



Electricity

WHAT IS CHARGING?

What is a PEV?

A plug-in electric vehicle (PEV) is a vehicle in which there is an onboard battery that is powered by energy delivered from the electricity grid. There are two types of electric vehicles: a battery electric vehicle (BEV) and a plug-in hybrid electric vehicle (PHEV). BEVs run exclusively on the power from their onboard battery. PHEVs have both an onboard battery and an internal combustion engine that is used when the car's battery is depleted.

There are upwards of 12,000 PEVs in the San Diego region (as of Summer 2015).

How many stations are in the San Diego region?

Currently there are over 550 public charging stations in the San Diego region.

How much does it cost to fuel my vehicle?

It generally costs less than half as much to drive an electric vehicle as an internal combustion engine

24-month average*	
Gasoline	\$3.35
Electricity**	\$1.22
Savings	\$2.13

*June 2013-June 2015

**Gasoline gallon equivalent



Level 1 Charging

Level 1 charging uses 120 volts AC. A PEV can be charged with just a standard wall outlet.

Level 2 Charging

Level 2 charging uses 240 volts AC. This is the same type of voltage as an outlet used for a dryer or electric range.

DC Fast Charging

DC fast charging is a very quick level of charging. An EV can be charged up to 80% within 30 minutes of charging.

What types of vehicles can use electricity?

Electric vehicles come in all shapes and sizes. These days, they are not merely limited to light-duty passenger vehicles (of which there are over 25 models!).

- Passenger vehicles
- Vanpool shuttles
- Pickup trucks
- Medium-duty vehicles
- Transit buses
- Forklifts
- Low-speed vehicles (like a golf cart)



TYPES OF ELECTRIC VEHICLES

Battery Electric Vehicle (BEV): Battery electric vehicles run entirely on the energy stored on an onboard battery. The vehicle is charged by electricity from the grid. On average, the vehicle's range is upwards of 80 miles on a single charge.

Plug-in Hybrid Electric Vehicle (PHEV): A plug-in hybrid electric vehicle runs on electricity and a gasoline as well. The onboard battery is charged by electricity from the grid, and when the battery is depleted, the gasoline engine is used.

Where can I learn more about electric vehicles?

You can learn more about EVs on the following websites:

- Alternative Fuel Data Center - www.afdc.energy.gov
- Plug-in Electric Vehicle Collaborative- www.pevcollaborative.org
- Plug-in America – www.pluginamerica.org
- Plug-in Cars – www.plugincars.com
- Go Electric Drive – www.goelectricdrive.org



