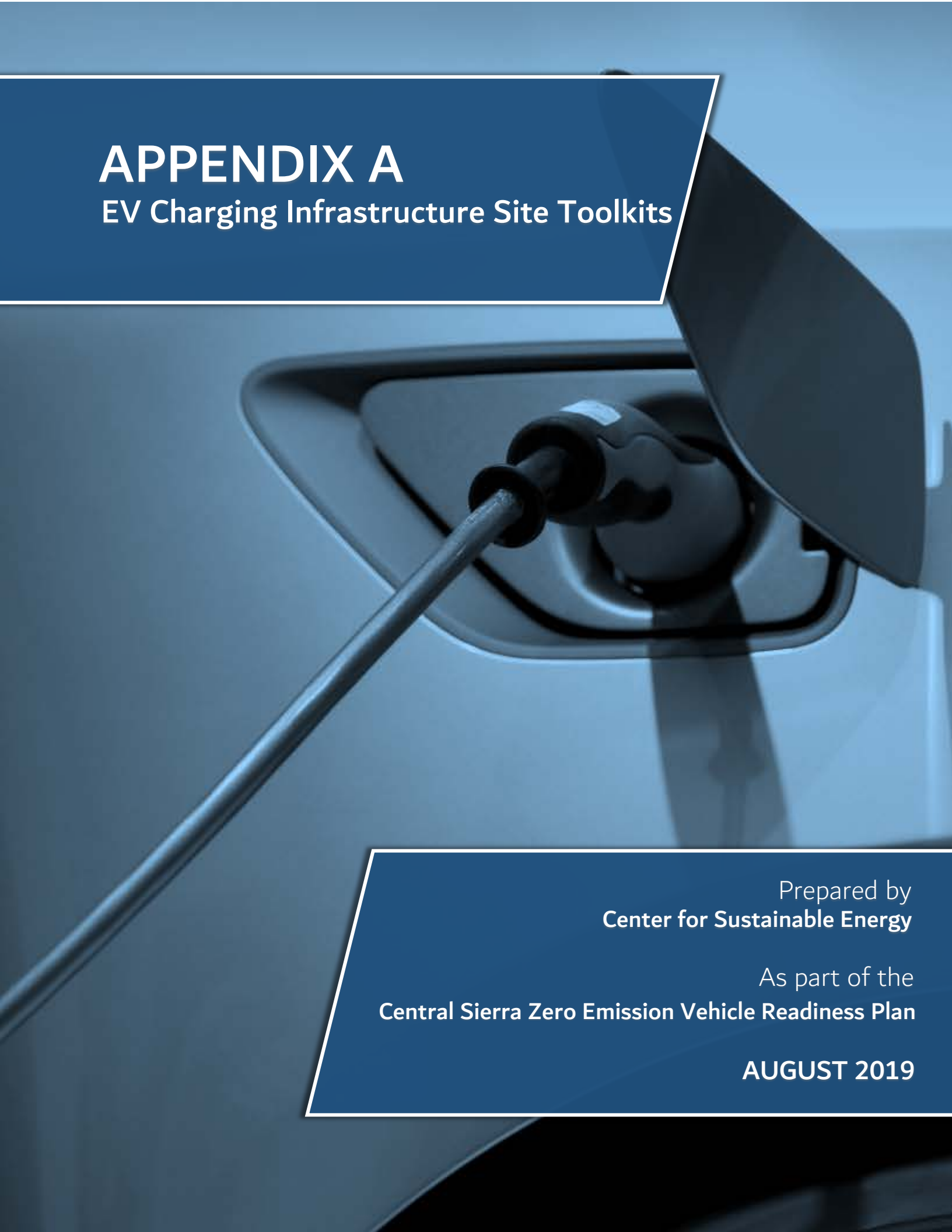


APPENDIX A

EV Charging Infrastructure Site Toolkits

Prepared by

Center for Sustainable Energy

As part of the

Central Sierra Zero Emission Vehicle Readiness Plan

AUGUST 2019

Appendix A1
ZEV Charging Infrastructure Toolkit - Destinations

Why Install Electric Vehicle Charging?

