenient for people to own PEVs also helps households save money on gasoline. A UC Berkeley study found that on average, a dollar saved at the gas pump and spent on other goods and services that households want creates sixteen time more jobs.[1] By taking steps to become "PEV ready" local governments in the Tahoe-Truckee region can help attract and retain the increasing number of residents, second homeowners, and visitors who drive PEVs.

2. Definitions

2.1 Vehicle Types

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.



[1] Roland-Holst, David. September 2012. Plug-in Electric Vehicle Deployment in California: An Economic Assessment. Retrieved from https://are.berkeley.edu/~dwrh/CERES_Web/Docs/ETC_PEV_RH_Final120920.pdf.

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

Table 1. Electric Vehicle Supply Equipment Types

	Level 1 Alternating Current	Level 2 Alternating Current	Level 2 & 3 Direct Current (aka DC fast charging)		
Description	Uses a standard plug - 120 volt (V), single phase service with a three prong electrical outlet at 15-20 amperage (A)	• Used 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
Use	Residential or workplace charging	Residential, workplace, or opportunity charging	Rapid charging along major travel corridors		
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 to 5 miles of range per 1 hour of charging Depending on the vehicle battery size, PHEVs can be fully charged in 2-7 hours and BEVs in 14-20+ hours	10 to 25 miles of range per 1 hour of charging Depending on the vehicle battery size, PHEVs can be fully charged in 1-3 hours and BEVs in 4-8 hours	50 to 70 miles of range per 20 minutes of charging Depending on the vehicle battery size, BEVs can be fully charged in 30-60 minutes.		
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.		

2.3 Charging types

- **Residential charging** occurs at home and can occur at Level 1 or Level 2.
- **Workplace charging** would typically be provided by an employer to employees via on-site charging facilities. Workplace charging would typically occur at Level 1 and Level 2.
- **Opportunity charging** is a broad category that captures non-residential and non-workplace charging. It can occur at retail locations, shopping centers, gas stations, or other areas where the amount of time a person typically spends parked is similar to the amount of time needed to charge. Level 1, Level 2, and DC Fast Charging are suitable for opportunity charging, depending on the location and type of site host.
- **Fleet charging** refers to the charging of electric vehicles in a commercial or government fleet, which is assumed to occur at some fleet-owned location.

3. Charging Infrastructure at New Developments

Local governments have an important role to play in the development of public and private PEV charging infrastructure due to their authority over zoning, parking, signage, building codes, and permitting and inspection processes. Local governments can use their authority to regulate and approve new development projects to ensure that ample charging opportunities are available. There are many ways to go about this. The most common is to require pre-wiring, which is when builders run electrical conduit that can power charging equipment to locations where vehicles will be parked. Since no chargers are installed, pre-wiring in and of itself does not create new charging opportunities, but it dramatically reduces the costs of installing chargers in the future. Local governments can also go a step further and require charging equipment to be installed, or they can take a softer approach and offer incentives or adopt policies that encourage charger installations.

There are a number of mechanisms through which local governments can require or encourage charging. These mechanisms are discussed below as well as issues to be considered when determining how best to foster more charging opportunities. There is no one “right” way to create new charging opportunities at private developments, but taking action now sets a precedent that local governments can expand upon as charging demand or development patterns shift.

3.1 Mechanisms to require charging stations or pre-wiring

3.1.1 Building Codes

Building codes set standards for new construction, and they are the most common mechanism through which local governments can require pre-wiring or charging. The 2016 Green Building Standards Code (CalGreen), effective as of January 1st, 2017, requires that all new developments include pre-wiring for Level 2 (208/240V) charging, so any local government that adopts the state building code by reference will have pre-wiring requirements in place. Specifically, CalGreen’s mandatory requirements specify that new single-family homes and townhomes with attached garages must pre-wire locations where vehicles

will be parked, and that multifamily developments with 17 or more units must pre-wire at least three percent of total parking spaces.[2] At non-residential developments, pre-wiring is required for a portion of total parking spaces, as summarized in **Table 2**.

Table 2. CalGreen non-residential EV pre-wiring requirements[3]

Total Number of Parking Spaces	Number of Required EV Charging Spaces
0-9	0
10-25	1
26-50	2
51-75	4
76-100	5
101-150	7
151-200	10
201 and over	6 percent of total

Local governments can take additional action to exceed the mandatory requirements in CalGreen by mandating pre-wiring for a greater proportion of spaces or requiring actual charger installations in lieu of pre-wiring. This could be achieved by adopting all or part of the voluntary tier 1 or tier 2 sections of GalGreen through an ordinance amending the local municipal code.

3.1.2 Parking Requirements and Zoning Development Standards

Local governments specify how much parking should be provided at different locations and/or land uses in their zoning ordinances, development guidelines and standards, or accompanying parking codes, and as such these documents can also include charging requirements or incentives. Local governments with minimum parking requirements in place may also wish to consider whether PEV parking should count toward overall parking requirements. Allowing PEV parking to count toward parking requirements is recommended, which would incentivize developers to provide PEV parking without increasing the total number of spaces required.

Zoning ordinances and development regulations are similar to building codes in that they can be used to specify in detail how much charging or pre-wiring should be provided, and where. However, there are two key differences between zoning ordinances and parking codes that allow local governments more flexibility in determining how to best create more charging opportunities:

[2] California Building Standards Commission, 2016 California Green Building Standards Code (GalGreen), California Code of Regulations, Title 24, Part 11, Chapter 4, Section 4.106.4. http://codes.iccsafe.org/app/book/toc/2016/California/Green/index.html.

[3] CalGreen, Chapter 5, Section 5.106.5.3

- **Zoning ordinances can be used to increase charging opportunities in high priority locations:** Whereas building codes usually categorize land uses broadly (e.g., residential and non-residential), zoning ordinances can be more nuanced, distinguishing between residential districts of different densities, non-residential districts with differing types and mixes of uses, or high-activity areas such as downtowns and transit stations. This means that zoning ordinances offer more flexibility to focus new infrastructure in the places where it matters the most, such as downtowns and activity centers with high turnover that are good candidates for opportunity charging or employment centers that need more workplace charging opportunities.
- **Zoning ordinances offer more flexibility in how to implement new charging infrastructure**: A zoning ordinance that requires pre-wiring would have the same effect as the CalGreen update discussed above. However, a local government could require actual charger installations at new developments in specific areas through its zoning ordinance or development standards,[4] or offer developers incentives such as density bonuses in exchange for providing increased charging opportunities. For instance, through its Planning Regulations, the City of Emeryville requires that at least 3% of parking spaces in parking facilities containing 17 or more spaces serving multi-unit residential and lodging uses shall be electric vehicle charging stations. Such spaces may be counted towards parking requirements. For all other uses, EV charging stations are eligible for development bonuses.[5]

3.1.3 Policies

Local governments can include policies and goals in general plans, climate action plans, or similar documents that require or encourage electric vehicle charging. These plans are broader and less detailed than building codes and zoning ordinances, so policies calling for increased charging opportunities typically do not contain specific details on where chargers are needed or on how much charging should be provided. However, even voluntary or vague policies can provide a basis for local governments to negotiate with developers to install chargers during discretionary review, as well as set the stage for more detailed implementation through building codes or zoning ordinances.

