Local Government Electric Vehicle Charging Station Siting Toolkit & Reference Guide

Driving to Net Zero

Submitted to: Santa Clara County
Submitted by: ICF

County of Santa Clara Office of Sustainability

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1. Purpose and Content of this Guide

Developed as part of the Santa Clara Driving to Net Zero Project, this report provides guidance on the key planning considerations for local governments in Santa Clara County who are seeking to install and support the regional deployment of electric vehicle charging stations (EVCS).

This report provides information and guidance on the following topics:

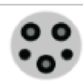
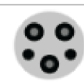
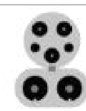
- Charging Infrastructure Types and Uses – reviews the different types of charging equipment, uses, and appropriate locations.
- Charging Infrastructure Deployment – provides an overview of California EV policy and goals and projections of EV charging needed in Santa Clara County to support wide spread adoption.
- Charging Infrastructure Siting Analysis – discusses the charging infrastructure siting analysis conducted as part of the DNZ project. Includes discussion of purpose and use of the analysis, methodology, and resulting maps.
- Planning Considerations – provides an overview of key planning element local governments should consider when deploying charging infrastructure, such as the level of charging needed and site assessments.
- Public Infrastructure Requirements and Design Guidelines – reviews the design requirements of public charging infrastructure that need to be followed based on state policy and regulations. Provides sample design guidelines and site drawings that local jurisdictions can use for public infrastructure projects.
- Station Ownership and Management Options – reviews the various ownership structures of hosting EV charging stations, as well as guidance on setting fees, time limits, and enforcement.
- Charging Infrastructure Costs Estimates – provides estimates on the capital costs for EV charging hardware, permitting, and installation, as well as on-going operations and maintenance.
- Emerging Issues and Opportunities – discusses two topics that DNZ stakeholders requested guidance on: power management/smart charging and supporting the electrification of car-sharing and ride-sharing fleets.

Note that this report serves as combined deliverable for two DNZ tasks: Task 2A - Electric Vehicle Charging Station Siting Plan Toolkit and Reference Guide, and Task 3A - Public Infrastructure Standards Evaluation and Recommendations Guide.

2. Charging Infrastructure Types and Uses

Electric vehicle (EV) 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 infrastructure types – Level 1, Level 2 and direct current (DC) fast chargers. 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 Charging 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 deploy and operate
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.

EV charging occurs at various locations and use is based on driver needs.

- **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 Deployment

3.1. State Policy & Goals

The primary legislation driving EV adoption throughout California is the Zero Emission Vehicle (ZEV) Program. The program today requires 15 percent of light-duty vehicles sold in California be ZEVs by 2025, which includes battery electric vehicles (BEVs), fuel cell vehicles, and transitional ZEVs such as plug-in hybrid electric vehicles (PHEVs). The Governor's Office followed up this Executive Order with its California ZEV Action Plan, which details more than 100 specific actions that state government is taking to accelerate the ZEV market. The ZEV program is largely responsible for the growing number of PEV models available on the market today.

In March 2012, Governor Jerry Brown issued an Executive Order that set a target of 1.5 million ZEVs on California's roadways by 2025. In January 2018, the Governor set a new more ambitious goal of 5 million ZEVs on the road by 2030. The Administration is also proposing a new eight-year initiative to continue the state's clean vehicle rebates and spur more infrastructure investments. This $2.5 billion initiative will help bring 250,000 vehicle charging stations to California by 2025.[1]

3.2. Projections of EVSE Required in Santa Clara County

It is important for local governments to have an understanding of how much charging infrastructure is needed to support regional EV adoption required by the ZEV program and outlined in the Governor's goals. Since the EV market is still in the early stages of adoption and vehicle technology is developing rapidly, the industry's understanding of driver behavior and charging patterns is evolving. Given this uncertainty, ICF developed EV charging infrastructure projections based on a scenario model. The methodologies detailed below and resulting scenario estimates are not meant to be definitive. Ultimately, more data and improved understanding of consumer behavior will help the DNZ stakeholder community make more robust decisions regarding the quantity of charging required.

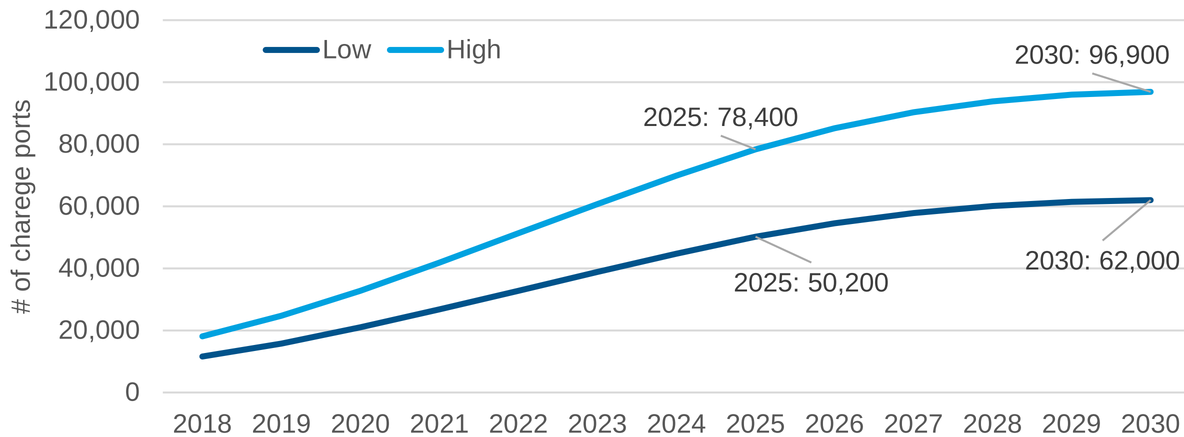
ICF assumes that the demand for charging will be a function of electric vehicle deployment (including vehicle architectures) and the type of charging considered (including residential, workplace, and away-from-home charging). We developed projections for regional EV deployment by taking the current county-level vehicle registration data from IHS Markit and applying the EV adoption growth curve from the EMFAC model. There were 46,570 plug-in EVs

[1] California Executive Order B-48-18. https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/

registered in Santa Clara County as of the end of 2017. ICF estimates that by 2025 there will be close to 250,000 EVs and by 2030, a little over 450,000 EVs in Santa Clara County.

Using the methodology detailed below, we estimate that by 2025, there will need to be 50,200 to 78,400 L2 charge ports deployed within Santa Clara County at workplaces, multi-family housing, and public charging locations to support projected regional EV growth. Table 2 presents our annual estimates by year from 2018 to 2030.

Figure 1. Estimated Need for L2 Charge Ports to Support EV Adoption in Santa Clara County



It is important to note that some of the forecasted EV charging deployment may be satisfied by L1 charging equipment; however, the level of charging would ultimately be determined by the host, and the EV service provider, which will likely be based on a variety of factors including an assessment of likely demand for charging and access to power. Further, the demand for Level 2 charging may be dampened by increased deployment of DC fast charging. At this time, however, it is unclear what the market will need to satisfy the diverse driving characteristics of PHEVs and BEV drivers.

For these infrastructure projections, ICF drew from internal research and modeling and a presentation from the Electric Power Research Institute (EPRI) regarding the amount of charging infrastructure needed to satisfy the demand for electric vehicle charging.

