Electric Vehicle Charging Station Installation Guidelines: Residential and Commercial Locations

Streamlining Permitting and Inspection of Residential and Commercial Electric Vehicle Charging Station Installations[1]

Purpose

With the growing adoption of plug-in electric vehicles (PEVs) there is increasing need for installing both residential and commercial charging stations, also known as electric vehicle supply equipment (EVSE). Jurisdictions can use this guide as a template to provide straightforward information to homeowners and electrical contractors about residential and commercial EVSE permitting requirements. Within the San Diego region, jurisdictions are encouraged to use this document directly or modify it to reflect the specific requirements of their agency.

How can I charge my plug-in electric vehicle at home?

The type of PEV purchased will determine the way people charge their vehicles. Homeowners may plug their vehicles into a conventional 120-volt household outlet or install a 240-volt circuit for faster charging.

PEVs come with a 120-volt charging cord that enables owners to charge their vehicle with a conventional outlet (Level 1 charging). This is a very practical solution for owners of plug-in hybrid electric vehicles (PHEVs), such as a Toyota Plug-in Prius or Chevrolet Volt.

A person who purchases a battery electric vehicle (BEV), such as the Nissan Leaf, may choose to use a Level 2 charging station. Level 2 chargers use 240 volts and cut the charging time by about one-half compared with 120 volt charging. Level 2 charging generally requires installation of a dedicated circuit and a charging station at your home (usually in the garage). In this case, the homeowner will be required to obtain a permit from their local jurisdiction.

Commercial Charging

Workplace Charging for Businesses in San Diego[2] offers guidance for installing EVSE at nonresidential locations. It includes information about how to evaluate commercial charging needs and assess potential sites as well as other relevant resources.

The following table illustrates the charging time associated with the most popular BEVs and PHEVs on the market.

Charging Level	Power Supply	Charger Power	Miles/Hour of Charge	Type of PEV	
				Nissan LEAF	Chevrolet Volt
Level 1	120 VAC	1.4 kW (onboard charger)	~3–4 miles	~17 hours	~9 hours
Level 2	240 VAC	3.3 kW (onboard charger)	~8–10 miles	~7 hours	~3 hours
		6.6 kW (onboard charger)	~17–20 miles	~3.5 hours	~1.5 hours

Source: California PEV Collaborative

What do I need to provide to obtain an installation permit?

Residential EVSE Permits

The following are submittal requirements to obtain a permit for a typical EVSE residential installation.

[1] Adapted from the City of Riverside's *ELECTRIC VEHICLE CHARGER INSTALLATION GUIDELINES* and the City of Oceanside's *Residential Electric Vehicle Charger Guidelines*

[2] http://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/san-diego/fact-sheets/Workplace%20Fact%20Sheet.pdf

Supporting Documentation	Description
Plot Plan	Identify the complete layout of existing parking spaces and proposed location of EVSE parking space(s) with respect to existing building and structures
Electrical Load Calculations	Home electrical load calculation that estimates if an existing electrical service will handle the extra load from residential EVSE and wiring methods based on the California Electrical Code (see sample electrical plan)
Electrical Plans	Single-line diagrams showing the system, point of connection to the power supply and the EVSE
EVSE Information	The EVSE manufacturer's installation instructions and charger specifications

(Note: Jurisdictions may need to modify this list to reflect their specific requirements)

In most cases, homeowners or contractors simply need to submit the documentation outlined above to the local permitting office (usually the building and safety division) for review and permit issuance. PEV owners and contractors are encouraged to check their local jurisdiction's permitting website to see if this process is available online. If not, they will likely need to visit the permitting office for an over-the-counter review and permit issuance.

If all of the information is provided and the proposal complies with the applicable codes, the review and approval process occurs shortly thereafter. It is important to note that load calculations per California Electrical Code (CEC), Article 220, are required if the existing service panel is rated less than 200 amps. Electrical panel upgrades and electrical wiring must be in conformance with the current edition of the CEC.

Commercial EVSE Permits

Installation of EVSE at commercial locations can be more complex than residential installations and may require additional permits or submittal documentation. The following are considerations for commercial EVSE.