Installing Charging Stations

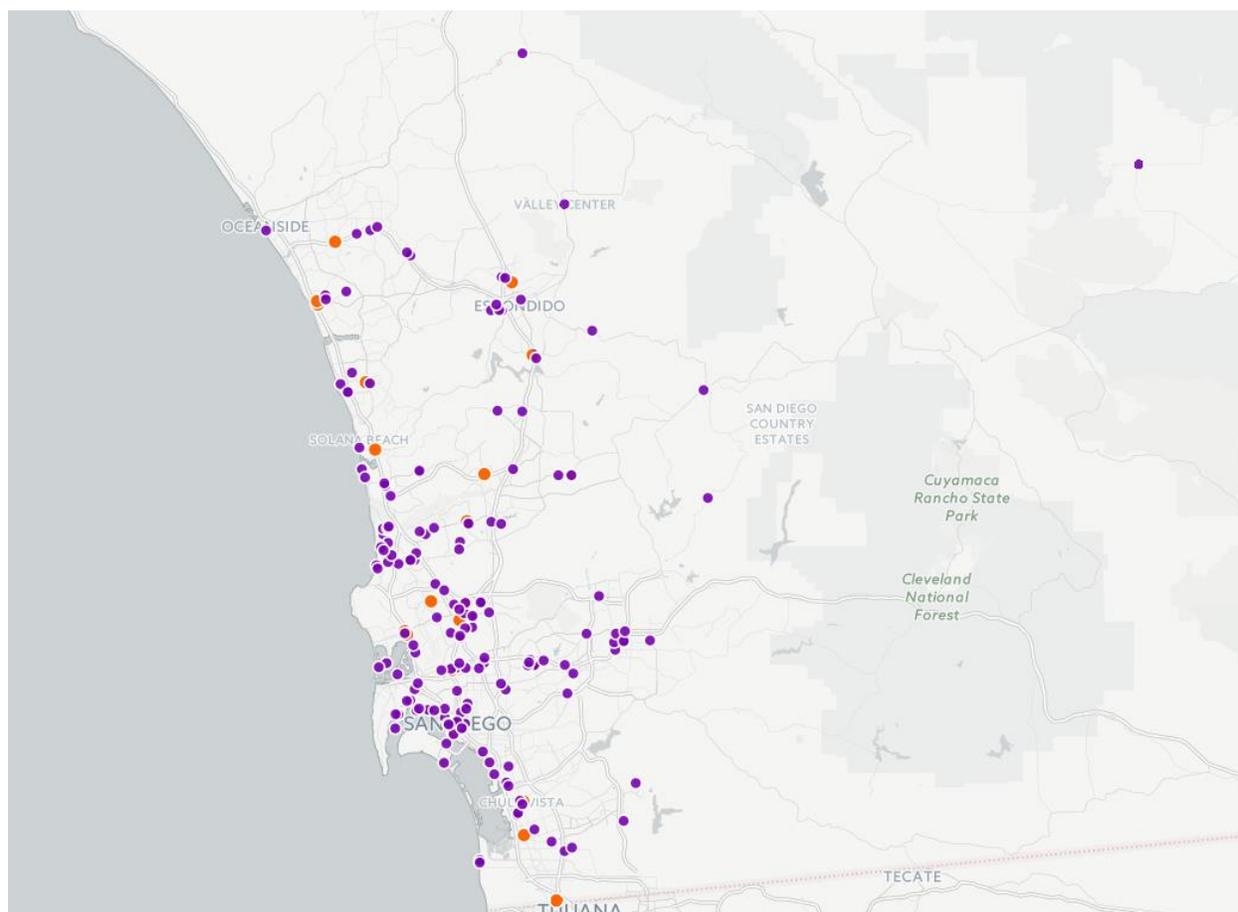
The following tools and resources are available to help guide you through your decision-making process when considering installing PEV charging stations.

Case Studies

City of Los Angeles: The City of Los Angeles, CA is leading the way in PEV charging station (EVCS) installations and permitting. Read more on the alternative fuel data center: <http://www.afdc.energy.gov/case/1002>.

Other case studies can be found on www.energycenter.org/pluginsd.

Map of Public PEV Charging Stations in San Diego Region



*purple indicates Level 2 site; orange indicates DCFC site

http://www.afdc.energy.gov/fuels/electricity_locations.html

Siting Charging Stations

Where to place charging stations?

- Consider the following basic feasibility points:
 - Availability of power** – can the site’s electrical panel support the addition of EVCS? If not, is it easily upgradable? Is it close to a transformer if new service is needed?
 - Constructability** – how far are the potential EVCS spots from the electrical panel? Does the site require extensive trenching? Construction costs increase when significant trenching is required.
 - Environmental protection** – will the EVCS cause environmental harm to the site?
 - Accessibility** – will all EV drivers be able to access the charging station safely?
- Think about dwell time** – one critique of PEV charging is that it takes at least a couple of hours to “refuel” a PEV instead of a matter of minutes for a conventional vehicle. With this in mind, EVCS should be placed in locations in which the user can conduct an activity while waiting for their vehicle to charge. The below chart provides an example of optimal locations for charging stations depending on the type of EVCS.

EVCS	User Profile	Typical Venues
Level 1	Parked for 6-8 hours	Airport (long term) Hotels Parking Garages Workplaces
Level 2	Parked for 2-4 hours	Shopping Centers Airport (short term) Street/Meters Parking Garages Medical Facilities
DC Fast Charge	Quick stop for 5-30 minutes	Shopping Centers Quick-serve restaurants Airport (short term) Highways & Commuting Roads

- Where is the demand?** – Determine which roads vehicles travel on the most and consider installing public EVCS on locations (see above) along those busy streets. In the same vein, target sites that are already highly frequented by the local community to avoid stranded assets. Further, it may be reasonable to plan for future demand. The State of California has a goal to provide enough infrastructure to support 1.5 million zero-emission vehicles on the roads by 2025.