Electric vehicle (EV) adoption is experiencing rapid growth. In 2018, nearly 8% of new car sales in California were EVs. The number of Plug-In Electric Vehicles (PEV) in the Central Sierra Region is projected to be between 1,548 and 2,233 by 2025. California policy, such as Governor Brown's 2018 Executive Order (EO) B-48-18, set ambitious targets for EV adoption and supportive infrastructure. Destinations visited by regional residents and tourists play a crucial part of transforming Central Sierra's transportation sector to zero emission vehicles (ZEVs); Note that hydrogen fuel vehicle infrastructure is not planned in the near-term for the Region, therefore not discussed herein.

Despite the relatively small permanent population, the Central Sierra Region is home to several historical state and national parks with beautiful scenery and recreational activities that attract visitors. Popular destinations include Yosemite National Park, Calaveras Big Trees, Columbia State Historical Park, Railtown 1897, Indian Grinding Rock, and Grover Hot Springs. According to the National Park Service, Yosemite National Park had over 4.3 million recreational visitors and nearly 1.9 million vehicles during 2017. Approximately three-quarters of 2017 visitors attended the park between May and October. Vehicle travel is greatest at the Arch Rock Entrance followed by the park's South Entrance (Badger Pass, Big Oak Flat, Hetch Hetchy) or Tioga Pass, which accounted for approximately 30% of the total volume in 2017. Visitors to the region do not have the capability to charge their PEV at home, and therefore an extensive charging network at regional destinations is both beneficial to the visitor and will encourage travel throughout the region.

Benefits of EV Charging

Attract Visitors	Reduce Local Emissions	Longer Stays = More Spending	Enhance Property Value	Positive Environmental Image

Site Owner EV Charging Checklist

While each installation is unique, many property owners have similar questions and challenges when planning EV charging stations (EVCS). This document summarizes common steps to help you consider options and understand how and when to engage the experts – your local utility, licensed contractors and EVCS vendors. The toolkit provides general information and helpful resources to guide you through each step of the checklist provided below.

While this checklist is presented in a linear format, the process of installing EVCS will be dynamic, with various interrelated considerations. Steps 1-4 will be preliminary explorations of issues that can be revisited with expert help once you've decided to move forward and contacted your utility and/or EVCS vendors. Actions listed are from the perspective of the project lead for your site. Your utility, vendors, and contractors will guide you through actual installation steps and more detailed considerations.

STEP 1: Estimate Demand

- ☐ **1.** Check availability of existing EVCS nearby using PlugShare.
- ☐ **2.** Contact customers/visitors to gauge interest; survey to quantify charging needs.
- ☐ **3.** Estimate average visitor dwell time - how many visits are suitable for EV charging?

STEP 2: Consider EVCS Options

- ☐ **4.** Consider appropriate charging equipment types based on estimated demand, visitor dwell time (Level I typically suit low mileage & long dwell, Level II mid/long mileage & mid/long dwell, and DCFC for short dwell)
- ☐ **5.** Examine physical siting constraints (e.g., access to electrical infrastructure, accessibility for the disabled, visibility etc.).
- ☐ **6.** Weigh EVCS ownership models - tenant, property owner, or third-party vendor?
- ☐ **7.** Determine if you want to measure EVCS use and charge users (paid vs. free model).
- ☐ **8.** Consider increasing installation size to account for growing demand, reducing future capital costs.

STEP 3: Estimate Capital Costs

- ☐ **9.** Determine the number and type of EVCS you want to install onsite.
- ☐ **10.** Measure distance to EVCS location from power point of connection to estimate Make-Ready costs (e.g., trenching and conduit installation).
- ☐ **11.** Determine if your electrical service/panel requires an upgrade (engage utility or technology provider).
- ☐ **12.** Have technology provider estimate operations & maintenance costs (e.g., electricity use, demand charges, networking fees).

