Plug-in Electric Vehicle Best Practices Compendium

Driving to Net Zero

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Table of Contents

Purpose and Content of this Guide

Developed as part of the Santa Clara Driving to Net Zero Project, this guide provides an overview of the key considerations for local governments who are seeking to support the deployment of plug-in electric vehicles (PEVs) and charging infrastructure. 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 established best practices for local governments. The information presented in this guide 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. This guide includes the following topics:

- **Building, Zoning, and Parking Codes** – Outlines the best practices local governments can use to require and incentivize the deployment of charging infrastructure.
- **Permitting** – Provides recommendations to streamline the permitting process and make it more affordable and easy for consumers to install PEV chargers.
- **Planning** – Outlines best practices for integrating PEV readiness into regional plans.
- **Multi-Unit Dwellings** – Discusses the unique barriers to PEV adoption and charging deployment in multi-unit dwellings, as well as recommendations on the aspects that local jurisdictions can help address.
- **Regional Charging Network** – Provides recommendations on how to best support the regional charging network and outlines relevant funding sources.
- **Fleets** – steps that local governments can take to aid the deployment of PEVs in their fleets. *Note that ICF is developing a guidebook for fleets as part of this project, which is forthcoming. The fleet guidebook will provide more detailed information and recommendations for this area.*
- **Interoperability –** Discusses the issue of non-standardized EVSE protocols and technology configurations.
- **Outreach and Education** – outlines strategies that can be used by local governments to educate and promote PEV adoption within their communities.

Building and Zoning Codes

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.

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. Pre-wiring involves installing raceways and infrastructure capable of supporting future electrical demands from EV charging. Having the electrical infrastructure pre-installed will allow the charging station equipment to be easily and cost-effectively added later.

The 2016 Green Building Standards Code (CALGreen), effective as of January 1st, 2017, requires that all new developments include pre-wiring for Level 2 charging, so any local government that has adopted the state building code by reference will have pre-wiring requirements in place. Under CALGreen, prewiring includes the installation of a listed raceway to accommodate a 208/240-volt branch circuit and sufficient panel capacity capable of supporting future electric vehicle supply equipment (EVSE). 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,[1] and that multifamily developments with 17 or more units must pre-wire at least 3% of total parking spaces.[2] At non-

[1] Two exemptions are provided to address situations where EV charging may not be practical: structures without commercial power supply; and where the out-of-pocket cost to the homeowner or developer for additional infrastructure costs (on the utility side of the meter) exceeds $400 per dwelling.

[2] California Building Standards Commission, 2016 California Green Building Standards Code (CALGreen), 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.

residential developments, pre-wiring is required for a portion of total parking spaces, as summarized in Table 1 below.[3]

Table 1. CALGreen 2016 Mandatory Non-residential EV Pre-wiring Requirements[4]

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

1.1 Adopt voluntary CAL Green EVSE requirements

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 CALGreen through an ordinance amending the local municipal code.

The residential voluntary measures in CALGreen related to EV charging include:

- For new one- and two-family dwellings and townhouses with attached private garages, the CALGreen Voluntary Tiers require that for each dwelling unit, a dedicated 208/240-volt branch circuit (rated at least 40 amps) shall be installed with the listed raceway that is already required by the mandatory measures of CALGreen.[5]
- For new multi-family dwellings with 17 or more units, the CALGreen Voluntary Tiers require that 5% (but in no case, less than 1) of the total number of parking spaces provided for all types of parking facilities shall be electric vehicle charging spaces capable of supporting future EVSE (pre-wired). This is higher than the mandatory requirement of 3%.[6]

For new non-residential construction, the CALGreen voluntary measures increase the number of required EV charging spaces according to Table 2.

[3] Please see CALGreen sections 4.106.4 and 5.106.5 for the full details of the requirements, including specifications for dimensions, location, and identification.
[4] CALGreen, Chapter 5, Section 5.106.5.3
[5] CALGreen, Appendix A4, Section A4.106.8.1
[6] CALGreen, Appendix A4, Section A4.106.8.2

Table 2. CALGreen 2016 Voluntary Tier 1 and Tier 2 Non-residential EV Pre-wiring Requirements[7]

Total Number of Parking Spaces	Number of Required EV Charging Spaces		
	Mandatory	Tier 1 Voluntary	Tier 2 Voluntary
0-9	*0*	0	0
10-25	*1*	2	2
26-50	*2*	3	4
51-75	*4*	5	6
76-100	*5*	7	9
101-150	*7*	10	12
151-200	*10*	14	17
201 and over	*6 percent of total*	8 percent of total	10 percent of total

1.2 Adopt local ordinance that exceeds CALGreen

CALGreen represents a "floor" upon which cities can innovate to address local conditions and fulfill local policy goals. To further strengthen PEV readiness, local governments can adopt an ordinance that exceeds the voluntary tiers of CALGreen. Such regulations can include requirements for pre-wiring, full circuit installations, and sufficient electrical panel capacity.

Best Practice Example: San Francisco

The City and County of San Francisco recently approved an Ordinance that establishes requirements for installation of electric vehicle charging infrastructure at new buildings or buildings undergoing major alterations.[8] Starting January 2018, the ordinance requires new residential, commercial, and municipal buildings provide the following[9]:

- Electrical capacity and raceway infrastructure to facilitate future installation and use of PEV chargers in 100% of off-street parking spaces provided for passenger vehicles and trucks.
- Install full circuits for PEV chargers (also referred to as turnkey or EVSE-ready outlets) to at least 10% of parking spaces, including listed raceway, sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable listed termination point such as a receptacle.
- Install sufficient electrical infrastructure to simultaneously charge vehicles in 20% of parking spaces.

As part of this legislation process, Energy Solutions (on behalf of PG&E) conducted a study that estimates the costs associated with including PEV charging infrastructure during initial

[7] CalGreen, Appendix A5, Section A5.106.5.3

[8] Defined as “Alterations and additions where interior finishes are removed and significant upgrades to structural and mechanical, electrical, and/or plumbing systems are proposed where areas of such construction are 25,000 gross square feet or more in Group B, M, or R occupancies of existing buildings.”

[9] City of San Francisco. Ordinance number 92-17. http://sfbos.org/sites/default/files/o0092-17.pdf

construction for multi-family and non-residential projects compared to retrofitting this infrastructure at a later date.[10] Cities in Santa Clara could potentially use the findings of this study to help support the adoption of stricter requirements in their jurisdictions; however, it is important to note that some of the cost parameters in this study (labor, permitting fees) were specific to the City of San Francisco.[11]

The study found that that the cost for installing complete or nearly complete 240-volt 40-amp electric circuits as a retrofit is several times more expensive than installing this infrastructure during new construction, as shown in Table 3 below.