- ICF used an updated version of an EVSE deployment model that we developed for the Bay Area PEV Readiness Plan[2] that decreases the demand for chargers over time to account for potential market saturation and the benefits of increased station utilization. This is a simple model with the structure as follows:

$$Infrastructure = (gPHEV_{deployment} + BEV_{deployment}) \times \alpha e^{-\beta t}$$

  Where $PHEV_{deployment}$ and $BEV_{deployment}$ represent the total number of electric vehicles on the road, α and β are constants and *t* is years from initial date of deployment. ICF notes

[2] ICF, Bay Area PEV Readiness Plan: Background & Analysis, Available online at: http://www.baaqmd.gov/~/media/files/strategic-incentives/ev-ready/bay-area-pev-readiness-plan-background-and-analysis-web-pdf.pdf?la=en

that for our low and high scenarios, we vary the value of γ, which accounts for the fact that it is unclear how much public charging will be required by PHEVs – we vary this value between 0.1—1.0.

- Research at EPRI reviewed how much electric vehicle charging is needed, with a focus on workplace and public usage.[3] EPRI reviewed the impacts of free charging and a benefits tested scenario on usage as a measure of charging stations per vehicle. EPRI's analysis yields a benefits tested scenario in which the charging station-to-vehicle ratio ranged from 0.01 to 0.15 for BEVs and PHEVs, respectively.

Based on our own modeling and the vehicle-to-charger ratios from the aforementioned EPRI presentation, ICF estimated the charging infrastructure that would be required for the corresponding electric vehicle deployment scenario for workplace, opportunity, and multi-family housing (as shown in Figure 1 above). ICF notes that these estimates are not intended as forecasts or predictions of market outcomes. Rather, they are intended to portray the level of infrastructure that may be required to support the mix of PHEVs and BEVs in various scenarios.

For a point of comparison, consider an alternative approach employed by the National Renewable Energy Laboratory (NREL) in the *California Statewide Plug-in Electric Vehicle Infrastructure Assessment*.[4] In this document, NREL sought to estimate the demand for charging infrastructure in two scenarios:

- *Home Dominant*: In this scenario, most PEV charging occurs at home, with workplace and public charging supporting only a fraction of total electric miles.
- *High Public Access*. In this scenario, NREL assumed that many PEV drivers place a "high premium" on public available charging, and that the market responds with workplace and public charging stations.

In both cases, the modeling is based on parameters including, but not limited to, access to home charging, average miles traveled daily, load profiles, total number of charging stations per unit area, and the level of charging through consumer demand. Similar to our own results, the intent of the modeling outcomes presented by NREL is meant to capture a range of options, rather than represent an explicit forecast or market outcome.

For the point of comparison, NREL reports the following estimates for charging points by 2020 for the entirety of the San Francisco Bay Area by 2020, assuming the deployment of 149,000 PHEVs and 74,000 BEVs (representing 25% of the total statewide population). Table 2 below highlights the results of NREL's analysis.

Table 2. NREL's Bay Area EV Estimates

Scenario	Home		Workplace		Public		
	L1	L2	L1	L2	L1	L2	DC
Home Dominant	126,000	90,000	5,000	20,200	400	5,000	133
High Public Access	128,000	72,000	5,700	36,000	520	11,500	377

[3] D. Bowermaster, EPRI. *How Much Electric Vehicle Charging is Needed?* California Plug-in Electric Vehicle Collaborative Meeting, August 2012.

[4] Melaina, Marc, Michael Helwig. National Renewable Energy Laboratory. 2014. California Statewide Plug-In Electric Vehicle Infrastructure Assessment. California Energy Commission. Publication Number: CEC-600-2014-003. Available online at: http://www.nrel.gov/docs/fy15osti/60729.pdf

4. Charging Infrastructure Siting Analysis

As part of the Driving to Net Zero (DNZ) project, ICF conducted a charging infrastructure siting analysis to assess the areas in Santa Clara County that are most likely to experience increased demand for EV charging.

4.1. Overview & Purpose

The purpose of the analysis is to employ a flexible methodology that can be updated and used to understand where EV drivers will likely live, work, and visit within Santa Clara County. It is best to consider the results of the analysis as a useful guide to coordinating and prioritizing investments in charging infrastructure at a high level for engaged stakeholders.

The siting analysis is an analytical exercise that looks at key EV ownership indicators and regional travel patterns to identify areas where there will likely be demand for charging infrastructure. The results can be used to identify areas where the deployment of chargers will likely be the most cost effective, as chargers located in an area where EV drivers are most likely to travel will be utilized more. Recent research by Idaho National Laboratory, for instance, demonstrated that charging equipment deployed in areas that fell within a planning process experienced nearly 90 percent greater utilization (as measured by charging events per week) compared to charging equipment deployed in unplanned locations.[5] It is important to note that the results of the siting analysis are not a deterministic approach that excludes certain areas from charging.

4.2. Methodology

Residential and Multi-family Charging

ICF initiated the analysis by identifying where EVs owners are most likely to live, which required identifying the most likely EV adopters. Table 3 reviews the information available regarding the characteristics of initial EV buyers from various surveys.

Table 3. Overview of Research on Early Adopters of EVs

Data Source	Income	Home Ownership	Dwelling Type	Household Vehicles	Hybrid ownership
2012 California EV survey —vehicles: LEAFs —region: California [1]	54%, $150k + 25%, $100k-$150k 18%, $50k-$100k 3%, <$50k	n/a	91% in single family w/ an attached garage 6% single family, detached garage 3% in apartment <1% other	n/a	n/a
2013 California EV survey —vehicles: LEAFs, Volt, Prius Plug-in —region: California	50%, $150k + 18% $100k-$150k 10%, $50k-$100k 2%, <$50k	93% own their home	88% in a single-family detached home 7% in single-family attached home	n/a	n/a

[5] Idaho National Laboratory. April 2015. How Does Utilization of Non-Residential EVSE Compare Between those Installed in Oregon in Planned versus Unplanned Locations? http://avt.inl.gov/pdf/EVProj/UtilizationOfNonResEVSEInstallationVsPlan.pdf.

Data Source	Income	Home Ownership	Dwelling Type	Household Vehicles	Hybrid ownership
[2]	20%, Unknown		4% in an apartment/ condominium 1% in other dwellings		
Bay Area LEAF survey —vehicles: all LEAFs —region: SF Bay Area, CA [3]	n/a	n/a	n/a	nearly all households have at least 1 other vehicle 30% have more than 2 vehicles	34% had a HEV in their home
Tal *et al*, California Survey —vehicles: mostly LEAFs —region: California [4]	46%, $150k + 37%, $100k-150k 16%, declined	96% own their home	96%, single family house		32% owned a HEV before they purchased EV 11% replaced a HEV w/ a EV 25% own HEV and EV
Chevrolet information [5]	average income, $170k	n/a	n/a	n/a	7% of buyers replaced a Toyota Prius HEV with the Volt
Nissan Information [6]	household income, $159k	home value of $640k			

[1] California EV Owner Survey. California Center for Sustainable Energy, data collected in February 2012. Available online at: http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project/vehicle-owner-survey

[2] California EV Owner Survey. California Center for Sustainable Energy, data collected in May 2013. Available online at: https://energycenter.org/clean-vehicle-rebate-project/vehicle-owner-survey/feb-2014-survey

[3] Bay Area LEAF Survey. Conducted by Bay Area Air Quality Management District, analyzed by ECOtality and ICF International. October 2012.