Local Case Study: County of San Diego

The County of San Diego knew that it wanted to provide charging stations for its employees and the public at ten of their County buildings. However, the County did not have the funding that was necessary to pursue such a project. They did not have the parking spaces, the business opportunity, and the governmental support. All that was needed was a vendor to install, own, and operate the equipment.

The prospects of having a vendor agree to such a deal seemed unlikely. Around the same time, the California Energy Commission released a funding opportunity for PEV charging station installations (PON-13-606). The County was able to apply and successfully secure \$500,000 for infrastructure installations. While the grant required 25% match from the County, it was met with the property value of the parking spaces (on which the charging stations would be installed) for five years.

Having the grant funding allowed the County to release an RFP for a vendor to install, own, and operate PEV charging stations at ten County sites. The \$500,000 would support the installation costs. ChargePoint won the County's bid and has already completed installation at the County Administration Center and County Operations Center. All electricity accounts for the installations are maintained by ChargePoint.

Level 2 charging use costs \$0.30/kWh and DC fast charging use costs \$0.50/kWh.



Challenges & Lessons Learned

Placeholder

Financing a PEV Charging Station

What are the costs of installing a charging station?

The cost of installing a charging station varies based on the type of charging station and the environment in which it will be installed. Though the cost of basic charging equipment is relatively low, the high costs come from potential electrical panel upgrades, wiring, and trenching.

Estimated Cost of Installing EV Charging Station ¹		
	Level 2	DC Fast Charging
Hardware	\$450-\$3,000	\$12,000-\$35,000
Electrician Labor	\$100-\$1,500	\$1,600-\$3,000
Electrician Materials	\$50-\$300	\$300-\$600
Other materials	\$50-\$150	\$100-\$400

Specific Cost Considerations ²	
Conduit	\$1.50-\$2.50/ft
Trenching	\$25-\$100/ft
Concrete Patch	\$14-\$15/sq. ft
Asphalt Patch	\$10-\$11/sq. ft

Charging station installations can certainly rise in cost, especially if your agency is planning to provide multiple charging stations for the community. Incentives are a way to reduce the overall cost in such projects.

Incentives

The California Energy Commission's **Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)**³ is a competitive grant program that provides up to \$100 million annually towards advanced technology projects. In Fiscal Year 2015-2016, there is an anticipated \$27 million available for EV charging infrastructure projects.

Several cities in the San Diego region have taken advantage of ARFVTP funding to install charging stations throughout their jurisdictions, such as the County of San Diego (above).

Federal Congestion Mitigation and Air Quality (CMAQ) Improvement Program funds may also be used towards the establishment of publicly owned or leased EV charging stations. Cities within Colorado have successfully used this funding in tandem with grants provided by the Colorado Energy Office, increasing the public charging stations in the state from 79 to 116 (as of 2013).

The California Capital Access Program now offers an **Electric Vehicle Charging Station Financing Program** for small businesses. While public agencies cannot take advantage of this program, it is useful to know of its existence so local businesses may take advantage of competitive loans for EVCS.

¹ Information gathered from CALSTART "Best Practices for Workplace Charging" and Rocky Mountain Institutes "Pulling Back the Veil on EV Charging".

² Ibid.

³ <http://www.energy.ca.gov/contracts/transportation.html>

Permitting

Usually, only an electrical permit should be required for the installation of an EV charging station. However, for charging stations in non-residential settings, zoning or building permits may be necessary, depending on the installation scenario.