Examples of Local Government PEV Policies & Goals

- TRPA 2016 Regional Transportation Plan "Facilitate the use of electric vehicles and zero emission vehicles by individuals and in public and private fleets by supporting increased deployment of vehicle charging and alternative fuel infrastructure within the Region and surrounding areas, and supporting incentives and education of residents, businesses, and visitors related to the use of electric and zero emission vehicles."
- The City of Cupertino's Climate Action Plan includes a goal to encourage community-wide use of alternative fuel vehicles through expansion of alternative vehicle refueling infrastructure. Specific actions include developing a siting plan, pre-wiring requirements, and public outreach program.

[4] Technically, it would be possible to require charger installations in lieu of pre-wiring through a local update to the building code, but this requirement would likely only make sense in areas with high charging need, so it will be more feasible to implement through a zoning ordinance that better allows local governments to focus on these high-need areas.
[5] City of Emeryville Planning Regulations, Emeryville Municipal Code Title 9 Ordinance No. 13-001. http://www.emeryville.org/DocumentCenter/View/814.

3.1.4 Considerations

The following considerations can help local governments determine the most appropriate way to create opportunities for new charging infrastructure.

What is getting updated next? The number of EVs on the road is growing rapidly, and the best opportunity to get EV-ready is almost always the most imminent one. Unless local decision-makers have specifically directed staff to update plans, ordinances, or codes to increase charging opportunities, any changes to these documents will likely take place in the context of a comprehensive update, which is a complex process that happens relatively infrequently. Local governments should watch for opportunities to incorporate policy language, incentives, or requirements into all updates to plans, ordinances, and codes—including adopting and enforcing the 2016 update to the building code with its pre-wiring requirements. Even if short-term actions do not include firm requirements or detailed language, they can still set the stage for stronger changes in the future.

How much new development will there be? All of the mechanisms discussed above apply only to new development; apart from funding property owners to install chargers local governments have little authority to create charging infrastructure at existing development. Making detailed changes to a building code or zoning ordinance to exceed current pre-wiring requirements or focus charging in high-need areas will only be worthwhile if there is enough new development at which to implement these changes. Otherwise, it may be easier and equally effective to enact policies encouraging charger installations that provide a basis for negotiating with developers when opportunities arise.

Are there high-priority charging locations? If so, a zoning ordinance is likely the best mechanism to create more charging infrastructure at these locations.

4. Installing Charging Stations

4.1 General Requirements

The State of California has created requirements for pre-wiring charging spaces in new development, indicating chargers with signage, and providing chargers that are accessible for disabled people. Table 2 summarizes these requirements as they apply to charging spaces in new development and newly-constructed charging stations and lists the source of each requirement.

Table 3. Summary of requirements for charging spaces and stations in new development

	One- and two-family residential	Multi-family residential	Nonresidential	Source
Number or pre-wired spaces required	1	3% of all spaces; at least 1	Approx. 1 in every 20	CalGreen[6]
Electrical requirements	Listed raceway to accommodate a 208/240-volt branch circuit	Listed raceway to accommodate a 208/240-volt branch circuit	Listed raceway to accommodate a 208/240-volt branch circuit	CalGreen (basic pre-wiring requirements); California Electrical Code, Article 625 (detailed requirements)
Dimensions	N/A	9’ x 18’	N/A	CalGreen
Signage required?	No	Yes	Yes	CalGreen (requirements); MUTCD[7] (allowable signage)
Number of accessible spaces required	None	1 in every 25 pre-wired spaces; at least 1.	Approx. 1 in every 15 chargers	CalGreen (spaces), California Building Code[8] (chargers)

The requirements summarized above can be detailed and highly technical, particularly the electrical requirements involved in charger installation, and we do not discuss them in depth here. However, we summarize two aspects of particular concern to installers: signage and Americans with Disabilities Act (ADA) accessibility. Installers should always refer to source documents when conducting installations.

4.2 Signage

Surface street directional signage serves two important functions. It directs PEV users to the nearest public charging infrastructure locations and educates non-PEV drivers about the availability of charging infrastructure in their community, allowing them to consider how a PEV might work for them. This important outreach element also enables the community to show its support for PEVs.

The California Vehicle Code (CVC) requires that an off-street PEV charging spot be properly identified with signage.[9] The California Manual on Uniform Traffic Control Devices (MUTCD), which creates

[6] California Building Standards Commission, 2016 California Green Building Standards Code (GalGreen); see Section 4.106.4 for residential requirements and Section 5.106.5.3 for non-residential requirements.
[7] California Department of Transportation (Caltrans), California Manual on Uniform Traffic Control Devices, Section 2I.03; summarized in Caltrans Policy Directive 13-01.
[8] 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.
[9] California Vehicle Code §22511.1(a).

consistent standards for signage on public roads, contains several signs and markings to designate spaces for EV chargers,[10] including:

- General service signs to indicate the location of chargers (**Figure 1**), which can be combined with directional arrows to guide drivers to chargers
- Parking signs to designate restrictions or time limits on charging spaces (**Figure 2**)
- Pavement markings to designate restrictions on charging spaces (**Figure 3**).

Federally Designated Alternative Fuel Corridors

The Federal Highway Administration (FHWA) is establishing a national network of alternative fueling and charging infrastructure for electric, natural gas (LNG and CNG), hydrogen, and propane fuel vehicles across the country. The corridor designations were divided into two categories.

- Signage-ready corridors currently have sufficient facilities to warrant signage along the corridor.
- Signage-pending corridors currently have demonstrated plans for future operational infrastructure.

FHWA will work with state and local agencies in these areas to identify existing barriers related to the installation of facilities.