[4] Tal, G; Nicholas, MA; Woodjack, J; Scrivano, D. Who Is Buying Electric Cars in California? Exploring Household and Fleet Characteristics of New Plug- In Vehicle Owners. Submitted to Transportation Research Record, August 2012. Available online at: https://sites.google.com/a/ucdavis.edu/gil-tal/evs-market

[5] Cristi Landy, Chevrolet. The Customer Experience: Reaching Buyers Beyond Early Adopters. GM Marketing, February 2012. Available online at: http://umtri.umich.edu/content/Crisit.Landy.GM.Marketing.PT.2012.pdf

[6] Nissan EV Information, handout from EVS26

Based on these surveys of initial adopters, ICF identified the key indicators for EV ownership. We used these key indicators to develop a scoring methodology that estimates the likelihood of EV adoption in a given census block group. The following parameters were selected for further consideration, with corresponding weighting factors highlighted below:

- **Income:** Market research suggests that households with higher incomes are more likely to purchase an electric vehicle. Because electric vehicles tend to have higher upfront costs, income can also be a limiting factor. In other words, individuals with low income might not be able to afford an EV.

- **Hybrid Electric Vehicle (HEV) Ownership:** Based on survey results, ICF gave HEV ownership a significant weighting factor. In addition to correlating with income, HEV ownership correlates well with influencing factors such as environmental stewardship and price sensitivity to gasoline, both of which have proven to play a significant role in the level of interest in EVs.
- **Home Ownership:** Households who own their property are more likely to adopt a EV than those who rent, according to market research by most major automobile manufacturers and the University of California, Davis. Home ownership reduces both financial and non-financial barriers to charging infrastructure deployment. The influence of home ownership will likely change considerably by 2020; however, in the near future, it will likely be a significant driver. There is already some correlation between home ownership and income, so the weighting for this parameter is designed to distinguish between census block groups that are already likely to include EV adopters based on the income profile. ICF only considered census block groups that had both an income greater than median income for the region and home ownership greater than the median level of home ownership for the region.
- **Dwelling Type:** Dwelling type (e.g., single-family detached, single-family attached, or multi-unit) is an important parameter because drivers are expected to charge their vehicles at home. We assume that consumers with a single-family detached home generally have fewer barriers to EV adoption. Only census block groups that were above the median income and above the median percentage of single-family residences were considered for the residential analysis. For multi-family units, ICF filtered for areas with high multi-family ownership by increasing the value of the weighting factor for dwelling type, and changing the structure of the scoring to favor areas with above median income, above median hybrid ownership, and a high share of multi-family dwellings (instead of a higher rate of single family units).

ICF used census data from the American Community Survey (ACS), an ongoing statistical survey that samples a percentage of the population every year. For the purposes of this exercise, ICF determined that the most complete datasets for census block groups were the 5-year estimates; ICF used data for years 2010-2015. ICF extracted demographic data on income, home ownership, and dwelling type in the Santa Clara County, as well as other counties where trips to Santa Clara originate. ICF analyzed vehicle registration data from IHS Markit to establish hybrid vehicle ownership rates by census block group.

Opportunity Charging

Opportunity charging covers a wide range of situations where an EV driver could potentially charge when away from home or work. Unlike residential and workplace charging, where vehicles are parked for long enough that they achieve a significant charge even with Level 1 charging, opportunity charging will take place at locations where drivers are parked for varying times; therefore, the level of charging bears much greater consideration when siting opportunity charging. Table 4 shows the preferred charging method based on the available charging time at different venues.

Table 4. Recommended Charging Level for Different Venues

Typical Venue	Available Charging Time	Charging Level (Primary/Secondary)
Shopping Centers	0.5–2 hours	Level 2/DC Fast
Other	< 1 hour	Level 2/DC Fast
Street/Meters	1–2 hours	Level 1/Level 2
Parking Garages	2–10 hours	Level 2/Level 1
Hotels/Recreation Sites	8–72 hours	Level 2/Level 1

To identify likely areas for opportunity charging, ICF used data from the Santa Clara Valley Transportation Authority (VTA) travel model to identify the origin-destination pairs for non-work related trips, such as home to shopping and home to social or recreational activity.

Similar to the residential charging analysis, U.S. Census ACS demographics on income, home ownership and dwelling type, as well a hybrid ownership rates were used to weight the trips on EV likelihood.

Workplace Charging

To identify likely areas for workplace charging, ICF used data from the Santa Clara Valley Transportation Authority (VTA) travel model to identify the origin-destination pairs for home-based work trips made between various TAZs. Using the areas that have the most likely EV adopters (see the previous subsection), ICF weighted trips based on the likelihood that it would be completed with an EV.

4.3. Accessing the Results & Mapping Tool

Jurisdictions can view the charging infrastructure siting analysis maps by visiting the following website: https://ecosystems.azurewebsites.net/SantaClara/

4.4. Scenario Analysis

The siting analysis methodology and resulting maps were presented to DNZ project partners for review and feedback. Based on these conversations, a common theme arouse around the need for jurisdictions to assess where to deploy charging infrastructure in disadvantaged communities (DACs). The initial analysis methodology and assumptions, as described above, is based on key EV ownership indicators of early adopters, who are more likely to have a higher income, perhaps own a hybrid, live in single-family homes, and own their home. These demographics are not typical characteristics of DAC populations. Therefore, ICF developed a set of scenarios and resulting charging demand maps that seek to target residents of multi-family buildings and DACs. The demographics of EV owners will likely evolve as vehicles become more affordable and the network of charging stations is built out. To address the evolving nature of the market, ICF also developed additional scenarios varying the weighting of key EV ownership indicators so that jurisdictions can compare results and use as needed, depending on their outlook and priorities. Table 5 below describes the key assumptions of these scenarios. Note that the “reference cases” reflect ICF’s initial analysis.

Table 5. Siting Analysis Scenario Descriptions

Scenario	Description
Focusing on single-family residential charging demand:	
Scenario 1 – Likely EV Buyers in Single-family Homes	Reference case, focusing on socioeconomic factors that favor EV ownership
Scenario 2 – Home Owners	Focus on single-family home owners as potential EV buyers; recognizes that there is still demand for EVs where home charging may be convenient i.e., in areas of high home ownership and high single-family homes
Scenario 3 – Hybrid Owners	Increases focus on hybrid ownership as proxy for environmental awareness as the key driver for EV interest
Scenario 4 – Workplace Charging as a Solution	Areas to target for workplace charging that could alleviate challenges of home charging for potential EV buyers (as determined by high income and high rates of renters and hybrid ownership)
Scenario 5 – Education & Outreach	Areas to target for education and outreach based on likely EV buyer characteristics, after removing hybrid ownership as a metric
Focusing on multi-family residential charging demand:	
Scenario 6 – Likely EV Buyers in Multi-family Units	Reference case, focusing on socioeconomic factors that favor EV ownership in multi-family units
Scenario 7 – Low Income in Multi-family Units	Targets low income population in multi-family units
Scenario 8 – High Income in Multi-family Units	Targets higher income populations in multi-family units

5. Planning Considerations

After identifying areas with potentially high demand for charging infrastructure through the siting analysis, the next step is to assess specific sites or parking areas within areas that would make good locations for charging infrastructure. Potential sites should have amenities to support the amount of time a driver will spend at the site while the vehicle is charging. In addition to amenities, key site considerations include safety, accessibility, and visibility to drivers.