Best Practices for Permitting⁴

- Allow online permitting: such as the City of San Diego's online permit system.
- Develop a standard fee for all single-family home EVCS installations across jurisdictions
- Enable one-day permitting for quick turnaround times
- Develop a uniform permit for EVCS installations: an example permit is found on the AFDC's website http://www.afdc.energy.gov/pdfs/EV_charging_template.pdf.
- Define EVCS as appliances and make it subject to the same permitting requirements

Permitting assistance for the San Diego region can be accessed on the Plug-in San Diego website: energycenter.org/pluginsd. Further assistance with general codes for EVCS can be found in the Transportation and Climate Initiative's document *EV Ready Codes for the Built Environment*.⁵

Codes and Standards

When installing a fueling station, it is important to adhere to the necessary codes and standards. This guidance document provides a thorough list of codes and standards when developing natural gas infrastructure:

<http://www.afdc.energy.gov/pdfs/48611.pdf>.

Electric vehicle charging stations are governed by codes similar to other electrical devices, notably, the National Electrical Code (NEC) 625.

Fueling Station Aspect	Pertinent Codes and Standards
Vehicle and Charger Interface	Society of Automotive Engineers (SAE) J-1772, J-2841, J-2293, J-2847, J-2836
Vehicle Charging Stations	NFPA 70 NEC article 625
Charging Station Components	UL FFTG, UL FFWA

CalGreen Code

Title 24, the *California Building Code of Regulations (California Building Standards Code)*, includes the *California Green Building Standards Code*, section 11 of Title 24 – the CALGreen code. The California Building Standards Code is updated every three years and it delineates building code requirements for implementation and enforcement by all cities, counties, and other permitting agencies in California.

⁴ http://www.transportationandclimate.org/sites/www.transportationandclimate.org/files/EVSE_Planning_and_Policy_Tool_Guide.pdf

⁵ http://www.transportationandclimate.org/sites/www.transportationandclimate.org/files/EV-Ready_Codes_for_the_Built_Environment_o.pdf

Cities, counties, and permitting agencies may adopt voluntary CALGreen standards or develop their own. In many code scenarios, permitting agencies may adopt voluntary “tiers”—additional requirements that may help jurisdictions further surpass mandatory CALGreen codes.

The 2013 CalGreen Intervening Cycle Update, which occurs between each three-year update to include supplements and amendments to the code as necessary, includes mandatory code language for PEV charging, and has become effective July 1, 2015. All public agencies must adhere to the mandatory CalGreen code and can adopt them in one ordinance. Local governments can integrate Tier 1 and Tier 2 measures as they see fit or develop their own additional requirements above and beyond the mandatory code.

This update includes the following changes:⁶

Multi-Family Residential	
Mandatory	Make at least 3 percent of total parking spaces ready for PEVs (through electrical capacity, building plans, etc.).
	- Developments under 17 dwelling units exempt Construction documents should show where electric vehicle charging station (EVCS) are to be located; at least ONE EVCS needs to be located in a common area for use by all residents.
Voluntary	(Tier 1 & Tier 2) Make at least 5 percent of total parking spaces ready for PEVs (through electrical capacity, building plans, etc.). - Developments under 17 dwelling units exempt
Single-Family Residential	
Mandatory	Install raceway and electrical panel capacity to support 40 amp capacity electrical circuit.
Voluntary	(Tier 1 & Tier 2) Install complete 208/240-volt branch circuit at minimum 40 amps.
Nonresidential	
Mandatory	Install electrical panel capacity to support 40 amp capacity electrical circuit.
	If there are more than 50 parking spaces, at least 1 or more must be ready for PEVs, see table below.
Voluntary	(Tier 1) At least 4 percent of parking spaces must be ready for PEVs.
	(Tier 2) At least 6 percent of parking spaces must be ready for PEVs.

⁶ State of California. Revision Record for the State of California: Supplement 2013 Title 24, Part 11, California Green Building Code. 1 July 2015. <https://www.iccsafe.org/cs/codes/Errata/State/CA/5570S133.pdf>.

Managing Usage and Payments

When offering public charging, there is concern over a few common issues: whether to require a fee for charging and how to regulate who parks in charging spots and for how long.

PEV Parking Policies, Ordinances, and Resolutions

It is a common practice for a local government to pass a policy, law, or resolution that regulates how public charging stations are used. Such resolutions often establish electric vehicle parking fees and regulation for PEV charging. Examples are below:

- City of Laguna Beach, Resolution 13.005:⁷ Sets PEV charging/parking rate as free for the first four hours of parking, and \$5 per hour fee for each additional hour.
- City of Lodi, Ordinance 1881:⁸ Amends Lodi Municipal Code Chapter 10.44 to include electric vehicle charging stalls into its code on “Stopping, Standing and Parking”.
- County of Alameda, Resolution 2013-89:⁹ Allows County-owner charging stations available to the public for no fee.