STEP 4: Evaluate Cost Recovery Options

- ☐ **13.** Research available incentive and funding programs (e.g., PG&E Fast Charge Program & EV Charge Network Program) You can find additional resources and websites on the last page of this toolkit.

- ☐ **14.** Consider contracting with EVCS network provider to recover ongoing charging costs.
- ☐ **15.** Look into vendors offering free charging for advertising space.

STEP 5: Contact Utility (PG&E, Liberty Utilities, Kirkwood Utilities Department, and the Tuolumne Public Power Agency) to Conduct Site Evaluation

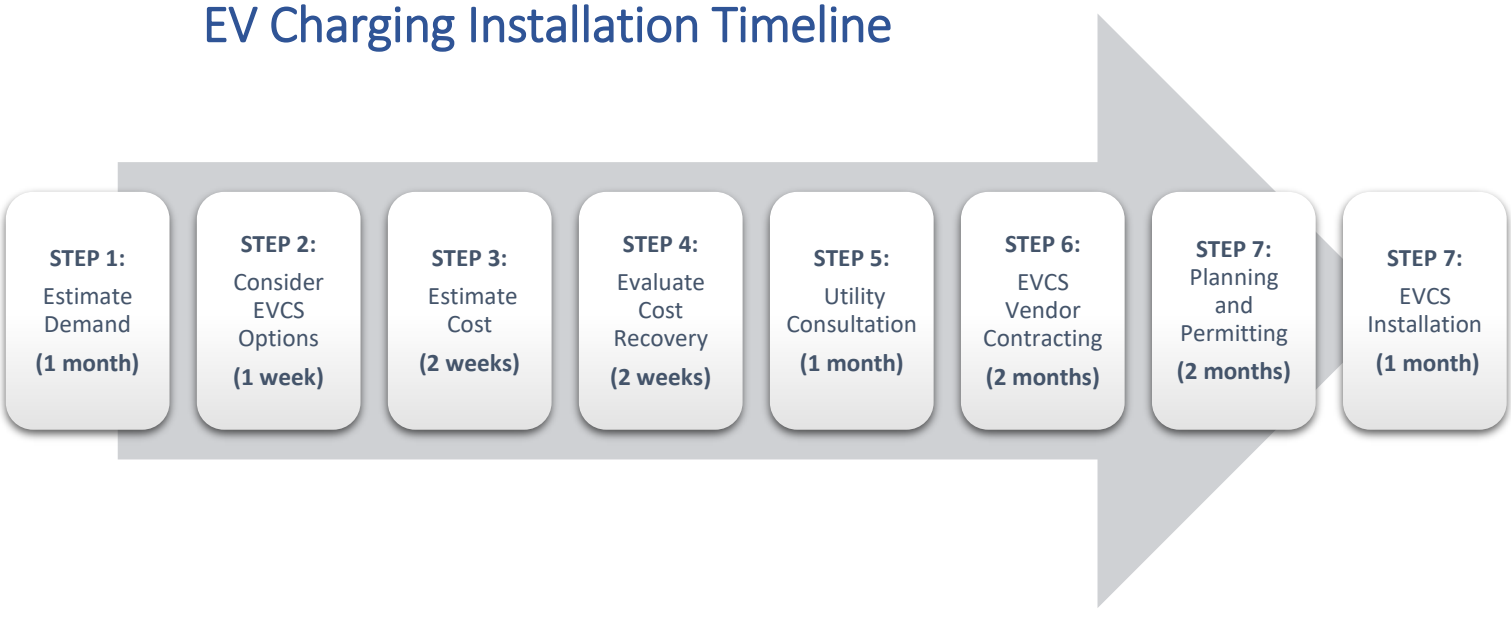
STEP 6: Contract with Vendors - Choose from offered equipment and service contracts

STEP 7: Hire Installers - Work with utility, vendors to plan, permit, and install EV charging