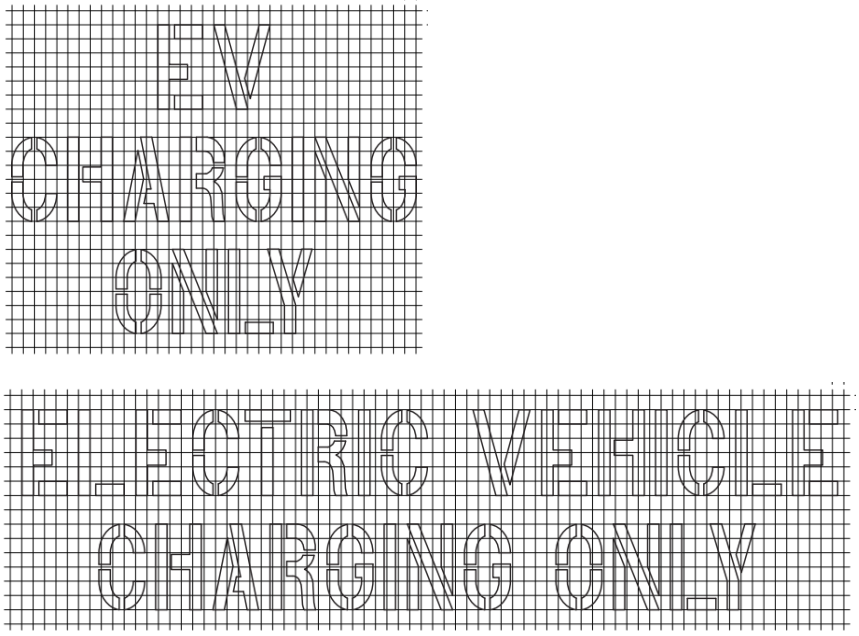
None of these signs are required by the MUTCD, but they should be used wherever applicable to provide consistency for drivers in search of charging. General service signs should be used at all charging stations, and parking signs and pavement markings should be used where applicable (see the following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

Figure 1. General service sign for chargers and additional signage to indicate DC fast chargers

[10] California Department of Transportation (Caltrans), California Manual on Uniform Traffic Control Devices, Section 2I.03; summarized in Caltrans Policy Directive 13-01.

Figure 2. Parking signs to place restrictions or time limits on charging spaces

Figure 3. Pavement markings indicating restrictions on charging spaces



Although not required, some charging station hosts choose to install educational signage. As shown below, the Truckee-Donner Public Utility district designed a sign that describes the environmental benefits for supporting PEVs.

4.3 ADA accessibility

Under the California Building Code, a portion of all chargers at multi-family buildings and non-residential developments are required to be accessible to people with disabilities. It is important to take these requirements into account when planning to install chargers because they impact the spatial requirements, and potentially the cost, of installations. The first new charger constructed is required to be accessible and be significantly wider than a typical parking space, not including space for adjacent access aisles. Property owners may have to sacrifice multiple regular parking spaces to build the first charging space.

Accessibility requirements for pre-wired charging spaces at new multi-family developments: CalGreen requires that multi-family residential developments with 17 or more parking spaces shall have three percent of parking spaces, but in no case less than one space, pre-wired for a level 2 charger. One in every 25 of these spaces, and at least one, are required to have an adjacent access aisle that is eight feet wide, though this width can be reduced to five feet if the space is over 12 feet wide. These spaces are also required to be relatively flat.[11]

Accessibility requirements for new public charger installations: The California Building Code requires roughly 1 of every 15 newly-installed chargers at public locations to be accessible. There are three different design standards for accessible parking spaces:

- Ambulatory parking spaces designed for people with disabilities who do not require wheelchairs, but may use other mobility aids.
- Standard accessible spaces designed for people who use wheelchairs but can operate vehicles.

[11] California Building Standards Commission, 2016 California Green Building Standards Code (GalGreen), Section 4.106.4.2.2.

- Van accessible spaces for vehicles carrying people who use wheelchairs who cannot operate their own vehicles.

Table 4 shows the number of each type of accessible space that is required based on the total number of chargers at a location.

Table 4. Number of accessible chargers required at installations of new public charging spaces[12]

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.

The Building Code describes in detail the site configuration requirements for accessible charging,[13] which include:

- level ground with a slope of less than 1:48
- vertical clearance of at least 98”
- location along an accessible route to the associated facility
- minimum widths of 144” (van accessible), 108” (standard accessible), 120” (ambulatory), 204” (drive-up)[14]
- accompanying access aisles at least 60” wide

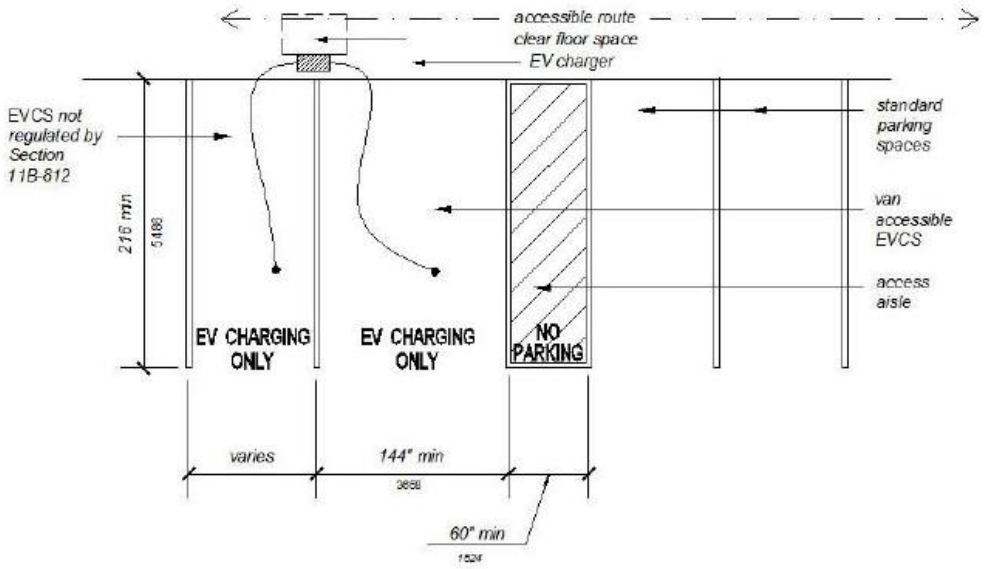
In some cases, charging spaces differ from most accessible parking spaces in that they are not required to be restricted to vehicles with an accessible parking permit. The Office of Planning and Research advises indicating accessible spaces that can be used by other vehicles with a sign stating, “Designed for Disabled Access - Use Last.”[15]