Table 3. Estimated Cost-Effectiveness of San Francisco Proposal, Two Scenarios[12]

	Per PEV Parking Space with Electrical Circuit		Total Incremental Cost of Building	
	New	Retrofit	New	Retrofit
Scenario A - 10 Parking Space Building, two PEV Parking Spaces	$920	$3,710	$1,840	$7,420
Scenario B - 60 Parking Space Building, 12 PEV Parking Spaces	$860	$2,370	$10,320	$28,440

For existing buildings, only 25,000 gross square feet or larger undergoing major renovations will be applicable due to the cost-prohibit characteristics of electrical service upgrades.[13]

Best Practice Example: City of Palo Alto

In October 2016, the City of Palo Alto passed an EVSE building policy (Ordinance No.5393) that is similar to San Francisco's but less stringent. While not all parking spaces are required to be pre-wired for future installation of EVSE, the ordinance does require that a minimum percentage of the spaces have EVSE installed. All new buildings in Palo Alto must meet the following requirements:[14]

- Single family:
  - Provide conduit only, EVSE-ready outlets, or EVSE installed for each residence
- Multifamily:
  - Resident parking – at least one EVSE-ready outlet (full circuit) or EVSE installed for each residential unit in the structure

[10] Energy Solutions. November 17, 2016. Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco. http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-PEV-Infrastructure-Cost-Effectiveness-Report-2016.pdf

[11] The report states, "All rights reserved, except that this documents may be used, copied, and distributed without modification".

[12] Energy Solutions. November 17, 2016. Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco. http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-PEV-Infrastructure-Cost-Effectiveness-Report-2016.pdf

[13] City of San Francisco. Ordinance number 92-17. http://sfbos.org/sites/default/files/o0092-17.pdf

[14] City of Palo Alto. Ordinance No. 5393. https://www.cityofpaloalto.org/civicax/filebank/documents/54976

  - Guest parking – provide conduit only, EVSE-ready outlets, or EVSE installed for at least 25% of guest parking spaces, among which at least 5% shall be EVSE installed.
- Non-residential structures other than hotels:
  - Provide conduit only, EVSE-ready outlets, or EVSE installed for at least 25% of parking spaces, among which at least 5% shall be EVSE installed.
- Hotels
  - Provide conduit only, EVSE-ready outlets, or EVSE installed for at least 30% of parking spaces, among which at least 10% shall be EVSE installed.
- For all, the property owner must ensure that there is sufficient circuit capacity to support a Level 2 EVSE in every location where circuit only, EVSE-ready outlet, or EVSE installed is required.

Best Practice Example: City of Oakland

In December of 2016, the City of Oakland passed an EVSE policy (Ordinance No.13408) that was designed to accelerate the installation of vehicle chargers to address demand. As of March 2017, builders in Oakland are required to provide the levels of PEV infrastructure in new multi-family and non-residential buildings shown in Table 4 below.

Table 4. City of Oakland PEV charging requirements for new multi-family building with 3+ units or non-residential buildings[15]

	1 parking space	2-10 parking spaces	11-15 parking spaces	16-20 parking spaces	More than 20 parking spaces
Full Circuit[16] (i.e. turnkey, EVSE ready outlet)	1 parking space	2 parking space	2 parking space	2 parking space	10% of parking spaces
Inaccessible Conduit Installed[17] (i.e. pre-wiring, raceways)	Not applicable	Not applicable	1 parking space	2 parking spaces	MDU: remaining 90% of spaces Other Non-Res: Additional 10%

[15] City of Oakland. Electric Vehicle Infrastructure Requirements for New Multi-Family and Nonresidential Buildings. http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak063669.pdf

[16] Full circuits are "ready to go" with the addition of a PEV charging station. Full circuit installations include 208/240V 40-amp panel capacity, conduit, wiring, receptacle, and overprotection devices. The endpoint of the system must be near the planned EV charger location.

[17] Conduit that will be difficult to access or alter after construction (e.g. enclosed within walls or pavement, etc.). Accessible conduit must be installed during new construction to avoid expensive and intrusive retrofits when additional EV charging capacity is needed in the future.

	1 parking space	2-10 parking spaces	11-15 parking spaces	16-20 parking spaces	More than 20 parking spaces
Electrical Panel Capacity	Sufficient to supply 1 parking space	Sufficient to supply 2 parking spaces	Sufficient to supply 3 parking spaces	Sufficient to supply 4 parking spaces	Sufficient to supply 20% of spaces

2. Zoning Codes and Incentives

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.

2.1 Allow PEV parking to count towards minimum requirements

Many jurisdictions have minimum parking requirements specifying the number of spaces that developers must provide for new construction in different land uses. For these jurisdictions, if PEV parking is not counted toward these requirements it can discourage developers from installing charging infrastructure, since developers must either build more structured parking or reduce the amount of developed space to accommodate the extra parking needed for PEVs to access charging stations. Amending the zoning or parking code to allow PEV parking to count toward parking requirements would allow developers to provide PEV parking without increasing the total number of parking spaces required. This is similar to the way that many local governments currently treat accessible parking, allowing it to count toward minimum requirements in spite of the fact that it has additional design requirements and is restricted to certain users.

2.2 Implement EVSE zoning incentives

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:

- **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,[18] or offer developers incentives such as density bonuses in exchange for providing increased charging opportunities.

Best Practice Examples

- 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..[19]
- The City of Lancaster's Municipal Code states that "electric vehicle charging stations shall be allowed within any legal single-family or multiple-family residential garage or carport" and are permitted as an accessory use where the charging station for public and private use is subject to specific requirements including its accessible and visible location, and safe design of pedestals.[20]
- The City of San Carlos provides developers with a density bonus for providing parking with EVSE. Under Section 18.05.030 of the City's Municipal Code, developers are allowed to exceed the maximum allowable floor area ratio by 10% if they provide additional environmental design features, including "electric car facilities".[21]

Resources

- California Governor's Office of Planning and Research (OPR) has developed an ordinance template for zoning PEV charging stations that can be used by cities and counties.[22]
- The Santa Clara Driving to Net Zero project will also be providing additional building and zoning code resources, such as a revisions template, to stakeholders as part of Task 3B of the project.

[18] 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.

[19] City of Emeryville Planning Regulations, Emeryville Municipal Code Title 9 http://www.codepublishing.com/CA/Emeryville/.