- ✓ Zoning Requirements
- ✓ Community or Design Guidelines
- ✓ Existing Use Permits
- ✓ Electrical Source/Metering
- ✓ Parking and Signage Requirements
- ✓ Permit and Inspection Fees

A simple commercial EVSE installation may have similar permitting requirements as a residential installation with the addition of a tenant improvement electrical permit. A more complex commercial installation may require a modification to an existing use permit or site plan addressing specific community or zoning design criteria. It is important to meet with staff at the jurisdiction's building department and, if necessary, planning department, to understand fully all of the requirements and fees prior to submitting permits.

Do I need to get my charging station inspected by the permitting jurisdiction?

All jurisdictions in the San Diego region require an inspection of an installed EVSE. When the installation is complete, an inspection of the work is scheduled with the building inspector upon request. Generally, inspections occur less than one week after the request. Typically, the homeowner or property owner (or tenant) needs to be present during the inspection so that the inspector can access the charging station location and review any other electrical or structural change. See the attached *EVSE Inspection Checklist*, which is designed to serve as a guide for local building inspectors and is endorsed by the National Electrical Contractors Association. A residential checklist used in the cities of Oceanside and San Diego is also included.

How do I install a charging station?

Residential Installations

Installing residential EVSE may require changes to the home's electrical wiring and prompt selecting different utility electricity rates.

- For a step-by-step installation guideline, view the attached *Plug-in and Get Ready* document. For more information on PEV charging stations currently available on the market, visit www.GoElectricDrive.com.

Commercial Installations

Commercial EVSE installations are often specific to the location and the proposed use. It is advisable to consult the permitting and/or planning agency before breaking ground.

When installing a home or commercial charging station, property owners are encouraged to choose a local electrical contractor with the proper expertise, information, tools and training for installing EVSE to ensure a high-quality and efficient installation experience. Please reference the wiring methods based on the California Electrical Code attached.

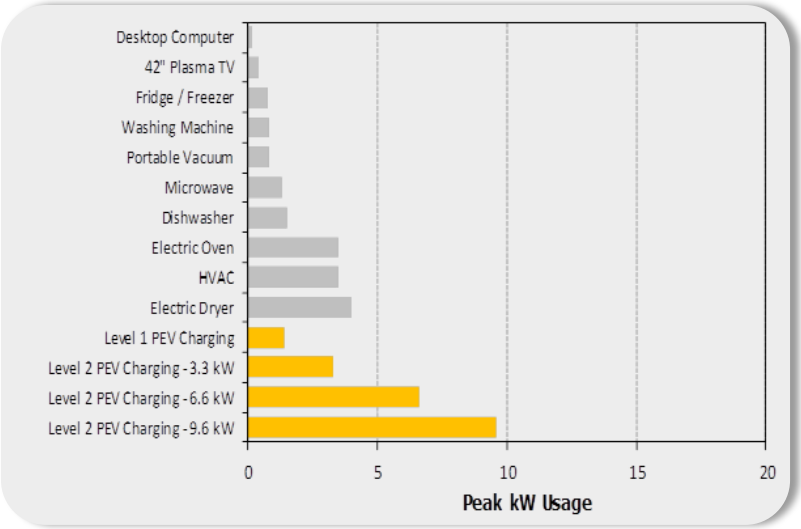
Why would SDG&E need to know about your charging station?

San Diego Gas & Electric (SDG&E) needs to accurately track the number of PEV charging stations installed to properly plan for local increases in electricity demand due to vehicle charging. The combined effect of several chargers in the same area could result in overloads on utility secondary wires and transformers. Therefore, utility notification is an important component of providing safe, reliable electricity to all SDG&E customers.

SDG&E can help businesses understand pricing options and identify potential EVSE rebates and incentives.

Load Level of Residential Charging

SDG&E's Clean Transportation Program created the figure below that displays the significant load difference of a residential EVSE as compared with typical household appliances. According to SDG&E, a PEV charging at 9.6 kW may double or triple a household's prior peak load. In addition, PEV owners who notify SDG&E of a residential EVSE installation will learn about their PEV time-of-use (EV TOU) rates that provide a significantly lower electricity cost of for PEV owners who charge at night, when demand is lower.