[12] California Building Standards Commission, 2016 California Building Standards Code, Section 11B-812.
[13] California Building Standards Commission, 2016 California Building Standards Code, Section 11B-228.3
[14] A drive-up EVCS is an EVCS in which use is limited to 30 minutes maximum and is provided at a location where the PEV approaches in the forward direction, stops in the vehicle space, charges the vehicle, and proceeds forward to depart the vehicle space. California Energy Commission, Accessibility Requirements for Electric Vehicle Charging Infrastructure.
[15] Governor’s Office of Planning and Research, Plug-In Electric Vehicles: Universal Charging Access Guidelines and Best Practices, https://www.opr.ca.gov/docs/PEV_Access_Guidelines.pdf.

4.4 Configurations

There are many possible configurations for electric vehicle charging stations, depending on where they are sited and who they will be used by. Public access stations that must comply with the ADA accessibility mentioned in the previous section and need to meet certain requirements. **Figure 4**, **Figure 5** and **Figure 6** below present some sample configurations of ADA compliant public access charging stations, and **Figure 7** shows a local Truckee charging station configuration.

Figure 4. Possible configuration for 2 EV charge ports[16]



[16] Configuration presented by Dennis J. Corelis (California Deputy State Architect) at the May 24th 2016 PEV Collaborative Webinar. Available online < http://www.pevcollaborative.org/sites/all/themes/pev/files/PEVC_presentation_160524.pdf>

Figure 5. Possible configuration for 3 EV charge ports[17]

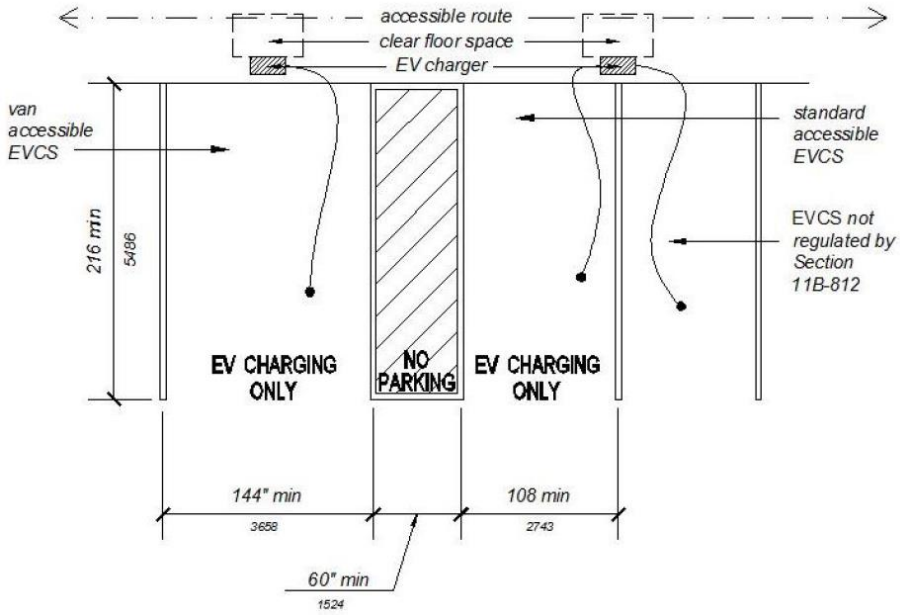
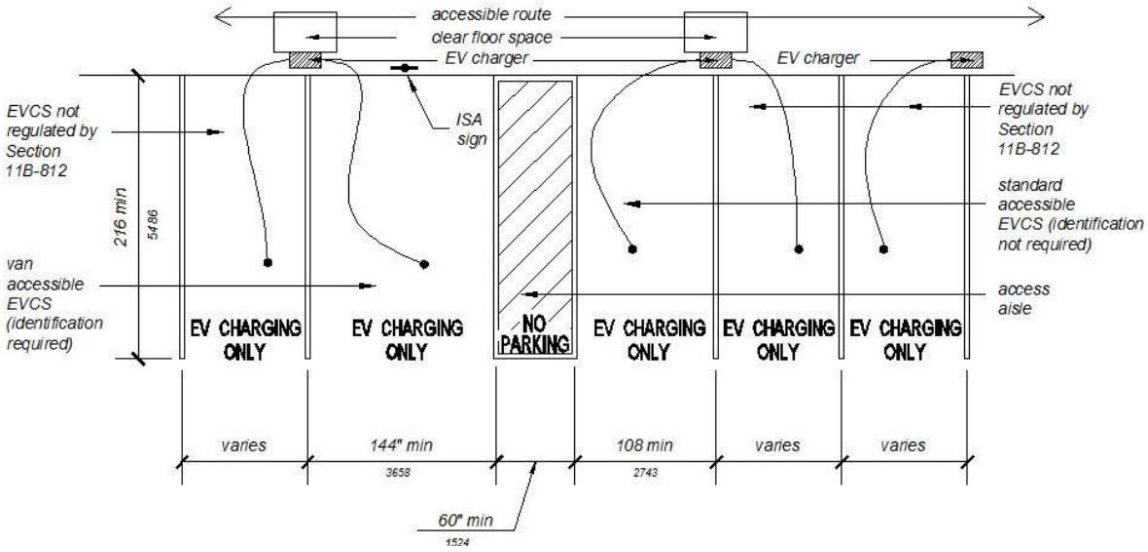