[20] California Governor's Office of Planning and Research. Zoning Example for Installation of Plug-In Electric Vehicle Charging Stations for City of Lancaster. www.opr.ca.gov/docs/Zoning_Example_for_PEV_charging.docx

[21] City of San Carlos, Municipal Code: Development Standards for Mixed-Use Districts, Section 18.05.030 A. http://www.codepublishing.com/CA/SanCarlos/#!/SanCarlos18/SanCarlos1805.html#18.05.030

[22] California Governor's Office of Planning and Research. Zoning Example for Installation of Plug-In Electric Vehicle Charging Stations for City of Lancaster. www.opr.ca.gov/docs/Zoning_Example_for_PEV_charging.docx

3. Addressing Existing Development

Requirements and ordinances on existing development are far less addressed than new development due to cost-inhibitive nature of electrical upgrades. One way to target existing development is to include major renovations in local building code ordinances. This was recently done in San Francisco, however the City limited the regulation to buildings undergoing major renovations (25,000 gross square feet or larger) due to the cost-prohibitive characteristics of electrical service upgrades. There are not many proven or effective examples of how local governments can address existing development through regulations or permitting. The City of Port Coquitlam (Canada) recently *proposed* a building code amendment aimed at existing multi-unit residential buildings. When an applicable building's electrical supply is changed, it requires that the new power supply must to be able to support potential PEV charging demands.[23] Even if this were implemented, the scope may be limited because electrical supply is not typically changed very often. In general, the most effective way local governments can address existing development is to provide financial incentives (or outreach and education about such incentives) to building owners to reduce the cost of PEV charging equipment and installation.

For additional information on addressing multi-family housing, please see the Multiple Unit Dwellings section of this report.

Parking Codes and Design Guidelines

4. Adopt PEV parking enforcement code

After establishing policies and strategies to encourage the deployment of PEV charging infrastructure, a next step for local governments is to amend parking ordinances to specify the regulations that apply to parking spaces designated for PEVs. The goal of these amendments is to ensure that PEVs have unobstructed access to PEV charging and to make sure that local governments can recoup the costs of publicly-available charging in the event that the local jurisdiction owns and operates the equipment.

When designating PEV parking, local governments should consider applicable definitions, restrictions, enforcement policies, time limits, and fees. In general, it is a best practice to restrict use of PEV charging stations to vehicles that are currently charging to ensure that the equipment is available for drivers who need them. This is supported by the California Vehicle Code, which allows only vehicles that are "connected for electric charging purposes" to park in spots designated for electric vehicles, and authorizes local governments to tow vehicles that are illegally using these spaces.

Best Practice Examples

- The City of Millbrae's electric vehicle parking ordinance states that electric vehicles are prohibited "from parking longer than two hours in an electric vehicle charging station"

[23] City of Port Coquitlam. January 27, 2017. Report to Smart Growth Committee. https://www.portcoquitlam.ca/wp-content/uploads/2017/05/Report-to-Smart-Growth-Committee-1.pdf

and "the vehicle must be plugged in while parking in the space, and forbids any non-electric vehicle from parking in a charging station".[24]

- In Washington State a penalty of $124 is charged for cars parked in a charging station that are not connected to a charging station.[25]
- In Boulder, Colorado a penalty of $50 is charged for violators who park non-electric vehicles at electric vehicle charging stations.[26]

5. Develop charging station design guidelines

Recent additions to the California Building Code include detailed specifications for charging station design and accessibility requirements. To make it easier for charging station hosts to determine the best configuration of their installation while also meeting building code requirements, local governments could also adopt uniform charging station design guidelines that address the many unique considerations associated with PEV parking spaces.

Local governments will likely need to create multiple sets of PEV parking guidelines that apply to a wide variety of parking scenarios. Design guidelines will vary depending upon the configuration of the parking and upon the context in which parking is located. At a minimum, design guidelines should address the following issues:

The Santa Clara Driving to Net Zero project will be providing charging station siting guidelines and standard drawings as part of Task 3A Public Infrastructure Standards. The report is forthcoming, however a link will be provided here once it has been published online.

- Minimum dimensions of PEV parking spaces.
- Parking configurations, including guidance on whether it is preferable to locate chargers in perpendicular, parallel, or angled parking spaces, and on the location of wheel stops, guard posts, and signage.
- Adopted technical standards that apply to electric vehicle charging stations.
- Regulatory signage and signs directing drivers to available PEV parking.
- Area lighting.
- Clearances, including minimum clearances around chargers to maintain access to controls, as well as on adjacent walkways to maintain pedestrian access. Pedestrian clearance guidelines should include recommendations for keeping sidewalks and walkways clear of cords and cables. Clearance recommendations should also address needs for snow plowing during the winter months.
- Location relative to other spaces, adjacent land uses, and electrical infrastructure. For example, guidance on locating on-street parking could include language such as "the last space on the block in the direction of travel will usually minimize cord management issues, and places user closer to crosswalks and curb ramps".
- Additional considerations that apply in overlay zones, such as flood control zones.

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[24] City of Millbrae, Electric Vehicle Parking Ordinance. http://ci.millbrae.ca.us/Home/Components/News/News/490/24

[25] Washington State Legislature Title 46.08 Electric Vehicle Charging Stations-Signage-Penalty, http://app.leg.wa.gov/rcw/default.aspx?cite=46.08.185

[26] City of Boulder, Colorado. City Council Agenda Item, 2014. https://documents.bouldercolorado.gov/WebLink/ElectronicFile.aspx?docid=124881&dbid=0

- Design of disabled access spaces, including requirements for the number of spaces in areas that must be accessible in areas with multiple PEV parking spaces and design standards for accessible spaces.

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 5 below 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 5. 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[27]
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[28] (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[29] (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.

[27] 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.

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

[29] 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.

5.1 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.

Signage can also be used to enforce parking restrictions. With the passing of Assembly Bill 1452 in October 2017, California now gives local jurisdictions the authority, by ordinance or resolution, to designate stalls or spaces in off-street and on-street parking for the exclusive purpose of charging. The bill, which amends the California Vehicle Code, authorizes the removal of a vehicle from a designated stall or space on a public street if the vehicle is not connected for electric charging purposes, provided the appropriate signage is installed.[30] The codes requires that signage installed for on-street pubic EV parking must be consistent with the California Manual of Uniform Traffic Control Devices (MUTCD).

The MUTCD, which creates consistent standards for signage on public roads, contains several signs and markings to designate spaces for EV chargers,[31] 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**).