STEP 8: Implement Management Policies

- ☐ **16.** Ensure compliance with ADA regulations, consider general parking and traffic flow issues
- ☐ **17.** Contact insurer regarding potential liability issues
- ☐ **18.** Consider installing signage guiding visitors to EV charging
- ☐ **19.** Communicate with site tenants/stakeholders regarding installation and use of EVCS
- ☐ **20.** Set schedule to review EVCS usage and contracts with third parties to consider adjustments

EV Charging Installation Timeline



EV Charging Resources

STEP 1. Estimate Demand

What is your current EV charging need, and how will it grow into the future? Weighing the need for EVCS at your commercial destination will require reaching out to stakeholders at your site and researching existing EV charging locations nearby. A simple first step is to contact each tenant or property stakeholder at the site to inquire about EV charging interest or their employees or visitors. A key question will be evaluating the typical vehicle dwell times at your site to consider the appropriate charging speed.

Tool 1: EV Charging Demand Sample Survey

The U.S. Department of Energy has prepared a sample survey for workplaces to gather information on employee EVCS demand. This can be adapted to evaluate visitor or customer travel to your site: https://afdc.energy.gov/files/u/publication/WPCC_sample_employee_survey_0816.pdf

Tool 2: EV Charging Location Maps

Use these maps to see where nearby chargers are located, how many chargers are available, and their rates and access rules. Keep in mind that demand will continue to grow. PlugShare: https://www.plugshare.com/. U.S. DOE: https://afdc.energy.gov/stations/#/find/nearest.

STEP 2. Consider EVCS Options

What charging speeds, controls and billing capabilities do you require? You will want to consider the demand and dwell times of visitors to your location to select appropriate charging equipment. The table below provides a summary of EVCS types. Levels 1-3 offer increasing charging speed but with added cost and complexity. Level 2 and Level 3 (DCFC) are typically the most appropriate for standard retail or other commercial locations.

Tool 3: EV Charging Information

The U.S. Department of Energy maintains a clearinghouse of information and resources for alternative fuels, including EV charging: https://afdc.energy.gov/fuels/electricity.html

	Level 1	Level 2	Level 3 (DCFC)
Charging Speed	3-5 miles of range/hour	10-54 miles of range/hour	75-300 miles of range/hour
Typical Locations	Single-family homes Townhomes Multi-family dwellings Office buildings	One and two-family homes Townhomes Multi-family dwellings Office buildings	Public access Retail shops Highway corridors Hospitality & recreation facilities
Equipment Description	Standard 120 VAC outlet and cord set charger that typically comes with EV Metering and billing not available	240 VAC outlet and wall-mounted or bollard style charging port Networked units available, allowing for advanced controls, billing options	Commercial-grade 208, 440 or 480 VAC converted into direct current (DC) through large standing unit Often requires upgrades to a site's electrical service Not all EVs can utilize

An important consideration is the number of EVCS that you will install at your location. For retail shops, you want to provide enough EVCS that potential customers are frequently able to charge while shopping, but not so many that the EVCS are underutilized. For stand-alone stores and smaller strip malls, this can mean 2 – 4 Level 2 EVCS,

and for shopping malls anywhere between 6 – 20 Level 2 EVCS. For state & national parks, visitors will tend to have a larger dwell time (exceeding 2-4 hours) so Level 2 EVCS are typically a good solution with limited DC Fast Charging stations located onsite for short-dwell visitors or long-mileage visitors. Due to the rapid adoption of EVs, and the fact that EVCS have an expected useful life of at least 10 years, you may want to consider increasing the size of your planned installation to meet future demand.

Another consideration when installing EV charging at a destinations is who will own the EVSE and how the purchase and installation costs will be covered. This is often dictated by which party initiates the installation of EV charging.

STEP 3: Estimate Cost

The cost of installing EV charging varies considerably based on specific site requirements. Aside from the actual cost of the EV charging equipment typical installation costs include trenching for electrical conduit and upgrades to the site's electrical service.