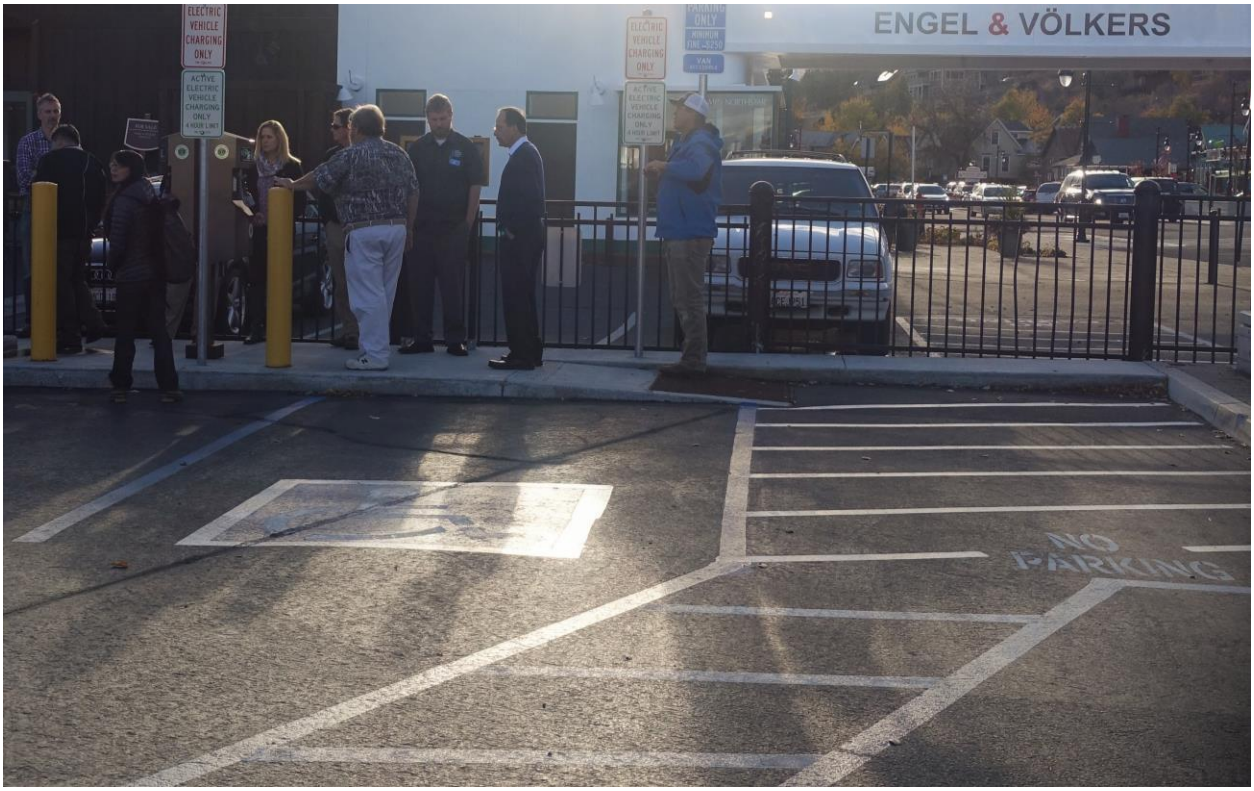
Figure 6. Possible configuration for 5 EV charge ports[18]



[17] California Building Standards Commission, 2016 California Building Standards Code, Section 11B-812, Figure 11B-812.9 Surface Marking.

[18] Configuration presented by Dennis J. Corelis (California Deputy State Architect) at the May 24th 2016 PEV Collaborative Webinar. Available online at: http://www.pevcollaborative.org/sites/all/themes/pev/files/PEVC_presentation_160524.pdf

Figure 7. TDPUD PEV Charging Configuration in Truckee



4.5 Weather considerations

When deciding on charging station hardware and site configurations, it is important to consider weather impacts. Accumulated snow can obstruct access to charging stations, especially ADA access. A good example of this is shown in below.

In addition, snow plows can damage cords if they are not stored properly. Snow and ice can also encase the cable if it is lying on the ground or otherwise exposed. One way of minimizing these impacts is to choose charging station hardware that comes with cable management systems or with suspended cables.

Site design can also impact snow removal. The use of bollards and curbing to protect charging hardware from vehicular impacts is recommended because they still provide accessibility and reasonably convenient

Figure 8. Charging station whose accessibility has been impacted by snow accumulation (source: PlugShare)

snow removal. Wheel stops are not recommended for areas that have heavy snow accumulations, as they can be problematic for snow removal.

4.6 Installation Costs

Charging infrastructure costs are primarily comprised of hardware, permitting, and installation. Total costs vary by charging level, site characteristics, and equipment features. However, in workplace charging, fleet charging, and opportunity charging, there may be significant costs attributable to trenching and concrete, as well as ensuring ADA accessibility.

Table 5 below summarizes the expected costs of Level 1, Level 2, and DC fast charging installations in non-residential applications.

Table 5. Cost ranges for single port electric vehicle charging stations in non-residential applications[19]

Cost Element	Level 1		Level 2		DC fast charge	
	Low	High	Low	High	Low	High
Hardware	$300	$1,500	$400	$6,500	$10,000	$40,000
Permitting	$100	$500	$100	$1,000	$500	$1,000
Installation	$0*	$3,000	$600	$12,700	$8,500	$51,000
Total	**$400**	**$5,000**	**$1,100**	**$20,200**	**$19,000**	**$92,000**

* The $0 installation cost assumes the site host is offering an outlet for PEV users to plug in their Level 1

The values presented in the table above are based single charge ports being installed at each location. It is also 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. Even for DC fast charging equipment, there is potentially significant savings with about 25-60% of the installed cost represented by the hardware.

Factors that affect the cost of electric vehicle charging infrastructure include:

- **Type of mounting**: Charging hardware are available as wall mounted or pedestal mounted units. Pedestal mounted units typically costs $500-$700 more than their wall mounted counterparts due to material, manufacturing, and install construction costs.
- **Technological Features**: The simplest units provide a charging port and electricity, however there are many amenities and features that can be included in hardware and subscriptions such as data collection, usage monitoring, user communication, and billing options.

[19] 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.

- **Location:** The further away the charging station is from the electrical panel, the higher the installation costs. This is due to the need to trench or bore long distances to lay electrical supply conduit from electrical panel to the charging location. A 2013 EPRI study found that L2 sites that that required special work such as trenching or boring were about 25% more costly.[20]
- **Electrical needs:** In most cases, charging stations need a dedicated circuit for each EVSE unit on the electrical panel, sufficient electrical capacity from the utility connection the electrical panel, and sufficient electrical capacity at the panel. If the selected site does not meet these three key electrical needs, then electrical upgrades are required. The most common electrical upgrade for installing a L2 electric vehicle charging station is a re-organization of the panel to create space for a 40 amp circuit. However, more significant electrical work such as upgrading transformers is more expensive.