When not directly required, these signs 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. Note that pavement markings for on-street EV parking spaces in the MUTCD is optional. Although not required, some charging station hosts also choose to install educational signage about the benefits of PEVs.

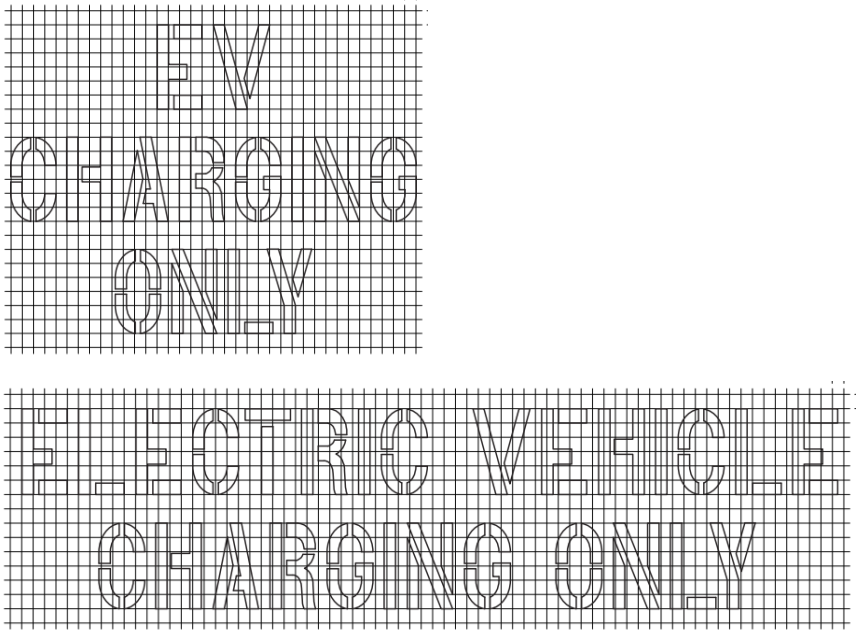
[30] California Assembly Bill 1452 - Parking: exclusive electric charging and parking on public streets. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1452

[31] California Department of Transportation (Caltrans), California Manual on Uniform Traffic Control Devices, Section 2I.03; summarized in Caltrans Policy Directive 13-01. http://www.dot.ca.gov/trafficops/camutcd/docs/2014r2/CAMUTCD2014_rev2.pdf

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

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

Figure 3. Pavement markings indicating restrictions on charging spaces



5.2 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.[32]

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

Table 6 shows the number of each type of accessible space that is required based on the total number of chargers at a location.

Table 6. Number of accessible chargers required at installations of new public charging spaces[33]

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.

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

[33] California Building Standards Commission, 2016 California Building Standards Code, Section 11B-812.

The Building Code describes in detail the site configuration requirements for accessible charging,[34] which include:

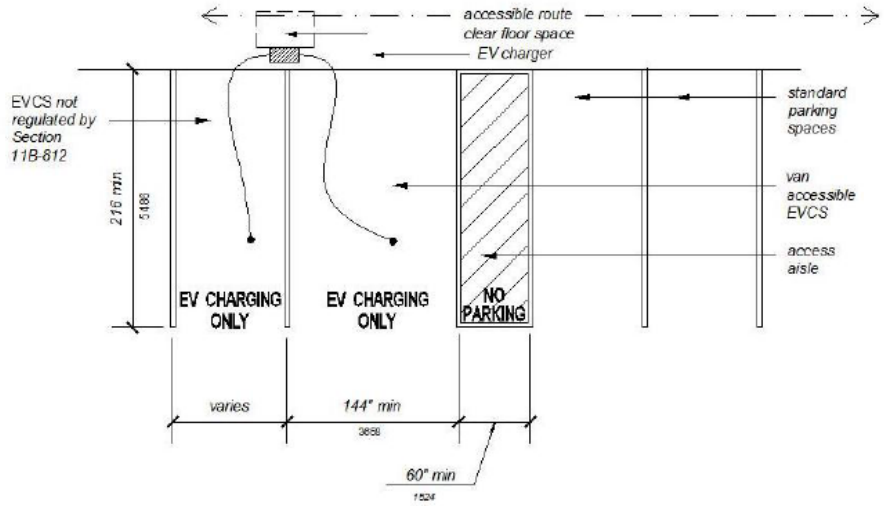
- level ground with a slope of less than 1:48
- vertical clearance of at least 98”
- location along an accessible route to the associated facility
- minimum widths of 144” (van accessible), 108” (standard accessible), 120” (ambulatory), 204” (drive-up)[35]
- accompanying access aisles at least 60” wide

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.”[36]

5.3 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 in new developments must comply with the ADA accessibility requirements mentioned in the previous section and therefore need to meet certain design requirements. Figure 4, Figure 5 and Figure 6 below present some sample configurations of ADA compliant public access charging stations.

Figure 4. Possible configuration for 2 EV charge ports[37]



[34] California Building Standards Commission, 2016 California Building Standards Code, Section 11B-228.3

[35] 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.

[36] 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.

[37] 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[38]