Tool 4: EV Charging Cost Report

The U.S. Department of Energy has prepared a report on average equipment and installation costs for non-residential EV charging projects:
https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

The table below provides a simplified estimation tool based primarily on costs provided in the Department of Energy report. It includes average potential costs that may or may not apply to every project. Early consultations with your utility and EVCS providers will help refine these estimates.

EVCS Installation Cost Estimator

Cost Driver	Average Costs	
Installation Costs		
Equipment – Level 2 (Non- Networked)	$500 - $2,000 x Units	=
Equipment – Level 2 (Networked)	$1,500-$6,000 x Units	=
Equipment – DCFC Equipment	10,000-$40,000 x Units	=
Installation – Level 2 Equipment	$3,000 x Units	=
Installation – DCFC Equipment	$8,500 - $51,000 x Units	=
Trenching for Electrical Conduit	$100 x Feet	=
Transformer Upgrade	$10,000-$25,000	=
	Total Estimated Cost:	=

Additionally, site hosts must consider the ongoing costs of EV charging. These consist primarily of the cost of electricity and any other impacts to utility bills, such as increased service or demand charges, but may also include monthly or annual payments to network service providers.

STEP 4. Evaluate Cost Recovery

Installing EV charging will often require a considerable up-front capital expenditure. While a retail shop may recover these costs through increased sales, and a property manager may recover them through increased rent

and lower tenant turnover, this section describes additional ways to either decrease or recover the up-front investment.

Site hosts may wish to recover the costs of installation and ongoing use from tenants and visitors based on individual usage, incorporate these costs into rent or lease terms, or elect to absorb the cost themselves and provide EV charging as a free amenity. No matter what cost recovery strategy you choose, there are additional resources that can provide funding for eligible EV charging installation projects, as listed below.

Tool 5: CALeVIP Incentive

The California Electric Vehicle Infrastructure Project (CALeVIP) is a California Energy Commission-funded project that provides incentives for Level 2 and DC fast charging in select locations throughout the state: https://calevip.org/

Tool 6: DriveClean Incentive Search Tool

The California Air Resources Board's DriveClean.ca.gov website provides a search tool to help you find incentives for EVs and charging infrastructure: https://www.driveclean.ca.gov/Calculate_Savings/Incentives.php

Tool 7: Add Solar photovoltaics to EV infrastructure

The National Renewable Energy Laboratory created a summary of considerations for adding distributed solar PV with EV charging: https://www.nrel.gov/docs/fy14osti/62366.pdf. Solar Sage provides an easy online calculator for estimating solar panel costs based on electricity demand.

STEP 5. Contact Utility

Once you taken time to consider the items listed in Steps 1-4 of the checklist, you'll be well prepared to begin speaking with your utility, EV service providers and electrical contractors who will be able to recommend solutions suited to the needs and constraints of your location. These experts can also help refine cost estimates and potential recovery strategies. The utility specifically can help walk you through any necessary electrical service upgrades, potential electricity bill impacts, and other technical aspects of the project.

Tool 8: Pacific Gas & Electric EVCS Resources

Explore PG&E's EVCS-related programs and resources, such as the EV Charge Network and a contractor search tool. Contact your account representative for additional support. https://www.pge.com/en_US/small-medium-business/small-medium-business.page

STEPS 6 & 7: Contract with Vendors & Hire Installers

EVCS equipment and network providers offer a variety of products, services, and unit ownership arrangements. Speaking with several vendors and reviewing case studies and past projects is an important step before finalizing a contract with your chosen provider.

Tool 9: CALeVIP Connects

CALeVIP Connects is provided as part of the CALeVIP incentive program. It is a free online directory that allows you to connect directly with EV service providers and request information for potential EV charging projects. https://calevip.org/find-an-evsp

STEP 8: Implement Management Policies

Once your EVCS is operational, you will want to take steps to ensure it is well utilized and enhances your site. Communication with property stakeholders, staff and visitors will be key to success. Distributing a written use

and management policy to tenants and installing signage to direct potential users to charging units are two important steps. You may also want to set a schedule to review utilization and ongoing costs to decide whether your current EVCS and services are still serving your needs.