For publically accessible L2 charging, which is the major focus of local government funded deployments, typical charging times range from 1-2 hours. A DC fast charging units requires significantly less dwell time and are typically sited along interstate highways. Level 1 equipment may be a good option for some workplace and fleet charging needs as they are easy and cost-efficient to install and vehicles need to be parked several hours to get a significant charge. This is the case for many employee owned vehicles that remain in the same parking spot during an eight hour shift, or fleet vehicles that are parked overnight. Using Level 2 charging for workplace and fleets may require vehicle rotation to ensure that multiple users have access to charging and that all charging needs are met.

5.1. Site Assessment

The specific location of charging equipment can impact station utilization and installation costs. Placing chargers in locations convenient to drivers is important. Note that Section 8 of this report includes EV charger cost estimates.

The most cost-effective charging installations are those in close proximity to an existing electrical panel that has the capacity to handle the additional load required for vehicle charging. The California Department of General Services recommends that the following factors should be accounted for when choosing a location for charging equipment:[6]

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

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

6. Public Infrastructure Requirements & Design Guidelines

The State of California has created requirements to ensure that chargers are Americans with Disabilities Act (ADA) accessible and easy to find via signage. To make it easier for charging station hosts to determine the best configuration of their installation while also meeting building code requirements, local jurisdictions should adopt uniform charging station design guidelines that address the many unique considerations associated with EV charging stations. The following section outlines the ADA and signage requirements, evaluates whether any local jurisdictions in Santa Clara County have existing EV public infrastructure standards, and provides example site drawings for various EV charging configurations.

6.1. Requirements

Accessibility

If the charging equipment is installed in a parking lot and will be made available for use by the public, then it will need to be designed so that it meets the California requirements for ADA accessibility. 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, so property owners may have to sacrifice multiple regular parking spaces to build the first charging space.

Table 6 shows the number of each type of accessible space that is required based on the total number of chargers at a location, according to the 2016 California Building Code. These requirements went into effect on January 1st, 2017 and encompass three types of ADA access:

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

Table 6. Number of accessible chargers required at installations of new public charging spaces[7]

Total number of EVCS[8]	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.

Note that International Symbol of Accessibility (ISA) signs are not required for small scale installations with 1 to 4 EVCS, however at least one accessibly designed EVCS is required.

The California Building Code describes in detail the site configuration requirements for accessible charging,[9] 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)[10]
- Accompanying access aisles at least 60” wide

There are also ADA requirements and guidelines relating to the actual charging equipment.

- Charging cables need to be kept off the ground and the cable receptacle should not be more than 48 inches above the surface of the surrounding ground area.
- The charger handle should not require undue strength to pull, lift, or operate the handle. Based on federal ADA guidelines, the amount of pulling of lifting strength required should be less than five pound force.

Signage

Surface street directional signage serves two important functions. It directs EV drivers to the nearest public charging infrastructure locations and educates non-EV drivers about the availability of charging infrastructure in their community, allowing them to consider how an EV might work for them.

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[7] 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.

[8] Where an EV charger can simultaneously charge more than one vehicle, the number of EVCS provided should be considered equivalent to the number of electric vehicles that can be simultaneously charged.

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

[10] A drive-up EVCS is an EVCS in which use is limited to 30 minutes maximum and is provided at a location where the EV 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.

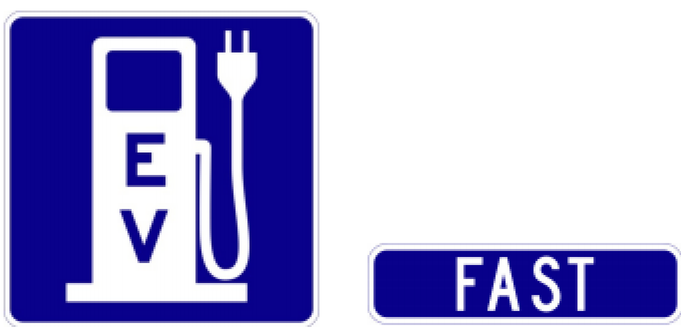
Signage can also be used to enforce parking restrictions. With the passing of Assembly Bill 1452 in October 2017, California now gives local jurisdictions the authority, by ordinance or resolution, to designate stalls or spaces in off-street and on-street parking for the exclusive purpose of charging. 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.[11] 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,[12] including:

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

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 EVs.

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

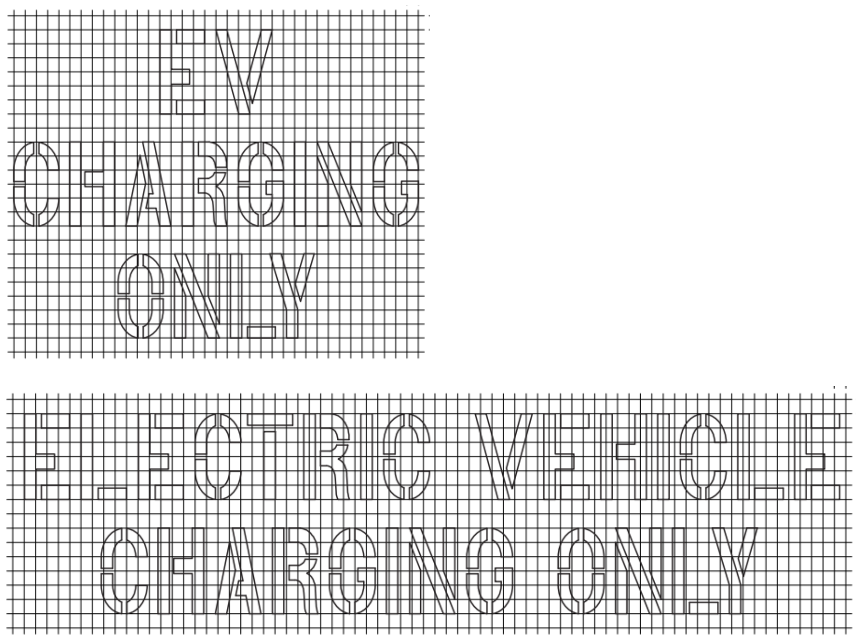


[11] California Assembly Bill 1452 - Parking: exclusive electric charging and parking on public streets. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1452

[12] 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 3. Parking signs to place restrictions or time limits on charging spaces

Figure 4. Pavement markings indicating restrictions on charging spaces



6.2. Evaluation of Existing Public Infrastructure Standards

Currently, local jurisdictions in Santa Clara County lack consistent public (non-residential) EV charging infrastructure development guidelines or standards that reflect the most recent requirements for site design, accessibility and signage. The City of Cupertino does offer some guidance, which references the Tri-Chapter Uniform Code Committee's EV charging system guidelines, but these are outdated (last updated in 2014). The City of San Jose mentions some EV charging station requirements in its Code of Ordinances (such as meeting applicable health, safety, and performance standards) but no actual guidance on how to site and configure the charging equipment is given. Therefore, there is a clear need for design guidelines that address the many unique considerations associated with EV charging stations.

6.3. Design Guidelines and Site Drawings

Local governments will likely need to create multiple sets of EV 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:

- Minimum dimensions of EV 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, where applicable.
- Location relative to other spaces, adjacent land uses (i.e., setbacks), 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.
- Design of disabled access spaces (i.e., ADA compliance) within existing developments, including requirements for the number of spaces in areas that must be accessible in areas with multiple EV parking spaces and design standards for accessible spaces.