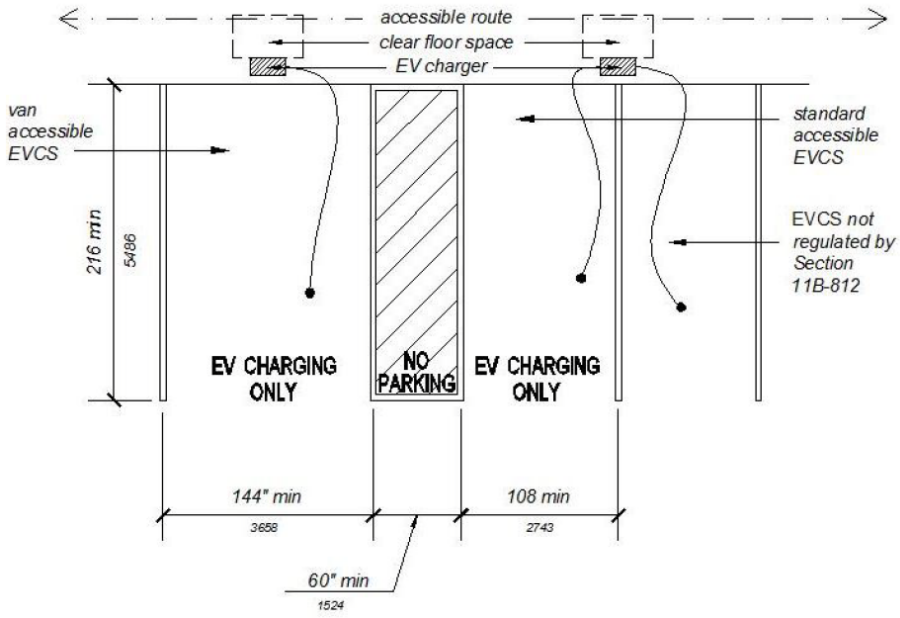
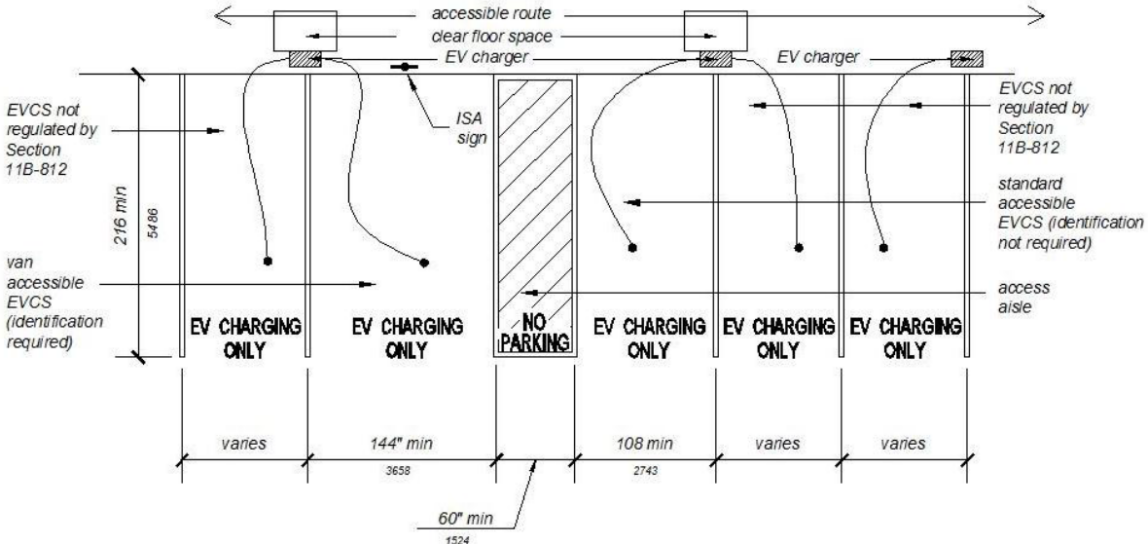


Figure 6. Possible configuration for 5 EV charge ports[39]



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

[39] 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

Permitting

6. Streamline Permitting 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. [40] 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[41]; 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.

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
- Prepare all guidance, including permitting and inspection checklist, and application materials for online submission to meet state law requirements

[40] 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

[41] Materials from the Governor's Office of Planning and Research are available online at http://www.opr.ca.gov/planning/transportation/zev.html

- 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

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.

Best Practice Examples

- The City of Sunnyvale has specific EV charger permitting guidance available online on their permitting website. The guidance describes what information needs to be provided with the permit (existing electrical panel size, load, and proposed changes), along with requirements for equipment protection and labeling. Sunnyvale residents can apply for the permit online if the new charging equipment is connected to the existing electrical panel/meter. If a separate electrical meter will be installed, they must apply for the permit in person, which is issued over the counter.[42]
- The City of Milpitas has issued guidance that summarizes the requirements for a PEV charger permit and includes diagrams illustrating typical configurations of chargers in different garage types in order to assist applicants of single-family residences with determining the proposed location of the charging system. Permit fees for residential and commercial electric vehicle charging systems are available on the website, along with electronic plan submittal and information on the building inspection procedure.[43]

7. Reduce Permitting Fees

Permitting fees vary across various jurisdictions in California. The California Plug-in Electric Vehicle Collaborative published a report in 2012 on PEV chargers and inspection best practices that noted that the average permit fee in California is among the highest in the nation.[44] To reduce the cost of permitting to building owners, local governments in Santa Clara County

[42] City of Sunnyvale. Electric Vehicle Charger (Single-Family) Permit. https://ecityhall.sunnyvale.ca.gov/cd/i_ElectricVehicleCharger.aspx

[43] City of Milpitas. Electric Vehicle Charging Station Permitting. http://www.ci.milpitas.ca.gov/milpitas/departments/building-and-safety-department/electrical-vehicle-charging-station/

[44] California Plug-in Electric Vehicle Collaborative EVSE permitting and Inspection best practices http://energycenter.org/sites/default/files/docs/nav/transportation/plug-in-get-ready/presentations/2.EVITP%20Seminar%20Permitting%2CCA_Final%2C1-6-13.pdf

should aim to levy permitting fees for charging stations that are between $75 and $200 per permit.

Local governments should also consider reducing EVSE permitting costs further, by waiving or subsidizing the fees to residents and/or businesses. This would be a similar approach to programs that some jurisdictions are using to waive permitting fees for solar PV installations.

Best Practice Examples

- To reduce the installation costs, the City of Encinitas provides an "energy efficiency permit fee waiver" for residential EVSE applications.[45]
- The City of Anaheim waives the costs of the residential building permit ($148) required to install EVSE through the City's EV Charger Permit Fee Waiver Program. [46]

8. Train Permitting and Inspection Staff

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 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

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[45] City of Encinitas, Energy Efficiency Permit Fee Waiver Flyer. http://www.ci.encinitas.ca.us/Portals/0/City%20Documents/Documents/Development%20Services/Planning/Land%20Development/Energy%20Efficiency%20Permit%20Fee%20Waiver%20Flyer.pdf
For additional information of the fiscal impacts that the City of Encinitas incurred to waive these permitting fees, see the July 2013 City of Encinitas City Council Agenda Report.

[46] City of Anaheim Building Division Information and Requirements for Electric Vehicle Chargers - http://www.anaheim.net/3474/Electric-Vehicle-Charger.

- 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

9. Create a Utility Notification Protocol

One of the primary causes for concern for PEVs, from the utility side, is clustering of the load associated with PEV charging. Utilities generally have a transformer replacement program to target regularly transformers that have reached the end of their useful life or have been identified as overloaded. However, the adoption of PEVs may occur faster in some areas, thereby causing gaps in the information that utilities would generally use to inform their replacement programs. Some replacements occur because a transformer fails while in service; utility notification protocols can help avoid transformer failure. In order for utilities to minimize the potential grid impacts of charging PEVs, they need to know where the vehicles are being deployed and how they are being charged (e.g., Level 1 vs. Level 2). This information allows the utility to evaluate if the local distribution system is adequate to serve PEV charging needs. For commercial installations that require electrical inspectors and permitting (e.g., Tesla deploying SuperChargers), there is less risk associated with utility notification because the entities involved are more accustomed to dealing with utilities. However, with residential installations, utility notification protocols that can adequately manage significant volumes of residential notifications through the use of automated processes are non-existent.