Tool 10: Veloz Accessibility and Signage Guide

Veloz provides a number of EVCS-related resources on its website, including a report with recommendations on parking management, accessibility and signage.
https://www.veloz.org/resource/accessibility-signage-for-pev-charging-infrastructure/

Additional Resources

Alternative Fuels Data Center (AFDC) – The U.S. Department of Energy's AFDC is an information clearinghouse with useful resources like case studies, an EV charging locator and a list of relevant laws and incentives. https://afdc.energy.gov/fuels/electricity.html

Veloz/PEV Collaborative – Veloz provides many useful resources including case studies, templates and fact sheets on their website. https://www.veloz.org/veloz-resources/

Appendix A2
ZEV Charging Infrastructure Toolkit – Public Institutions

Why Install Electric Vehicle Charging?

Electric vehicle (EV) adoption is experiencing rapid growth. In 2018, nearly 8% of new car sales in California were EVs.[1] The number of Plug-In Electric Vehicles (PEV) in the Central Sierra Region is projected to be between 1,548 and 2,233 by 2025.[2] California policy, such as Governor Brown's 2018 Executive Order (EO) B-48-18, set ambitious targets for EV adoption and supportive infrastructure. Local governments play a crucial part of transforming California's transportation sector to zero emission vehicles.

Hydrogen fuel infrastructure is not currently planned to be widely deployed in the Central Sierra Region. Hydrogen fuel cell vehicles may be a suitable solution for very limited public agencies but the high cost and limited infrastructure likely is not realistic in the near-term; as a result, this toolkit will focus on EV infrastructure.

Installing EV charging at public institutions is a visible display of commitment to local clean air and sustainability efforts and providing services to the community. Whether located at a public location like a park or library or at an administrative center, EV charging stations (Charging Stations) provide many benefits to the public and to local governments. EV charging is an increasingly valuable service for visitors as well as employees. Adding EVs to your fleet can significantly lower operating costs through reduced fuel and maintenance needs. Charging station installations can be paired with other sustainability upgrades, such as solar arrays, to offset the increased electricity use.

In short, charging stations is a good fit for many types of public institutions. While different use cases will involve diverse considerations, many resources and case studies are available.

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[1] California New Car Dealers Association. California Auto Outlook. Vol. 15 No. 1. Available at: https://www.cncda.org/wp-content/uploads/Cal-Covering-4Q-18.pdf

[2] EMFAC, 2017

Potential Locations for EV Charging

Fleet Yards	Administrative Centers	Public Parks	Public Libraries	Agency Offices	Community Centers

Public Site EV Charging Checklist

While each installation is unique, many locations have similar questions and challenges when planning for charging stations. This document summarizes common steps to help you consider options and understand how and when to engage the experts – your local utility, licensed contractors and charging stations vendors. This toolkit provides general information and resources for each step of the following checklist.

This checklist is presented in a linear format, but the process of installing charging stations will be dynamic, with various interrelated considerations. Steps 1-4 will be preliminary explorations of issues that can be revisited with expert help once you've decided to move forward and contacted your utility and/or charging stations vendors. Actions listed are from the perspective of the project lead for your site. Your utility, vendors, and contractors will guide you through actual installation steps and more detailed considerations.

STEP 1: Estimate Demand

- ☐ **1.** Check availability of existing charging stations nearby using PlugShare or other maps.
- ☐ **2.** Contact site employees/visitors to gauge interest; survey to quantify charging needs.
- ☐ **3.** Estimate average employee/visitor dwell time – what speed of EV charging is appropriate?