Source: San Diego Gas & Electric

Visit SDG&E's Electric Vehicles website for more information about their EV programs.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE) INSPECTION CHECKLIST

Key Concerns for Electric Vehicle Supply Equipment Inspections
1. Is the appropriate permit secured and is there a plan and calculation as required by the AHJ?
2. What type of electric vehicle supply equipment (EVSE) is being installed (i.e. Level 1, Level 2, other)?
3. Where is the EVSE located in relation to the charging location and the service or supply source?
4. Is the EVSE listed by an NRTL and are the installation instructions available for reference?
5. Is the EVSE going to be cord-and-plug connected (and so listed) or direct wired to an individual branch circuit?
6. What amount of voltage and current is required for the type of EVSE (nameplate information)?
7. Is the EVSE securely mounted to the structure and individual branch circuit wiring installed per NEC?
8. Is the properly sized equipment grounding conductor connected and proper overcurrent protection provided?
9. Does the service or source have adequate capacity for the load served?
10. Are separate utility meter(s) and/or service disconnecting means installed for special utility rates?

INSPECTION CHECKLIST (non-inclusive)

EVSE Inspection Activity Details				
	Item	Inspection Activity	Code Reference	Comments
	1.	Verify permit is posted and all plans, calculations and installation instructions are available as required. May require use of examples in NEC Chapter 9. A calculation may be required to determine adequate capacity.	Local Regulations and NEC 90.8, 220.12, 220.14, 220.16, 220.82	
	2.	Verify that the EVSE is listed by an NRTL and installation instructions are provided.	NEC 90.7, 625.5, 110.3(B)	
	3.	Verify the EVSE location and that it is securely fastened to the structure and guarded from physical damage as required.	NEC 110.13, 110.27(B), 625.29, 625.30	
	4.	Determine if EVSE is directly wired to the branch circuit or is cord-and-plug connected. Must be listed for cord-and-plug connection. Individual receptacle reqd.	NEC 110.3(B), 625.13, 625.18, 625.19, 625.29	
	5.	Verify an individual branch circuit is installed for the EVSE. Applies to Level 1, Level, 2, and fast chargers. Branch circuit and feeders (if applicable) must be sized 125% of nameplate current.	NEC Article 100 continuous load, 210.19(A)(1), 215.2(A), 625.21	
	6.	Verify installed branch circuit wiring method is listed and securely fastened to the structure. Listed wiring and fittings must be installed. Check fished and surface wiring.	NEC 300.11 and the applicable .30 section of article	
	7.	Verify the size of the branch circuit overcurrent protection is per nameplate and protects the conductors.	NEC 110.3(B), 240.4	
	8.	Verify circuit conductors are sized not less than 125% of EVSE nameplate current. Be sure that the conductor ampacity complies with the rating of the overcurrent protection.	NEC 210.19(A)(1), 215.2(A), 110.3(B), Table310.15(B)(16), 310.15(B).	
	9.	Verify properly sized equipment grounding conductor is installed with the branch circuit and connected at the EVSE and to panelboard or service. Verify the equipment grounding conductor is identified.	NEC 250.110, 250.112, 250.114, 250.120, 300.3(B), 250.119, 250.122.	