The typical residential installation will have three parties: 1) the homeowner and PEV driver, 2) the contractor, and 3) the electrical inspector. The electrical inspector is there to protect the interests of the homeowner on behalf of the local government. Contractors engaged in the installation of EVSE have generally been trained to encourage the homeowner to contact his/her local utility and notify them of the installation. Even if homeowners do not contact their utility expressly to notify them of a charger installation, most homeowners likely will take advantage of special PEV rates offered by utilities. Despite these various opportunities to notify the utility, there is still considerable anecdotal evidence of homeowners who have chosen to forgo utility notification after installing a charger.

In order for utilities to minimize the potential grid impacts of charging PEVs, they should work with local governments to develop a notification protocol through the permitting process to understand where vehicles are being deployed and how they are being charged (e.g., Level 1 vs. Level 2). This information will allow local utilities to evaluate whether the local distribution system is adequate to serve PEV charging needs.

Planning

10. Regional Coordination

Santa Clara County benefits from multiple agencies engaged in the deployment of charging infrastructure to support the nascent market for PEVs. However, there is little to modest coordination amongst City governments and local agencies within the county to date. The Driving to Net Zero project is helping improve this situation, especially through engagement with the stakeholder group. There are myriad funding programs (e.g., via air pollution control districts and Electrify America), engaged utilities (PG&E, Palo Alto, Silicon Valley Clean Energy) and planning efforts underway that can support charging infrastructure deployment. However, these efforts are not coordinated at a regional level beyond informal and ad hoc avenues.

One of the challenges associated with charging infrastructure deployment is aligning local and regional planning efforts. All land use planning and decisions in California will continue to be made by local jurisdictions. Meanwhile, regional agencies such as BAAQMD are responsible for long-term regional transportation plans, which are increasingly inclusive of alternative fuel vehicles like PEVs. It will be important moving forward to align these efforts to the extent feasible, ensuring that regional actions can help direct charging infrastructure investment without encroaching upon the local land use considerations.

11. Integrate PEV Readiness into Local Planning Efforts

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.

Local governments that have taken steps to amend their general plans and codes to encourage PEV deployment have found that adopting such policies is a critical first step in building consensus among policymakers and the public to support more specific PEV readiness implementation measures. The exact policies that local governments can choose to include can range from broadly encouraging increased adoption of PEVs to requiring or encouraging charging stations at specific land uses or sites where local agencies see development opportunities or anticipate high demand for charging. These policies build not only consensus, but also make it easier to fund plans and capital projects that accelerate the deployment of PEVs. The incremental cost of PEV readiness planning is lower if it is part of a larger-scale effort. For example, tying PEV readiness to local policies can make it easier to allocate different funding streams toward PEV plans and projects. Incorporating implementation strategies related to PEVs in general plans or climate action plans (CAPs) can also streamline environmental review of these strategies in the future, since the CEQA Guidelines allow lead agencies to streamline project-level environmental review off of these plans.

Key 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 PEVs on the road is growing rapidly, and the best opportunity to get PEV-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. 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.

Best Practice Examples

- The City of Cupertino has integrated many PEV readiness recommendations into its local planning efforts. In their 2015 Climate Action Plan,[47] the city outlines goals and actions specific to alternative fuel vehicles (AFVs) and PEVs including: incorporating PEVs into fleets; providing fueling infrastructure for fleets and the community; exploring additional building and zoning code revisions that expands PEV charger installation throughout the community; and working with regional agencies to develop tools and technical support for developers/contractors interested in providing public PEV charging ports in new projects.
- The City of San Carlos' Climate Action Plan lists emission reduction measures that encourage dedicated parking lot spaces for PEV charging, along with a goal to convert more City vehicles to hybrid, electric, or alternative fuel vehicles.[48]
- In its Climate Action Plan, the City of Berkeley has dedicated emission reduction goals and policies that address PEVs such as "create incentives for high efficiency vehicles,

[47] City of Cupertino. Climate Action Plan 2015. http://www.cupertino.org/Home/ShowDocument?id=9605

[48] City of San Carlos. Climate Action Plan 2009. http://www.cityofsancarlos.org/generalplanupdate/whats_new_/climate_action_plan___adopted.asp

including electric vehicles and plug-in hybrids in the community", reducing parking fees, and providing dedicated parking spaces.[49]

Multiple Unit Dwellings

Multiple unity dwellings (MUDs) or multi-family units are a commonly identified gap in the PEV charging market today. This area continues to be one of the most challenging because of the varying dynamics between vehicle owner, property owner, parking accessibility, electricity demand and load considerations at the facility, and long-term management of the charging equipment.

PEV charging station installations in MUDs will vary depending on the building architecture, physical electrical designs, parking structures, and parking space ownership model. There are several approaches based on previous case studies, however, each application is case-specific and therefore, each method should be carefully evaluated before implementation.[50]

In garden apartments and low-rise condominiums, the biggest problem is the location of the electrical room. Often times, the distance between this electrical room and charging locations are not optimal. This may require major excavations through asphalt and cement for wiring which significantly increases the total installation cost and time. Disturbing major hardscapes should be avoided to minimize the total cost. In this case, one option is to install the chargers near the electrical room and designating them as a community resource for residents to share rather than installing individual charger across the property. Some issues with this option are establishing guidelines for using the chargers such as how long a resident can charge and the potential to interfere with the community's established assigned parking spaces.

For mid- and high-rise apartments and condominiums with parking garages, a common issue is the electrical capacity in the parking structures. Because parking lots were only designed to accommodate low electrical capacity to support lighting, elevators, and other miscellaneous loads, an electrical upgrade may be required depending on the current capacity, desired number of chargers, and the type of chargers. Such upgrade may require boring through walls and ceilings of the parking garage which can be both costly and time-consuming. Alternatively, low-cost surface-mounted conduits for circuit wirings can be adopted since visual aesthetics are not a major concern in parking structures to minimize costs. This usually involves coordination with a local utility and electrical contractors. A low-level charger installation is an option to avoid electrical service upgrade, however, this will increase the charging time.