Example Site Drawings

There are many possible configurations for EV charging stations, depending on where they are sited and who will be using them. Jurisdictions may wish to specify preferences that fit with local conditions. For example, not every jurisdiction will be able to accommodate charging installations in on-street parking spaces due to high demand or space limitations. The figures that follow illustrate a variety of different EV charging station configurations. Agencies can use these site drawings to establish standards or guidelines, or modify as needed.

ADA Accessible Charging Stations

Public access charging stations that must comply with the ADA accessibility mentioned in the previous section and need to meet certain requirements. The figures below present sample configurations of ADA compliant public access charging stations for standard, van, and ambulatory accessible spaces.

Figure 5 illustrates a standard accessible electric vehicle charging space, outlined in red.

Figure 5. Standard Accessible Multi-port Charging Configuration

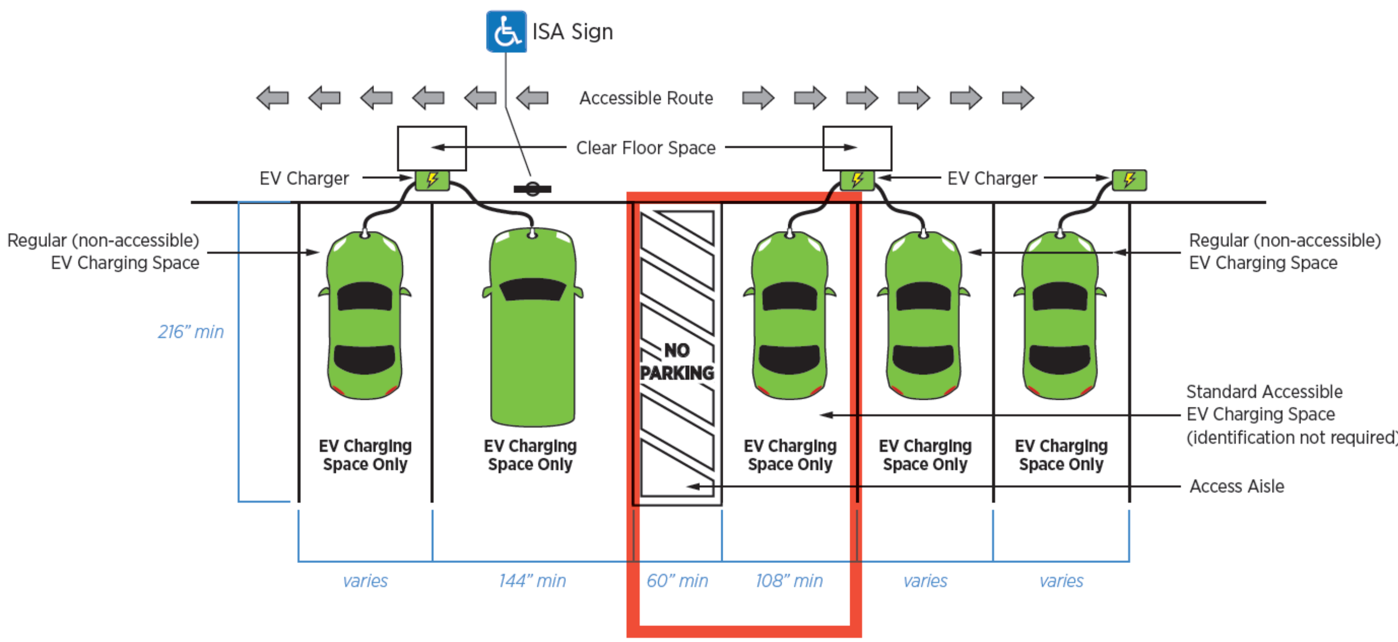


Figure 6 is similar to the previous drawing but highlights a van-accessible charging space.

Figure 6. Van Accessible Multi-port Charging Configuration

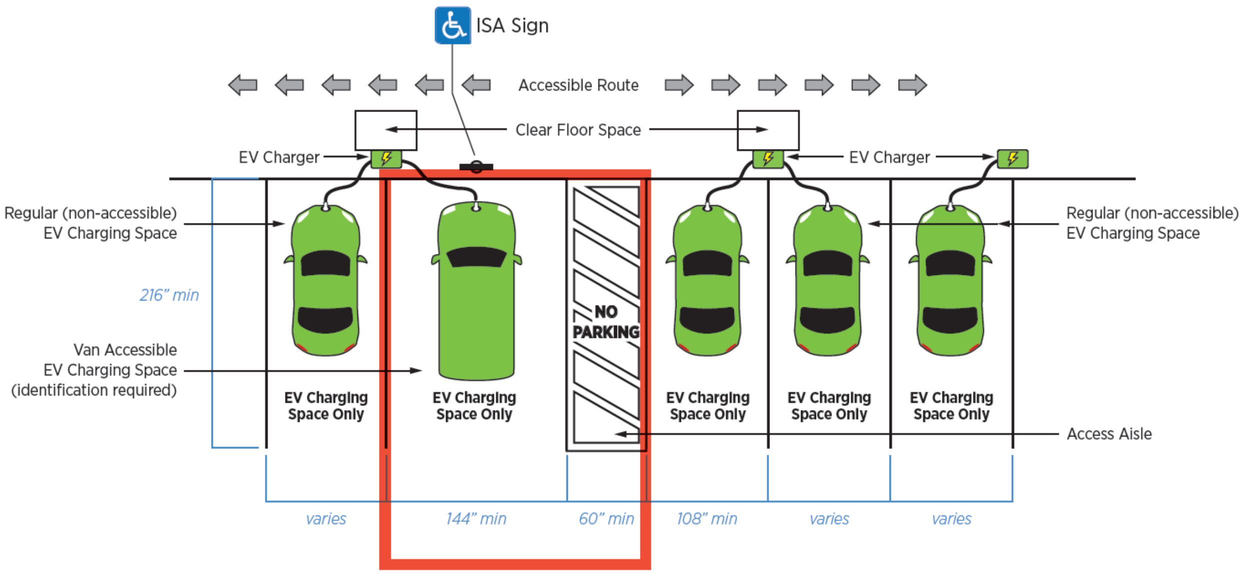
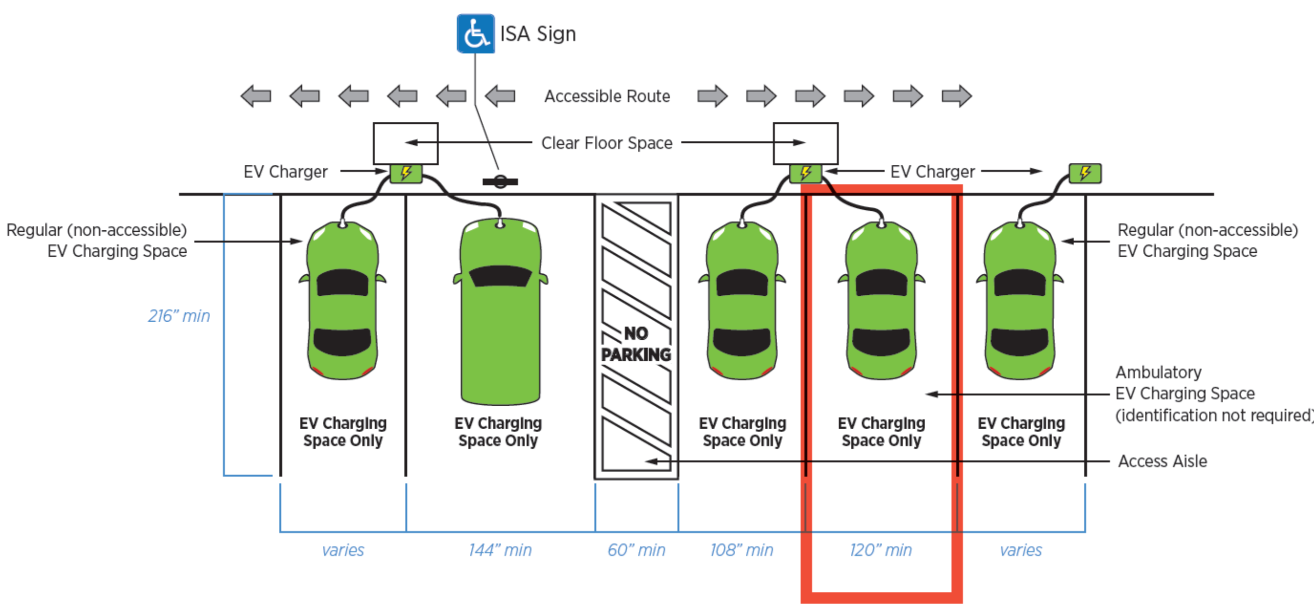