	10.	Check the electrical connections of the circuit conductors and equipment grounding conductor connections.	NEC 110.14, 250.148(A) Annex I	
	11.	Verify disconnecting means is provided and properly located for EVSE rated greater than 60 amperes and 150 volts.	NEC 625.23	
	12.	Verify installation of EVSE is in a neat and workmanlike manner.	NEC 110.12, NECA 1, NECA 413	
	13.	Verify existing service conductors are of adequate size. For Level 2 EVSE installations, identify any existing service conductor sizes that might have been installed using NEC 310.15(B)(7) and Table 310.15(B)(7)	NEC 230.31, 230.42, 310.15(B)(7) and Table 310.15(B)(7)	
	14.	Verify circuit breaker compatibility with existing panelboard or service equipment. Must be manufactured by the panelboard or service equipment manufacturer.	NEC 110.3(B), Article 240 Part VII, Article 408 part I	
	15.	Branch circuit device and any disconnects must be identified as to the use.	NEC 408.4(A), 110.22(A)	
	16.	Where separate utility metering and enclosures are installed, verify NEC compliance for service equipment and conformance to applicable utility regulations.	Utility company regulations and NEC Article 230	
	17.	Verify equipment is suitable for connection to the line side of the service disconnecting means.	NEC 230.82	
	18.	Verify sufficient working space is provided at EVSE, Panelboards, service equipment, and disconnects.	NEC 110.26	
	19.	Verify additional service disconnects (if installed) are grouped.	NEC 230.72	
	20.	Verify the maximum number of service disconnects has not been exceeded	NEC 230.71	
	21.	Verify that any additional service disconnect is properly rated.	NEC 230.79	
	22.	Verify the wiring method used for the additional service conductors installed.	NEC 230.43	
	23.	Verify that additional service disconnects are properly identified.	NEC 230.70(B)	
	24.	Verify service disconnect is listed as suitable for use as service equipment.	NEC 230.70(C)	
	25.	Verify the overcurrent protection for any newly installed service equipment and conductors.	NEC 230.90, 230.91	
	26.	Verify grounded conductor (neutral) is brought to the service disconnect and bonded to the enclosure.	NEC 250.24(C)	
	27.	Verify metal service equipment enclosures and raceways are bonded together effectively.	NEC 250.92, 250.92(B)	
	28.	Supply-side bonding jumpers are sized properly	NEC 250.102(C), 250.66	
	29.	Verify existing service grounding and bonding.	NEC 250.50, 250.104(A) and (B)	
	30.	Verify EVSE that is intended to be used as interactive systems, bi-directional, or optional standby systems be listed for that purpose.	NECA Articles 702 and 705	

** Note: These items included in the checklist are non-inclusive and are to serve as a guide or basis for inspection. They do not include any local Code requirements or regulations.*

LEVEL 2 ELECTRIC VEHICLE CHARGER - SERVICE LOAD CALCULATION

INSTRUCTIONS: Review the list of electrical loads in the table below and check all that exist in the home (don't forget to include the proposed Level 2 EV Charger). For each item checked, fill-in the corresponding "Watts used" (refer to the "Typical Usage" column for wattage information). Add up all of the numbers that are written in the "Watts Used" column. Write that number in the "Total Watts Used" box at the bottom of the table and proceed to the next page.

(Loads shown are rough estimates; actual loads may vary – for a more precise analysis, use the nameplate ratings for appliances and other loads and consult with a trained electrical professional.)

✓Check All Applicable Loads	Description of Load	Typical usage	Watts used
GENERAL LIGHTING AND RECEPTACLE OUTLET CIRCUITS			
✓	Multiply the Square Footage of House X 3	3 watts/sq. ft.	
KITCHEN CIRCUITS			
✓	Kitchen Circuits	3,000 watts	3,000
	Electric oven	2,000 watts	
	Electric stove top	5,000 watts	
	Microwave	1,500 watts	
	Garbage Disposal under kitchen sink	1,000 watts	
	Automatic Dish washer	3,500 watts	
	Garbage Compactor	1,000 watts	
	Instantaneous hot water at sink	1500 watts	
LAUNDRY CIRCUIT			
✓	Laundry Circuit	1,500 watts	1,500
	Electric Clothes Dryer	4,500 watts	
HEATING AND AIR CONDITIONING CIRCUITS			
	Central Heating (gas) and Air Conditioning	6,000 watts	
	Window mounted AC	1,000 watts	
	Whole-house or attic fan	500 watts	
	Central Electric Furnace	8,000 watts	
	Evaporative Cooler	500 watts	
OTHER ELECTRICAL LOADS			
	Electric Water Heater (Storage type)	4,000 watts	
	Electric Tankless Water Heater	15,000 watts	
	Swimming Pool or Spa	3,500 watts	
	Other: (*describe)*		
	Other:		
	Other:		
ELECTRIC VEHICLE CHARGER CIRCUIT			
	Level 2 Electric Vehicle Charger rating*		
(Add-up all of the watts for the loads you have checked ✓) **TOTAL WATTS USED ➔**			

Use name plate rating in watts or calculate as: (Ampere rating of circuit X 240 volts = Watts)

INSTRUCTIONS: Apply the ***Total Watts Used*** number from the previous page to the Table below to identify if the Existing Electrical Service Panel is large enough to handle the added electrical load from the proposed Level 2 EV Charger. If your electrical service is NOT large enough, then you will need to install a new upgraded electrical service panel.