In some cases, a third-party vendor that provides charging equipment, installations, operations, and maintenance has proven to be cost-effective and successful. Such contract can also involve a subscription-based program in which residents are directly billed for their usage with no

[49] City of Berkeley. Climate Action Plan 2009. https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Berkeley%20Climate%20Action%20Plan.pdf

[50] California Plug-in Electric Vehicle Collaborative. Plug-in Electric Vehicle Charging Infrastructure Guidelines for Multi-unit Dwellings. http://www.pevcollaborative.org/sites/all/themes/pev/files/docs/reports/MUD_Guidelines4web.pdf

interactions required by the property owner or the building management, eliminating any potential administrative burden.

12. Role of Local Governments in MUD Planning

Though these are important issues for property managers, it is not necessarily a barrier that local governments can address through zoning and parking ordinances. The most important role local governments can play for MUDs is to provide outreach and education to homeowner associations, developers, and building owners. There helpful tools and guidebooks on MUD charging that can address common concerns and provide strategies and options best suited to the building's individual needs. These include:

- Plug-in Electric Vehicle Charging Infrastructure Guidelines for Multi-Unit Dwellings. The PEV Collaborative published this set of guidelines 2013. It provides information, resources, case studies, and tools to residents, homeowner associations, and property owner/managers on the installation of charging stations at MDUs.
- The Alternative Fuels Data Center provides links to numerous guidebooks and tools that specifically address MUD needs and concerns.

As noted earlier, the biggest barrier to MUD charging is the high initial cost of equipment and installation. Local governments can provide funding to reduce these costs through applying for grants or providing outreach on the funding and incentives available through PG&E and Volkswagen's Electrify America program. Details on these programs are provided in the next section of this report, under Supporting the Regional Charging Network.

13. MUD Case Studies

- CityFront Terrace is a 320-unit condominium with 417 parking spaces in downtown San Diego. The HOA installed 20 Level 2 meters on different floors of the parking structure. Then, residents established their own service directly with the local utility company, San Diego Gas and Electric, and are able to benefit from the PEV specific time-of-use (TOU) rates. Although this project had higher initial installation cost of $80,000 or approximately $4,000 per parking space, it allowed residents to take full responsibility for their own charging equipment and costs, rather than involving the property management or the HOA.[51]
- 200 Brannan – 1 Federal in San Francisco's South Beach area. This comprises of two buildings: a ten-story loft-style condominium completed in 2004 and a three-story 1 Federal building built in 1907. Together, they house 241 units with 335 deeded resident parking spaces with no visitor parking. The property management chose EverCharge for a full-service solution, eliminating any direct involvement from the property management and the HOA. The company managed the entire installation process and maintenance including management, billing, and customer support. The company used their SmartPower system to meet the electrical demand without any major upgrades by learning and adapting to drivers' charging behavior, then allocating the available power

[51] California Plug-in Electric Vehicle (PEV) Collaborative. Case Studies. http://www.pevcollaborative.org/sites/all/themes/pev/files/cityfront%20copy.pdf

as needed. Individual residents pay the company for the installation cost of $1,000 to $2,800 and purchase a charging station for $1,000. Then, a monthly fixed charge of $15 per month plus a flat electricity rate is charged. A total of 6 Level 2 EverCharge Gen2 Units were installed.[52]

Supporting the Regional Charging Network

Local governments can play a critical role in accelerating regional PEV adoption in Santa Clara by identifying grants and other funding opportunities for the purchase and installation of charging stations. One of the common barriers to PEV adoption is range anxiety - the fear that a vehicle has insufficient range to reach its destination. The 2016 ZEV Action Plan notes that upwards of 1,000,000 charge points will likely be needed at homes, workplaces and public locations by 2020. Developing a robust charging station network in Santa Clara will ensure that residents and visitors can easily get around the region in a PEV.

Local governments should identify, apply for, and/or provide outreach on the various funding opportunities available for charging infrastructure. These include:

- 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.
- **Bay Area Air Quality Management District (BAAQMD) Transportation Fund for Clean Air** (TFCA) provides grant funding for projects that result in the reduction of motor vehicle emissions. Revenues are collected from a $4 surcharge fee on vehicles registered in the Bay Area, generating about $22 million each year (60% of which is allocated to the TCFA.
- **PG&E's Electric Vehicle Charge Network** program aims to install up to 7,500 EV charging stations at MUDs and workplaces that can host more than 10 charging stations, covering the equipment cost up from 25 to 100%. The program is expected to launch in late 2017 and will be accepting qualifying applicants from their service territory.
- The California Air Resources board recently approved the first of four plans by Volkswagen (VW) to invest $800 million over 10 years in zero-emission vehicle (ZEV) infrastructure, public outreach, and access to these ultra-clean vehicles for residents of disadvantaged communities.53 The funds will be invested by **Electrify America**, a subsidiary of VW created for that purpose, in four installments of $200 million each over the next 10 years. The Cycle 1 plan will invest in ZEV infrastructure, education, and access activities to support California's effort to increase ZEV adoption in five major metropolitan areas including Los Angeles, San Francisco, San Jose, Sacramento, and Fresno. The San Jose-Sunnyvale-Santa Clara area has been prioritized for the community charging investment for the Cycle 1 Plan, for which $45 million (total for all

[52] California PEV Collaborative. Case Studies: 200 Brannan – 1 Federal. http://www.pevcollaborative.org/sites/all/themes/pev/files/MUD_Brannan_final.pdf

[53] https://www.arb.ca.gov/newsrel/newsrelease.php?id=946

the cities) will be invested in 350 or more charging stations at five major use cases including, MUDs, workplace, commercial/retail, community centers, and municipal lost/garages.[54]

Fleets

12. Provide educational resources to employers and fleet managers

Information sharing can encourage investment in PEVs among fleets. Fleets often require assistance navigating and weighing the various considerations associated with PEV ownership as compared to conventional vehicle ownership. As part of the Driving to Net Zero project, ICF is developing a guidebook for fleets. Local governments in Santa Clara should promote this guidebook to their fleet managers as well as employers in the region.

Beyond providing educational materials to fleet managers, regional agencies and local governments should consider organizing or funding technical assistance and training workshops for local fleet managers. Local governments can take part in trainings offered by Clean Cities Coalitions. For example, the Sacramento Clean Cities Coalition has hosted workshops on green fleet manager training and alternative fuel technologies and strategies.

13. Opt-in to Low Carbon Fuel Standard

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. Numerous Bay Area entities have opted into this program and are earning credits for their charging stations. To date, these include the City of Dublin, Alameda County, City of Palo Alto Utilities, and Santa Clara Valley Transportation Authority (SCVTA).