Figure 7 is an ambulatory charging space. Note the larger dimensions, with a 120-inch minimum, compared to the standard accessible space. The additional width provides better access for individuals with mobility challenges.

Figure 7. Ambulatory Accessible Multi-port Charging Configuration



Private Charging Configurations: Fleets and Workplace

EV charging stations that are not publically accessible, such as private multi-family parking garages and private fleet/workplace parking lots are not required to comply with the ADA requirements set forth in the California Building Code. However, it is important to note that there may be future obligation for “reasonable accommodation” request based on ADA Title I Employment provisions.

Figure 8 illustrates a configuration found often at multiple indoor and outdoor sites, including workplaces, multi-unit dwellings, and commercial areas. The recommended charger location corresponds with the existing electrical panel.

Figure 8. General Configuration for EVCS (not ADA accessible)

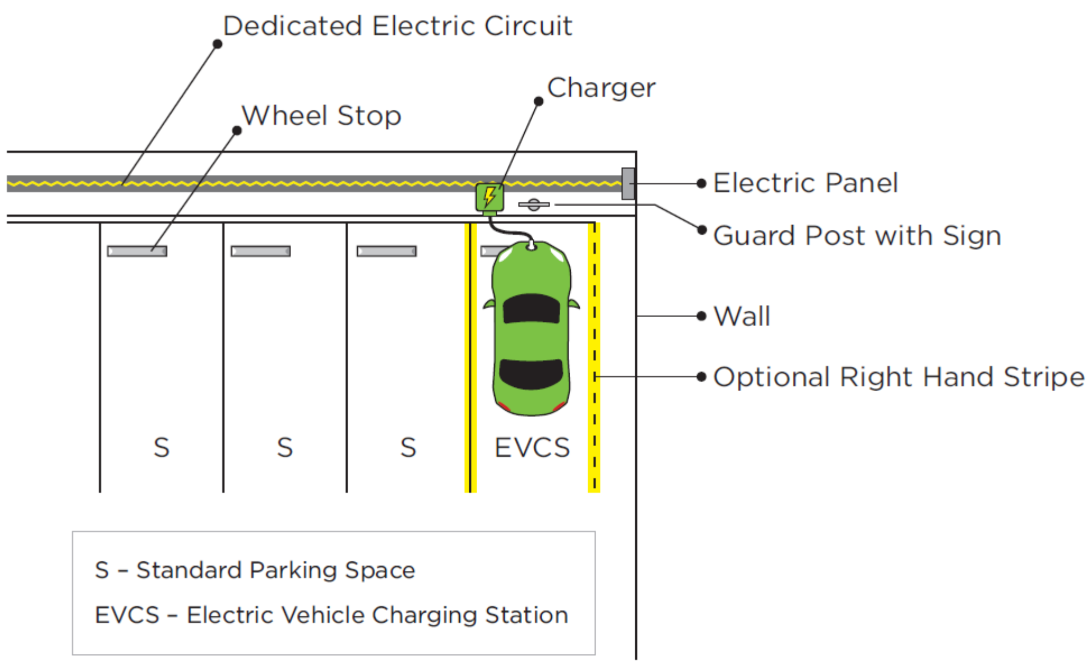


Figure 9 shows a configuration that allows for four charging spaces with a central location for the equipment. This example most closely aligns with a parking garage, though the configuration could also be applied to a surface lot, such as at a shopping mall.

Figure 9. Multiport Configuration for EVCS (not ADA accessible)

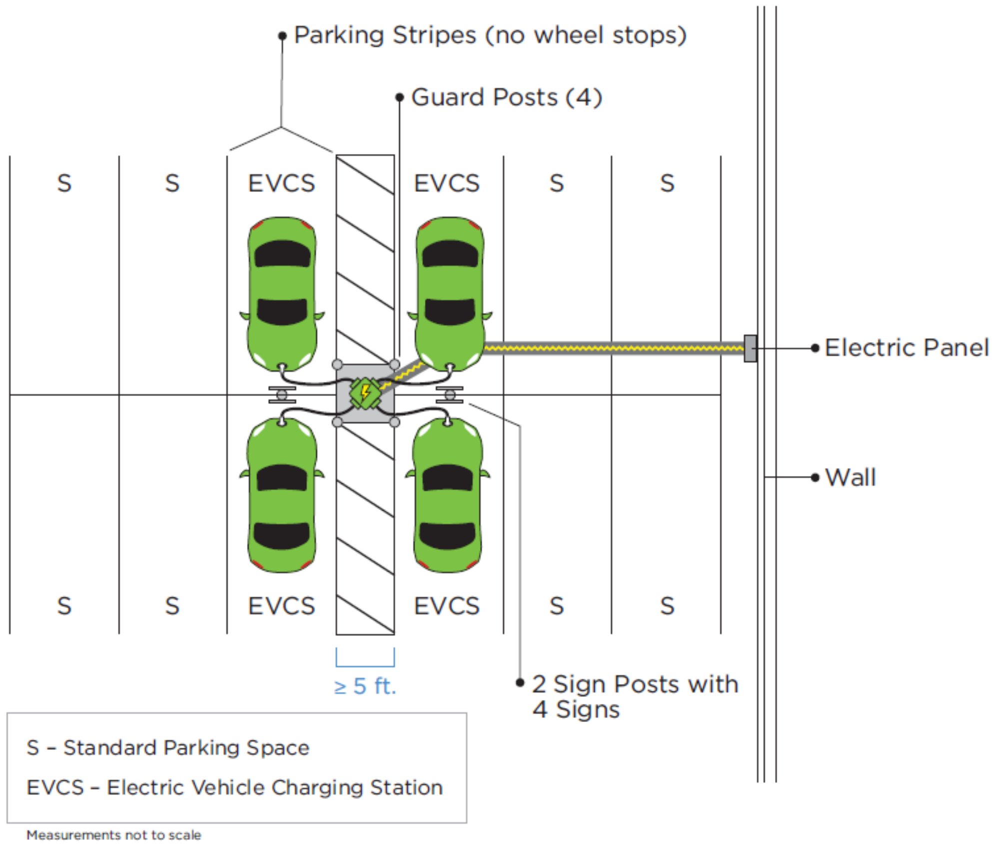
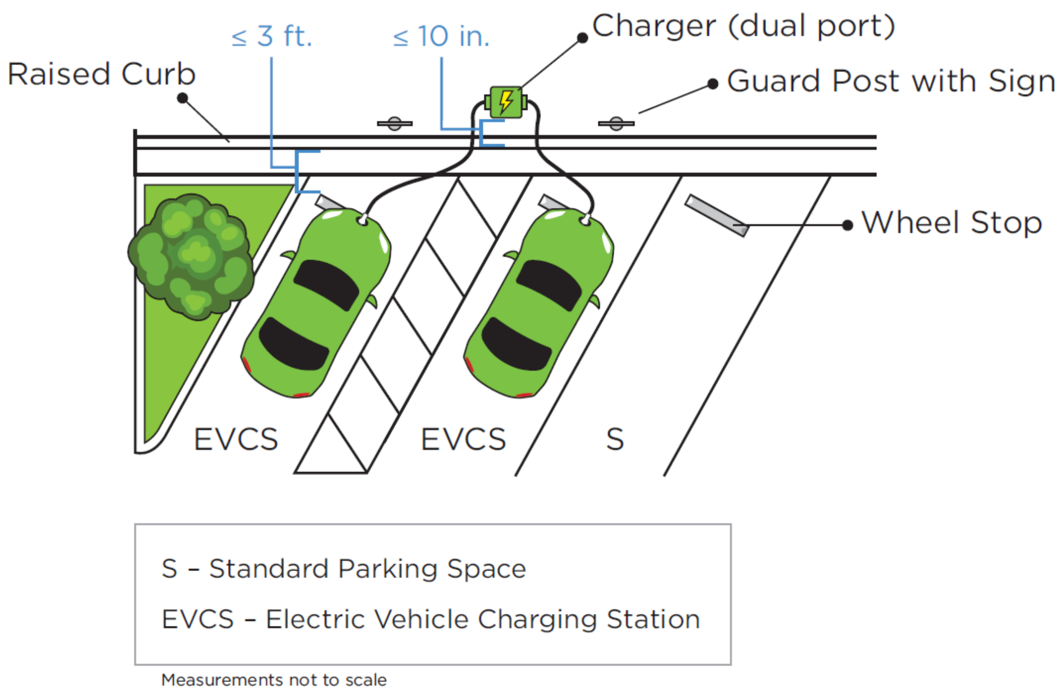