STEP 2: Consider Charging Station Options

- ☐ **4.** Consider appropriate charging equipment types based on estimated demand, visitor dwell time (Level I typically suit low mileage & long dwell, Level II mid/long mileage & mid/long dwell, and DC Fast Charging for short dwell).
- ☐ **5.** Examine physical siting constraints (e.g., access to electrical infrastructure, ADA, visibility etc.).
- ☐ **6.** Weigh charging stations ownership models – public agency or third-party vendor.
- ☐ **7.** Determine if you want to measure charging station use and require payment from users. This will lead to other considerations (e.g., software reqs., networked vs. non-networked capability, in-house vs. third-party payment options, and using pricing to drive parking space turnover).
- ☐ **8.** Consider increasing the installation of make-ready spaces to account for growing demand, reducing future capital costs related to site development (e.g. trenching, wiring).

STEP 3: Estimate Capital Costs

- ☐ **9.** Determine the number and type of charging stations you want to install onsite.
- ☐ **10.** Measure distance to charging stations location from power point of connection to estimate make-ready costs, which cover laying the infrastructure needed for the immediate installation of a charging station in the future (e.g., trenching and conduit installation).

- ☐ **11.** Determine if your electrical service/panel requires an upgrade (engage utility or technology provider).
- ☐ **12.** Have technology provider estimate operations & maintenance costs (e.g., electricity use, demand charges, networking fees).

STEP 4: Evaluate Cost Recovery Options

- ☐ **13.** Research available incentive and funding programs (e.g., PG&E EV Fleet Program, Fast Charge Program, & EV Charge Network Program, Carl Moyer Memorial Air Quality Standards Attainment Program, and State Programs such as Alternative and Renewable Fuels and Vehicle Technology Program (ARFVTP) and Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP). Some programs (ex. HVIP) require approval prior to equipment purchase to guarantee coverage.
- ☐ **14.** Consider contracting with charging stations network provider to recover ongoing charging costs.

STEP 5: Contact Utility (PG&E, Liberty Utilities, Kirkwood Utilities Department or Tuolumne Public Power Agency) to Conduct Site Evaluation

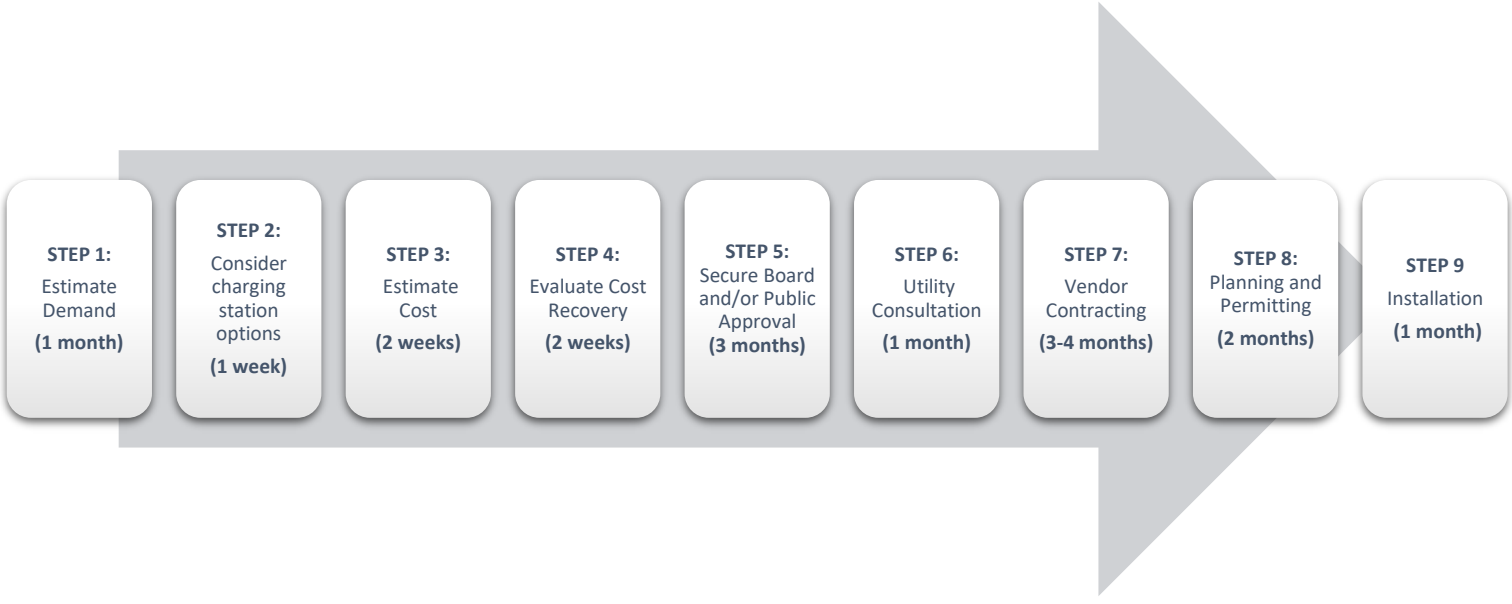
STEP 6: Contract with Vendors - Choose from offered equipment and service contracts