Other Bay Area entities also earn credits through LCFS for providing electricity for fixed guideways and residential charging. These include transit providers (SCVTA. BART, SFMTA), and utilities (PG&E, Silicon Valley Power, City of Palo Alto Utilities, and Alameda Municipal Power).

[54] Electrify America. June 29, 2017. Supplement to the California ZEV Investment Plan Cycle 1. https://www.arb.ca.gov/msprog/vw_info/vsi/vw-zevinvest/documents/california_zev_investment_plan_supplement_062917.pdf

14. Provide employee and driver education

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.

15. Minimize the cost of fleet charger installations

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.[55]

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.

[55] 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

- 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.

Interoperability

PEVs are an emerging market area with many different, non-standardized EVSE protocols and technology configurations. Some of this variation exists at the level of the charge plug itself (e.g., competing plug types for Direct Current Fast Charging). Other variation among public EVSE transaction systems requires EV drivers to carry multiple membership cards for public networks with different payment systems. Still more variation exists in the communication architectures and protocols used by EVSE manufacturers and service providers to communicate between EVSE stations and utility back-office transaction and station management platforms.

Interoperability represents the capability of a device to function as intended with other devices without special effort of the user. In the case of EVs, drivers should be able to charge their vehicle at charging stations, regardless of the network provider and the payment system. One of the most pressing issues associated with interoperability relates to the interaction between the customer and the EVSE, primarily at non-residential charging stations. There are several network operators—including but not limited to Car Charging Group (operating the Blink network), ChargePoint, EVgo, SemaConnect, and EV Connect. In many cases, access to charging stations operated by these network operators requires membership and an access card, which creates a situation whereby drivers have to hold many access cards to ensure they can charge their vehicle. The network service provider industry responded to some extent by forming the ROEV Association—although there is good representation there, not all infrastructure providers are members. Further, that group was founded in 2015 and there still is no approved interoperability for members of the association.

The industry is coalescing around the Open Charge Point Protocol (OCPP); the communication protocol enables charging equipment and network operators to match interoperable hardware and software. It is important to note that OCPP is not a recognized standard; rather, it is the leading candidate for consideration by a standards making body in Europe (eMI3), which will also impact the North American market. For the sake of reference, Electrify America is requiring that any equipment on its network to be based on the OCPP.

It is also important to note that OCPP does not address all interoperability and standardization issues, such as roaming protocols. The same standards organization, eMI3 is chartered with solving these types of issues, including but not limited to roaming protocols, station-to-network management protocol, and identifying station locations.

The issues of interoperability and standardization are becoming more pressing. Multiple states, including California, Washington, and Massachusetts have started to take up the challenge of addressing interoperability more seriously. California, for instance, passed the Electric Vehicle Charging Open Access Act in 2013. The act requires publication of all station locations on the Alternative Fuels Data Center (AFDC) website; disclosure of all fees before a charging event begins, including plug-in fees if not a member of the network; and provide accessibility to nonmembers of the network, including the ability to accept multiple forms of payment.

Interoperability ensures the success of the charging infrastructure system and the continued operation of EVSE. We suggest that local jurisdictions track the evolution of the OCPP and where possible, include interoperability specifications in EVSE procurement contracts.

General Consumer Outreach and Education

16. Provide resources online

Hosting a simple AFV or PEV website is an effective way to educate your community on the benefits of PEVs and provide information on charging equipment and locations. The website should ideally be a "one stop shop" for residents interested in PEVs, providing information with links to permitting, incentive finders, and utility time-of-use rates.

17. Host regional ride and drive events

Ride-and-drive events are regularly held public events usually sponsored by automakers to showcase new products and provide an opportunity for consumers test drive and experience new technology. There are also ride-and-drive events sponsored by NGOs and government agencies to increase awareness specifically on PEVs.[56] Some examples include California's Experience Electric Campaign[57], the National Drive Electric Week[58], and Oregon Electric Vehicle Association's EV Fest.[59]

Ride-and-drive events can provide a first-hand experience for consumers and are one of the most influential sources of information and awareness on PEVs.[60] There is a consensus that these events play a crucial role in increasing PEV sales. According to a survey conducted after the 2015 California Ride-and-Drive Series, 15% of the participants either purchased or leased a PEV within six months of the event and 94% shared their experience on PEVs with others.[61] Similarly, participants in the Drive Electric Northern Colorado's (DENC) Ride-and-Drive

[56] Jin & Slowik. Literature review of electric vehicle consumer awareness and outreach activities. http://www.theicct.org/sites/default/files/publications/Consumer-EV-Awareness_ICCT_Working-Paper_23032017_vF.pdf

[57] Center for Sustainable Energy. Experience Electric – the Better Ride Campaign. https://energycenter.org/experienceelectric

[58] National Drive Electric Week. https://driveelectricweek.org/index.php

[59] Oregon Electric Vehicle Association. EV Fest 2016. http://www.oeva.org/events/evfest2016

[60] Williams and Johnson. EV Consumer Characteristics, Awareness, Information Channels & Motivations. https://energycenter.org/sites/default/files/docs/ext/transportation/2016-07-20%20EVR9-CSE-PEVmarkets%20handout.pdf

[61] Paauwe. California PEV Collaborative Statewide Ride-and-Drive Series. http://evroadmapconference.com/program/presentations16/GennetPaauwe.pdf

campaigns have responded they are more likely to adopt PEVs in the future after having experienced PEVs.[62]

The lack of understanding and awareness in personal benefits of PEVs are primary issues in PEV adoption. The perceived negative characteristics of PEVs whether it is the higher initial cost compared to internal combustion engine (ICE) vehicles, inconveniences of charging, or performance, they can quickly change after a first-hand experience such as a test drive.[63] Furthermore, such events and showcases contribute to increased general awareness by receiving grants from the government. For example, Drive Oregon (now renamed to Forth) was awarded a $1 million grant from the U.S. Department of Energy to develop a permanent showcase for EVs in the region for the next three years.[64]

[62] Freyschlag. Drive Electric Northern Colorado (DENC): A Community-Wide Approach to EV Adoption. http://evroadmapconference.com/program/presentations16/AnnieFreyschlag.pdf

[63] Plug in America. Evaluating Methods to encourage Plug-in Electric Vehicle Adoption. https://pluginamerica.org/wp-content/uploads/2017/03/PIA-Incentive-Survey-Paper-Final-Oct.-2016.pdf

[64] Ayre. Advocacy Group Drive Oregon Changes Name To "Forth," Expanding Efforts Beyond State-Lines. https://cleantechnica.com/2017/05/16/advocacy-group-drive-oregon-changes-name-forth-expanding-efforts-beyond-state-lines