Table based on NEC 220.83 (A).

✓Check the appropriate line	Total Watts Used	Minimum Required Size of Existing 240 Volt Electrical Service Panel *(Main Service Breaker Size)*	Identify the Size of Your Existing Main Service Breaker *(Amps)***
	up to 24,000	60 amp	
	24,001 to 48,000	100 amps	
	48,001 to 63,000	125 amps	
	63,001 to 78,000	150 amps	
	78,001 to 108,000	200 amps	
	108,001 to 123,000	225 amp	

**Please note that the size of your Existing service MUST be equal to or larger than the Minimum Required Size identified in the Table above or a New Upgraded electrical service panel will need to be installed (separate permit required for new service).

CAUTION: This table is **NOT** to be used to determine the size of a ***NEW UPGRADED*** Electrical Service Panel if your existing panel is too small or overloaded according the Table above. In order to determine the size of a NEW or UPGRADED Service Panel, there is a completely different load calculation methodology that applies. Sizing of a NEW or UPGRADED Electrical Service Panel should only be done by a qualified Electrical Contractor or Electrical Engineer.

STATEMENT OF COMPLIANCE

By my signature, I attest that the information provided is true and accurate.

Job Address: _____
(Print job address)

Signature: _____ _____
(Signature of applicant) (Date)

In addition to this document, you will also need to provide a copy of the manufacturer's installation literature and specifications for the Level 2 Charger you are installing.

Please note that this is a voluntary compliance alternative and you may wish to hire a qualified individual or company to perform a thorough evaluation of your electrical service capacity in lieu of this alternative methodology. Use of this electrical load calculation estimate methodology and forms is at the user's risk and carries no implied guarantee of accuracy. Users of this methodology and these forms are advised to seek professional assistance in determining the electrical capacity of a service panel.

OTHER HELPFUL INFORMATION FOR EV CHARGER INSTALLATIONS:

The Table below illustrates the type and size of wire and conduit to be used for various Electric Vehicle Charger circuits.

Size of EV Charger Circuit Breaker	Required minimum size of Conductors (THHN wire)	Conduit Type and Size***		
		Electrical Metallic Tubing (EMT)	Rigid Nonmetallic Conduit – Schedule 40 (RNC)	Flexible Metal Conduit (FMC)
20 amp	#12	1/2"	1/2"	1/2"
30 amp	#12	1/2"	1/2"	1/2"
40 amp	#10	1/2"	1/2"	1/2"
50 amp	#8	3/4"	3/4"	3/4"
60 amp	#6	3/4"	3/4"	3/4"
70 amp	#6	3/4"	3/4"	3/4"

******Based on 4 wires in the conduit (2-current carrying conductors, 1-grounded conductor, 1-equipment ground).***

As an alternate, Nonmetallic Sheathed Cable (aka: Romex Cable or NMC) may be used if it is protected from physical damage by placing the cable inside a wall cavity or attic space which is separated from the occupied space by drywall or plywood.

The Table below illustrates the required supports for various types of electrical conduit or cable.

Conduit Support	Electrical Metallic Tubing (EMT)	Rigid Nonmetallic Conduit – Schedule 40 (RNC)	Flexible Metal Conduit (FMC)	Nonmetallic Sheathed Cable (NMC)
Conduit Support Intervals	10'	3'	4-1/2'	4-1/2'
Maximum distance from box to conduit support	3'	3'	1'	1'

In addition to the above noted requirements, the California Electrical Code contains many other provisions that may be applicable to the installation of a new electrical circuit. Installers are cautioned to be aware of all applicable requirements before beginning the installation. For additional information or guidance, consult with the Building and Safety Division staff or a qualified and experienced Electrical Contractor.