Fee versus Free Charging

Charging for Fee	Charging for Free
<p>Benefits:</p> <ul style="list-style-type: none"> • Prevents free-riding (i.e., cars staying plugged in too long, too often) • Allows charging station host to cover cost of electricity usage • Allows “efficient” use of charging stations <p>Considerations:</p> <ul style="list-style-type: none"> • Penalizing extended charging times by increasing fee after x amount of hours • High costs may discourage charging station use • Costs may incur when collecting money (e.g., credit card transaction fees) 	<p>Benefits:</p> <ul style="list-style-type: none"> • Promotes EV charging for a relatively new market • Attractive for PEV drivers to use the equipment • No cost associated with collecting fees for charging <p>Considerations:</p> <ul style="list-style-type: none"> • Cannot cover the cost of electricity • PEVs may stay plugged in for too long, preventing those who need a charge from charging

⁷ http://lagunabeachcity.granicus.com/MetaViewer.php?view_id=3&clip_id=299&meta_id=23343

⁸ <http://publicdocs.lodi.gov/Docs/ORDINANCES/2013/ord1881.pdf>

⁹ http://www.acgov.org/sustain/documents/EV_Charging_Station_Policy.pdf

Relevant Policies and Laws

There are several reasons to want to install a public charging station. One primary motivation is the fact that installing an alternative fuel station and promoting the alternative fuel helps California achieve its climate mitigation goals.

Strategy Origin	Year	Objectives	Goals and Milestones
Federal Clean Air Act	1970	Air Quality	80 percent reduction of NOx by 2023
Federal Energy Policy and Conservation Act	1975	Petroleum Reduction	Set into place the Corporate Average Fuel Economy to improve fuel economy.
Federal Energy Policy Act	1992	Petroleum Reduction	Defined alternative fuels and required certain fleets to increase alternative fuel vehicle acquisitions
AB 1493 (Pavley regulations)	2002	GHG Reduction	17 percent reduction in climate change emissions from light-duty fleet by 2020 and 25 percent overall reduction by 2030
Petroleum Reduction and Alternative Fuel Goals (<i>Reducing California's Petroleum Dependence</i>) ¹⁰	2003	Petroleum Reduction	This document was developed in response to AB 2076 (Shelley). It set goals to reduce petroleum fuel use to 15 percent below 2003 levels by 2020, and recommended the State adopt a goal of 20 percent nonpetroleum fuel use in the year 2020
AB 1007 (<i>State Alternative Fuels Plan</i>)	2005	GHG Reduction	Develop and adopt a plan that sets increased alternative fuel use goals for years 2012, 2017, and 2022
Energy Policy Act of 2005; Energy Independence and Security Act of 2007	2005	Renewable Fuel Standard	36 billion gallons of renewable fuel used in the US by 2022
Executive Order S-3-05	2005	GHG Reduction	By 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels
AB 32 (Global Warming Solutions Act)	2006	GHG Reduction	Reduce GHG emissions to 1990 levels by 2020
Executive Order S-06-06 (<i>Bioenergy Action Plan</i>)	2006	In-State Biofuels Production	Produce in California 20 percent of biofuels used in state by 2010, 40 percent by 2020, and 75 percent by 2050
Low Carbon Fuel Standard	2007	GHG Reduction	10 percent reduction in carbon intensity of transportation fuels in California by 2020
Executive Order B-16-2012	2012	ZEV Mandate	Accommodate 1 million zero-emission vehicles by 2020 and 1.5 million by 2025
Governor Brown Inaugural Address 2015	2015	Petroleum Reduction	Reduce petroleum use in cars and trucks by up to 50 percent within the next 15 years (2030)

¹⁰ Reducing California's Petroleum Dependence, an Energy Commission and ARB, joint agency report, August 2003, publication #P600-03-005F.