Another consideration is ADA compliance with regards to parking spaces for people with disabilities. These spaces may be underutilized with minimal potential to recoup the costs of the charging

Clean Cities' Tips for Minimizing PEV Charging Station Costs

EVSE Unit Selection

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

Location

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

Long Term Planning

- Contact your utility early in the planning stages to discuss electricity consumption and demand charges as well as electrical service needs. Avoid utility demand charges by balancing charging time windows with other electricity usage and working closely with your utility.
- Consider the quantity and location of EVSE that you plan to install over the next 10-20 years when installing your first unit. Upgrade your electrical service for your anticipated long term EVSE load and run conduit to your anticipated future EVSE locations. This will minimize the cost of installing future units.
- Consider the electricity infrastructure for EVSE when building a new facility. It is less expensive to install extra panels and conduit capacity during initial construction than to modify the site later.

Additional information available from the DOE Clean Cities report on the Costs Associated with Non-Residential Electric Vehicle Supply Equipment

[20] EPRI 2013

equipment installation. One solution has been to provide a charging space that is wide enough to accommodate access for a person with a disability but not having a sign indicating the spot as disabled parking. This solution, even though indicating PEV use, would still allow disabled people to use this space.

4.7 Funding and Financing Installations

There are many incentives and financing options to help defray the costs of deploying charging infrastructure. Similar to vehicle purchasing, these incentives vary at the federal, state, and local levels. **Table 6** provides an overview of the incentives available to local governments for PEV charging infrastructure deployment.

Table 6. Funding opportunities for local government installation of PEV charging infrastructure

Government Entity	Incentive Program	Funder	Available to	Incentive available
Federal	Low and Zero Emission Vehicle Research, Demonstration, and Deployment Funding	Federal Transit Administration	Local, state, and federal government entities; public transportation providers; private and non-profit organizations; and higher education institutions	Financial assistance is available for research, demonstration, and deployment projects involving low or zero emission public transportation vehicles. Funding may cover up to 80% of project costs, with a required 20% non-federal cost share requirement. Eligible vehicles must be designated for public transportation use and significantly reduce energy consumption or harmful emissions compared to a comparable standard vehicle.
State of California	Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)	California Energy Commission	Public entities, businesses, workforce training partners, fleet owners and consumers	Competitive grant program that provides funding for EVSE infrastructure, light duty PEV deployment, workforce training and development, and regional PEV readiness plans. The 2016-2017 investment plan includes $17 million for the deployment EVSE infrastructure.[21]

[21] California Energy Commission. May 2016. 2016-2017 Investment Place Update for the Alternative and Renewable Fuel and Vehicle Technology Program. Retrieved from http://www.energy.ca.gov/2015publications/CEC-600-2015-014/CEC-600-2015-014-CMF.pdf

California – local air districts	Motor Vehicle Registration Fee Program	El Dorado and Northern Sierra Air Quality Management Districts	Local government, businesses, individuals, and non-profit organizations in CA	Funding is available for projects that reduce air pollution from on- and off-road vehicles. Eligible projects include purchasing alternative fueling vehicles and developing alternative fueling infrastructure.

Please note that the federal Alternative Fuel Infrastructure Tax Credit is not included in the table above, as local governments are not tax liable entities therefore this incentive is irrelevant.

5. Managing Charging Stations

5.1 Ownership Structures

Charging infrastructure ownership can be retained by the station provider or transferred to the charging site host or another third party. The traditional sale method would make the host, whether residential or commercial, the owner and operator of the charging equipment and responsible for the operation and maintenance of the equipment. Under some contracts, the charging station provider may retain ownership of the charging equipment and provide compensation to the host for the use of the site. The charging station provider then may be responsible for the maintenance and operation of the equipment.

Some charging infrastructure business models relate to providing charging at no cost to the driver. Access fees, whether through the subscription method or pay per use generate revenue (discussed in more detail below), are expected to be charged at most publicly available charging sites. This revenue may be shared with the charging site host; some ownership models will provide a percentage split with the host based upon negotiated terms with the charging station provider. This method encourages the host to maximize the utilization of the equipment. Other contracts may provide a fixed rate to the host, and is typically designed to compensate for the host's identified costs associated with hosting the charging infrastructure and/or rent for the parking space. The balance of any revenue then would be retained by the charging station provider.

Electric Vehicle Service Providers can offer a variety of services along the charging infrastructure value chain, including procurement, installation, management, ownership, and network services. Some common EVSPs include (in alphabetical order): CarCharging/BLINK, Chargepoint, Electric Trees, eVgo, Greenlots, SemaConnect, and Tesla.

5.2 Fees

Often, owners of charging spaces contract with electric vehicle service providers or third party operators who install, operate, and set the fees on charging equipment. However, when owners do have the ability to set fees—either explicitly or implicitly through their choice of operator—they face conflicting goals. Owners often need to recoup the costs of installing, maintaining, operating chargers, and may

also wish to price charging in order to encourage turnover so chargers are available to those who need them most, both of which push operators toward charging higher fees. On the other hand, pricing charging so that driving an electric vehicle is cheaper on a per-mile basis than a gasoline-powered vehicle creates an incentive for people to purchase electric vehicles or charge plug-in hybrids so that they use more electricity and less gasoline.

When access fees are assessed, they may be set on a fixed fee, a fixed rate or a pay per energy consumed basis.

- Fixed fee would mean that each connect has a set cost. It would not matter how long the connection is made or how much energy is charged into the battery, since the set connection fee is charged. The fixed fee may be assessed by an employer in a workplace setting or when charging is provided as part of a parking lot fee. It may be expected that the owner will be parked for a significant period of time in this location.
- A fixed rate fee may be charged if high utilization and turnover of vehicles is desired. Fees may be charged per hour or other intervals for AC Level 2 charging and a per minute basis for DC fast charging. It would be desirable for the PEV driver to be aware of the time the vehicle is charging to maximize the charge with the convenience of gaining range.
- A pay per energy consumed basis would require measuring the energy delivered and charging a rate based upon the cost of electricity to the host. A multiplier on this cost may be applied to recover other operational costs.

Membership or subscription programs may offer the same type of services. A fixed rate may be charged to the driver on a monthly basis for an unlimited number of connects or time connected at publicly available charging infrastructure. Discounts on the fixed rate may be provided by the membership program for a tiered membership fee. In most cases, a pay per use is generally available although restrictions may apply based upon the membership program.