Figure 10 displays a charging station installed at angled parking spaces, which may be found outside office or retail locations.

Figure 10. Dual Charger at Angled Parking Spaces (not ADA accessible)

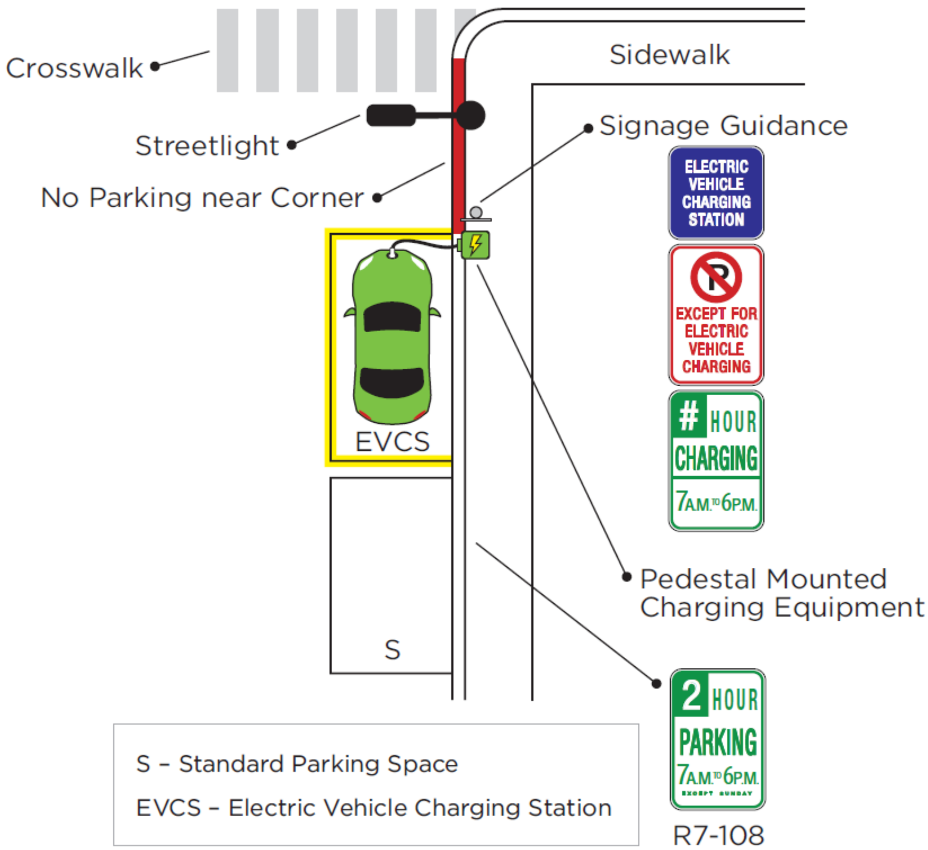


On-Street Charging Configuration

The California Building Code does not regulate EV charging station in the public right-of-way, therefore they are not required to be ADA accessible. However, accessibility is still required under the federal Americans with Disabilities Act. Since there are no explicit regulations, it will be up to site hosts to provide an accessible solution which is acceptable to local jurisdictional authorities, and for local jurisdictions to decide what is acceptable.

Figure 11 illustrates an on-street parking configuration that is not ADA accessible. Since on-street charging stations will most likely be accessible to the public, corresponding signage is included.

Figure 11. On-street EVCS Configuration



7. Station Ownership and Management Options

7.1. 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 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.

7.2. Setting Fees for EV Charging

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. Site hosts often need to recoup the costs of installing, maintaining, operating chargers, and may also wish to price charging strategically encourage turnover so chargers are available to those who need them most. 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.

- **An Access Fee** is a fee associated with gaining access to the charging station irrespective of if the vehicle is charging and/or how long it remains connected. It is essentially a flat rate for initiating a session by connecting to the charging station.
- **A Station or Time Based Fee** is a fee associated with the length of time a connection is established with the station, irrespective of whether the vehicle is charging or not (typically $1-2 per hour). As long as the vehicle is connected to the charging station this fee would apply. 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.

- **An Energy Fee** is a fee associated with the amount of energy consumed by the connected vehicle. This is based on a per kilowatt-hour flat rate and only applies when the vehicle is actively charging. This fee is typically not applied when the vehicle is not receiving power even if the vehicle remains connected to the EV station. A multiplier on this cost may be applied to recover other operational costs.

Some jurisdictions have implemented graduated pricing schedules to increase vehicle turnover so that there is greater availability of charging and utilization of assets. Typically, the fees are increased after a two to four hour period of charging at a lower rate. Fees should be periodically reassessed to ensure that costs are being recouped and stations are utilized.

Over the long term, infrastructure owners should pilot innovative agreements with utilities and charging station providers 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 an EV 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.

7.3. Time Limits and Enforcement

Time limits can help ensure turnover at chargers so that they are available to drivers who need them. Otherwise, EV 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. 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 to 6 hours
Level 2	1 to 2 hours
DC Fast	15 to 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 EV ownership, but it can also make enforcement challenging.