5.3 Considerations

Over the long term, infrastructure owners should pilot innovative agreements with utilities and infrastructure to make charging cost-competitive with driving a gasoline-powered vehicle. Over the short term, however, infrastructure owners may need to establish higher fees in order to recoup costs and encourage turnover. Various regional Infrastructure owners should consider adopting the same fee, particularly in high-demand locations, to create consistency throughout the region. With these types of fees, vehicles are less likely to remain parked after their charge is complete and other drivers are drawn to spaces that they know are more likely to be available. Local governments looking to adopt a PEV charging fee may need or want to conduct a study to demonstrate that the fee is necessary to cover their costs and/or create a revenue-sharing agreement with private infrastructure operators.

5.4 Time limits

Time limits can help ensure turnover at chargers so that they are available to drivers who need them. Otherwise, PEV owners may keep their vehicles at chargers after a charge is complete in order not to interrupt their business. When setting time limits, charging station owners should consider how much of a charge vehicles parked at a given location will likely need. In the Tahoe-Truckee region, time limits mostly apply in commercial areas, and the type of trips that drivers take to these areas—for shopping, eating out, or socializing—tend to be relatively short, so most drivers traveling from their homes should be able to recharge from their trips in under 2 hours. However, drivers running a series of errands may be looking for a more significant charge time. The time needed to achieve a significant charge is shown in Table 7.

Table 7. Time needed to achieve a significant charge, by charging type

Charger type	Time needed to achieve a significant charge
Level 1	4—6 hours
Level 2	1—2 hours
DC Fast	15—45 minutes

Consistency with time limits for regular parking may also influence time limits on charging. Having longer time limits at charging spaces than at regular parking spaces may enable more EV drivers to achieve a significant charge and create incentives for PEV ownership, but it can also make enforcement challenging.

5.5 Enforcement

The California Vehicle Code allows the owner of a space to remove a vehicle if it occupies a space in violation of posted regulations,[22] including signs designating spaces for charging vehicles or time limits on charging spaces. In order for signs to be enforceable, governments in the Tahoe-Truckee region must specify time limits, penalties, and provide all of the necessary definitions through a local ordinance.

Parking Enforcement Example
The City of Roseville has adopted an **ordinance** approving changes to their Municipal Code to include electric vehicle parking enforcement.

Enforcement is key to making sure that chargers are available for drivers who need them, but it can be challenging, potentially requiring increased funding for parking agents as well as education to ensure that agents can differentiate a charging vehicle from a non-charging one in the absence of any universal standard for indicating a vehicle's state of charge. Instead of devoting resources to effective

[22] California Vehicle Code §22511.1(a).

enforcement of time limits, it may be more effective to charge fees that escalate steeply after a certain time to encourage turnover at stations.

6. Streamlining the Permit Process

A key step in the installation of PEV charging equipment is obtaining city or county permits and passing inspection. Because regional infrastructure has been expanding rapidly, there are many opportunities to streamline permitting and inspection procedures and harmonize processes between jurisdictions. Making the permitting process easy, affordable, and less time consuming can help speed the roll out of charging infrastructure and make installations more straightforward.

Recognizing the important role of permitting in the deployment of charging infrastructure, California legislators passed a law in 2015 requiring local governments to streamline the permitting process. [23] AB 1236 requires communities with populations greater than 200,000 to adopt ordinances that expedite the permitting process for PEV charging stations by September 30, 2016. All other jurisdictions must adopt an ordinance by September 30, 2017.

The required ordinance must include several streamlining elements. Local governments must provide a permitting checklist; installation projects that meet all requirements on the checklist must be eligible for expedited review. Cities and counties can use the latest version of the "Plug-In Electric Vehicle Infrastructure Permitting Checklist" from the *Zero-Emission Vehicles in California: Community Readiness Guidebook* published by the Governor's Office of Planning and Research (OPR)[24]; they can also modify the standards based on "unique climactic, geological, seismological, or topographical conditions." In addition to developing streamlined procedures, permitting offices must provide the permitting materials on the government's website and must allow for electronic submittal of the application materials online.

The forthcoming Tahoe-Truckee PEV Readiness Plan includes a goal to support and help coordinate the development of a model streamlined permitting process, useful for the local jurisdictions in the Tahoe-Truckee Region. Achieving this goal will depend on the gain of sufficient resources.

6.1 Staff expertise and training

By training permitting and inspection staff to be able to specifically handle PEV charging station projects, local jurisdictions can streamline the installation process and improve the deployment of infrastructure in the area. If no electrical panel upgrades or additions are required, installations at single-family residences can be relatively simple and often do not require significant review by permitting staff; in areas where most or all projects are straightforward residential projects, training may not be necessary or cost-effective. However, installation of commercial or public stations or stations at multi-family

[23] Full text of chaptered Assembly Bill 1236 available at the California Legislative Information webpage: https://leginfo.legislature.ca.gov/faces/billVersionsCompareClient.xhtml?bill_id=201520160AB1236

[24] Materials available from the Governor's Office of Planning and Research at: https://www.opr.ca.gov/s_zero-emissionvehicles.php

dwellings are more complex and require more oversight and review; and until more projects are implemented, most jurisdictions and installers do not have extensive, if any, experience with these more complicated and varied types of installations. Jurisdictions seeing or anticipating significant implementation of these types of projects may benefit the most by training their staff and by offering a list of professional electricians qualified to assist with PEV charging station installations.

There are institutions that provide training in PEV charging station installations. The Electric Vehicle Infrastructure Training Program (EVITP) offers courses that train and certify electricians throughout the area to install stations; it has developed a 6- to 8-hour course curriculum especially tailored for local government staff and stakeholders, sometimes working with local governments to tailor classes to local needs and constraints. Alternatively, there may be local staff from jurisdictions with experience from working on various types of projects who can provide a peer training workshop. Additionally, Clean Cities produced a series of YouTube training videos on residential electric vehicle supply equipment installation. Key information for training includes:

- Battery types, specifications, and charging characteristics
- National and California code requirements for EVSE
- Utility interconnect, notification, policies and requirements
- Brand- and model-specific installation instructions for Level 1 and 2 EVSE and hands-on installation demonstrations.
- Service-level site assessments, load calculations, and upgrade implementation

6.2 Required information

Different permitting and inspection offices have different requirements for PEV charging station projects. Jurisdictions require some or all of the following:

- Permit application
- Plan for installation
- Line drawing
- Electrical load calculation
- Permit and inspection fee
- Inspection

Requirements vary depending on each jurisdiction's process. Some permitting offices do not require site plans, especially for installations at single-family detached residences. Permitting commercial or public stations are often more complex than residential installations and may require significant back and forth between the installer and permitting staff. CALGreen, the green building code of the California Building Standards Code (Title 24, Part 11), requires new construction to be pre-wired for electric vehicle charging, which includes providing a service panel and conduit that can support the electrical load

necessary for Level 2 charging.[25] Pre-wiring greatly simplifies installations, so additional streamlining may be possible for charger installations in new construction.