The California Vehicle Code allows the owner of a space to remove a vehicle if it occupies a space in violation of posted regulations,[13] including signs designating spaces for charging vehicles or time limits on charging spaces. In order for signs to be enforceable, governments in the Santa Clara County must specify time limits, penalties, and provide all of the necessary definitions through a local ordinance.

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

8. Charger Infrastructure Cost Estimates

The cost of installing and managing charging stations vary depending on the number and type of equipment used and where the stations are sited. It is important for potential site hosts to understand these costs in order to make informed decisions regarding long term EV charging station planning and development.

8.1. Capital 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 8 below summarizes the expected costs of Level 1, Level 2, and DC fast charging installations in non-residential applications.

Table 8. Cost ranges for single port electric vehicle charging stations in non-residential applications[14]

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 EV 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 charge port installations—for each level of charging infrastructure shown in the table above – is a fraction of the total installed

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

[14] 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.

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.
- **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.
- **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** which can require special curb cutouts, van accessible parking spaces, level parking spaces, and specific connector heights, all of which affect the design and cost.

Clean Cities' Tips for Minimizing EV 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 that may be a great distance from the electrical panel, use signage to direct EV 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

8.2. Operation & Maintenance Costs

Operation and maintenance (O&M) costs of EV charging stations vary depending on the type and quantity of charging equipment, station utilization, and ownership structure. Typical on-going O&M costs include electricity charges, station management and maintenance, and network fees.

Electricity Costs

EV charging station owners pay for the cost of electricity supplied by the equipment. These costs are comprised of two separate factors – the electricity consumption charges and demand charges. Electricity consumption charges are determined by the utility rate ($/kwh) and the amount of electricity consumed. The consumption of electricity will vary based on the number of vehicles using the chargers, power output of the equipment, vehicle power acceptance rate, and amount of time the vehicles charge.

Large commercial and industrial electricity rate structures also have demand charges that can be costly if not managed properly. Demand charges are additional fees based on the maximum energy load drawn by a customer during the billing period. Utilities use demand charges to cover the wear-and-tear on the distribution system components (i.e., transformers, substations, and primary conductors) and some portion of the transmission system, if the load is large enough. They are meant to cover the maximum capacity needed to satisfy all their customers' peak energy needs. Demand charges are typically not a big financial burden in smaller L2 deployments, but can be high for DC fast chargers or larger deployments of L2 chargers.

The metering configuration of chargers also affects demand chargers. If an L2 charger is put on an existing building meter that already has high overall demand, then charging events may not cause a spike, but rather blends in with the existing usage. It is worth noting that PG&E does have a small general time of use rate that does not have a demand charge, but its limited customers who have less than 75kW of total peak electricity consumption.[15]

Maintenance

Maintenance and repair costs vary on the type and features of charging equipment deployed. Basic L1 and L2 chargers (non-networked) do not generally require regular maintenance. Basic equipment is typically modular in design, so any malfunctioning components can be replaced separately rather than replacing an entire unit. Networked chargers with advanced features or communications systems may require more periodic maintenance. The most common issue with these is wear on the pins in the connector due to frequent use which may eventually not make a good connection and need to be replaced.

Depending on the station ownership structure, maintenance and extended warranties may be included in agreements or provided as a fixed annual fee by charging network companies.

Network and Charging Session Fees

If the EV charger unit is networked, station owners will have to pay a fee that covers the cost for cellular/Wi-Fi network communications and back office support. Network fees will vary from $100-$900 annually, depending on the type of EVSE unit (Level 1, Level 2, DCFC), the EVSE unit features, and the EVSE manufacturer or provider. Typically for L2 chargers, network fees are around $250 per charge port.

Networked charger owners may also be responsible for paying a charging session fee to the network provider, which is typically 10% of the total fees.

Table 9 below shows an example of the annual operations and maintenance cost estimate of a charging station deployment by the City of Berkeley where two dual port chargers are installed onto an existing building meter.

[15] See PG&E rate options A6 and A10, described in more detail on page 9 of the EV Charge Network Program Guide.

Table 9. City of Berkeley Annual O&M Cost Estimate for Two Networked Dual Port Chargers [16]

Expense	Cost per charge port ($/year)	Notes
Network Service Fee	$230	
Charging Session Fees	$219	10% of collected charging station fees
Electricity Consumption	$871	Assumes charger is utilized 4 hours per day (3.3 kW average delivery, $0.15/kWh for 350 days, $0.90/kWh for 15 days)
Electricity Demand Charges	$504	Assumes marginal demand charge based on 14 kW at an average of $12/kW (at a meter with 4 charging ports)
Maintenance	$375	Assumes annual dual-port charging station maintenance of $750

[16] City of Berkeley Annual Operations and Maintenance Estimate for Two Networked Dual Port Chargers. Available online: https://www.cityofberkeley.info/Clerk/City_Council/2015/05_May/Documents/2015-05-26_Item_31k_Fees_for_Use_of_Electric_Vehicle.aspx

9. Emerging Issues and Opportunities

Through outreach conducted as part of the Driving to Net Zero Project, we heard feedback from partner jurisdictions requesting some information and guidance on a few emerging EV issues and opportunities.

9.1. Power Management Strategies and Smart Charging

Power management strategies – which take form as network software capabilities – can be used to dynamically manage and split the amount of power delivered to each charge port based on site-specific factors. Vehicle charging can be controlled and staggered during high consumption periods or prioritized by need based on the existing state of battery charge.

Smart charging allows for either the EV owner, station owner, or grid operator to control the timing and amount of power the charger delivers to the vehicle based on driver preferences and grid conditions. In non-residential applications, smart charging strategies can be implemented to match charging power with network capacity to help alleviate demand charges or limit charging when rates are highest. More sophisticated smart charging that's currently being piloted involves vehicle-to-grid integration, in which a utility provider can slow charge when demand gets high, then return to regular charging when demand on the grid lightens.

The more sophisticated and "smart" charging equipment is, the more expensive it will be to purchase and maintain. Jurisdictions should assess these costs and benefits for each charging station deployment, as a one-size fits all approach does not apply. Power management and smart charging strategies may reap cost savings for some site hosts whose stations involve many charge ports or who are faced with limits on available electrical capacity and do not want to take on the cost of electrical upgrades.

9.2. Supporting the Electrification of Car and Ride Sharing

Exposure to EV technology, whether it's by test driving or riding along as a passenger, has proven to be one of the key ways of convincing consumers about EV benefits. Ride-sharing and car-sharing programs are uniquely suited to potentially provide EV exposure to the masses. So how can local governments support the electrification of car-sharing and ride-sharing fleets to support technology diffusion, as well as their climate change and air quality goals?

Local governments have very limited regulatory power over these types of service providers. Deploying EVs in car-sharing fleets can be difficult because they typically do not own the parking spots where shared cars live. If the municipality is a site host to a car-sharing vehicle, then there may be some opportunity for collaboration or cost sharing for installing a charging port.

While the taxi industry is regulated by cities, ridesharing companies are regulated by the State. Both major Transportation Network Companies (TNCs) have plans and goals for electrifying a portion of their rides. Even if some TNCs do install and maintain chargers for their fleet's use, electrified ride-sharing drivers will also rely on the pubic charging network. Local governments can be supportive of these efforts by making it easier and cost effective to install charging infrastructure (e.g., through streamlined permitting, zoning).