In addition to variations in the application materials required for different local governments, the permitting and inspection fees vary widely. Some jurisdictions may require fees less than $100 while others in the northern California region charge over $300. Even within a city or county, fees may vary if they do not charge a fixed fee for PEV charger installations; some fees depend on the project size or value.

In some places, permit applications can be submitted online while some must be handled in-person in other jurisdictions. It should be noted that AB 1236 requires jurisdictions to provide permit materials and allow submission of applications online:

> *The checklist and required permitting documentation shall be published on a publicly accessible Internet Web site, if the city, county, or city and county has an Internet Web site, and the city, county, or city and county shall allow for electronic submittal of a permit application and associated documentation, and shall authorize the electronic signature on all forms, applications, and other documentation in lieu of a wet signature by an applicant.*[26]

If an electrical panel needs to be upgraded or a new panel is being added, the installer also needs to work with the electrical service provider to meet all of the utility requirements, which may include submitting an application, communicating with a utility representative, and scheduling an inspection. These steps may add significant time to the project, depending on the complexity of the service change.

Depending on where the charging station is sited, a permit from the Tahoe Regional Planning Agency (TRPA) may also be required:

- If the charging station is going to be installed on existing impervious surface and/or if grading under 7 cubic yards is needed, TRPA requests that applicants submit a qualified exempt application (for no fee).[27]
- If grading or trenching over 7 cubic yards is needed for the installation, a grading permit is required. Grading permits are approved through TRPA and the fee is approximately $501 (as of December, 2016). Grading permits are only issued in the grading season which is from May 1 through October 15.
- If they are adding coverage on an undeveloped site, more permitting is involved.

[25] More information available from the State Department of Housing and Community Development's 2014 Report to the Legislature: Status of the California Green Building Standards Code (Sept 2014), available for download at: http://www.hcd.ca.gov/codes/calgreen/docs/calgreen-report-to-legislature-2014.pdf

[26] Text of chaptered Assembly Bill 1236 available at the California Legislative Information webpage: https://leginfo.legislature.ca.gov/faces/billVersionsCompareClient.xhtml?bill_id=201520160AB1236

[27] Qualified exempt applications can be emailed to Alyson Borawski aborawski@trpa.org. For more information please see http://www.trpa.org/wp-content/uploads/Exempt-Qualified_Exempt_Activity_Application_2-26-16.pdf

To provide permitting consistency between jurisdictions within the Tahoe Truckee Region, it is recommended that guidelines are developed for local governments on PEV charging systems for single-family residences and for multi-family residences and commercial properties.[28] Cities and counties should consider adopting the guidelines described below.

- Provide information about the PEV charging system, including level of equipment (Level 1 or 2), equipment certification by nationally recognized testing laboratory, in compliance with UL 2202 (Standard for PEV Charging System Equipment)
- Conduct load calculations to determine if existing electrical service panel is adequate or if an upgrade is required
- Upgrade panel and wiring in conformance with the California Electrical Code (Part 3 of the California Building Standards Code) [29]
- Determine if an additional electrical meter must be installed for an EV charging utility rate
- Identify charging equipment location and install according to manufacturer specifications
- Provide manufacturer installation guidelines to inspector on site

In addition to these guidelines for single-family residences, multi-family and commercial installations need to consider the following:

- At least one ADA accessible space must be provided, although it will not count towards minimum ADA counts since the non-disabled users can charge in those spots
- Property owners or Homeowners' Associations must approve of installations
- Lighting, shelter, and flood zones must be considered
- Approvals from the city or county engineering and fire departments may be required

6.3 Guidance

To prepare for a future of increased PEV adoption and mandated procedures, local governments may need to examine their current permitting and inspection practices and update their processes to improve convenience and support increased installations. However, they must balance efforts to simplify permitting and inspection while maintaining quality and safety standards.

The following practices can help jurisdictions increase efficiency while meeting standards and state requirements:

- Prepare combined informational materials providing all guidance on the permitting and inspection processes specific for residential, multi-family dwelling, and non-residential charging equipment installations

[28] The guidelines can be downloaded from the East Bay Chapter of the International Code Council (ICC) at: http://www.eastbayicc.org/index.php/tucc

[29] Note that 2016 California Building Standards Code is effective January 1, 2017. The current codes are available to view on the California Building Standards Commission website at: http://www.bsc.ca.gov/Codes.aspx

- Prepare all guidance, including permitting and inspection checklist, and application materials for online submission to meet state law requirements
- Work with other local governments to make permitting and inspection procedures consistent between jurisdictions by using consistent guidelines or other agreed-upon standards
- Consider streamlining permitting for installations in single-family residences by reducing application material requirements; for example, eliminate site plan requirements and require installer to provide manufacturer specifications and approved equipment testing certification at the time of inspection, limit to one inspection, and set a fixed fee
- Work with local utilities to create a notification protocol for new charging equipment through the permitting process
- Train permitting and inspection officials in EV charging equipment installation

Additionally, utilities can support permitting and inspections with the following:

- Assign utility representatives with relevant experience to review and approve PEV charging installation projects
- Work with local government permitting offices to create a notification protocol for new charging equipment

While developing or adopting standardized permitting processes, local governments may also want to consider surveying charging station owners and installers to identify additional barriers and opportunities for improvement and to ensure that officials are designing processes that consider the needs of installers and consumers in addition to the needs and limitations of the government staff.

7. Resources

7.1 Guidebooks and Toolkits

- U.S. Department of Energy (DOE) Plug-in Electric Vehicle Handbook for Public Charging Station Hosts: published in 2012, this handbook covers PEV and charging basics, charging station locations and hosts, ownership and payment models, and installing and maintain charging stations.
- U.S. DOE Clean Cities Workplace Charging Challenge Employer Workshop Toolkit provides best practices for planning, organizing, and executing successful and educational workplace charging events. Includes employer workshop and outreach templates, as well as examples of workplace charging events.
- 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, California! A Guide to EV-Ready Communities provides public agencies throughout California with guidance on how to advance community PEV readiness. This guide provides standardized policies, ordinances and best-practices, providing a consistent framework for deployment of PEVs and charging infrastructure including information on signage, ADA compliance, permitting and other key matters.