STEP 7: Hire Installers - Work with utility, vendors to plan, permit, and install EV charging

STEP 8: Implement Management Policies

- ☐ **15.** Ensure compliance with ADA regulations, consider general parking and traffic flow issues.
- ☐ **16.** Contact insurer regarding potential liability issues.
- ☐ **17.** Consider installing signage guiding visitors to EV charging.
- ☐ **18.** Communicate with site staff/stakeholders regarding installation and use of charging stations.
- ☐ **19.** Set schedule to review charging stations usage and contracts with third parties to consider adjustments.

EV Charging Installation Timeline



EV Charging Resources

STEP 1. Estimate Demand

What is your current EV charging need, and how will it grow into the future? Weighing the need for charging stations at your public location will require reaching out to stakeholders at your site and researching existing EV charging locations nearby. A simple first step is to contact each stakeholder at the site to inquire about EV charging interest for their staff and visitors. A key question will be evaluating the typical vehicle dwell times at your site to consider the appropriate charging speed.

Tool 1: EV Charging Demand Sample Survey

The U.S. Department of Energy has prepared a sample survey for workplaces to gather information on employee charging stations demand. This may not be appropriate for evaluating public demand but will give a good idea what types of questions to consider:
https://afdc.energy.gov/files/u/publication/WPCC_sample_employee_survey_0816.pdf

Tool 2: EV Charging Location Maps

Use these maps to see where nearby chargers are located, how many chargers are available, and their rates and access rules. Keep in mind that demand will continue to grow. PlugShare: https://www.plugshare.com/. U.S. DOE: https://afdc.energy.gov/stations/#/find/nearest.

Considerations for Charging Fleet Vehicles

For public agencies operating a vehicle fleet, part of estimating demand will involve deciding whether to acquire EVs as fleet vehicles. Determining what type and model of EV may be appropriate for your needs can be a daunting process, but many resources are available to help. Many public agencies find the sustainability benefits and reduced fuel and maintenance costs are worth the higher purchase price of EVs, especially factoring in the available incentives and rebates. When thinking about setting up charging stations for fleet purposes, you'll want to evaluate battery-electric vehicles (operate on electricity only) versus plug-in hybrid vehicles (gasoline and

electricity), based on driving radius and charging needs. Fleet vehicles may not need to have usage tracked and can stay parked overnight; non-networked Level 2 or even simple Level 1 solutions can be an appropriate, low-cost strategy. You'll need to decide if your site layout and operational needs call for separate fleet-only charging stations or whether they can share use with the public or employee vehicles. Consider upsizing your installation to prepare for future EV purchases. As prices and technology continue to improve, more fleet applications will be appropriate for EVs.

Tool 3: Ready Set Charge Fleets Report

The Bay Area Climate Collaborative has prepared a detailed guide for implementing EVs as fleet vehicles, including charging stations considerations. http://baclimate.org/wp-content/uploads/2015/10/Ready-Set-Charge-Fleets-EV-Fleet-Guide.pdf

Tool 4: Vehicle Incentive Projects

California's Clean Vehicle Rebate Project provides funding for eligible EV purchases, including rebates up to $7,000 for public agencies in designated areas: https://cleanvehiclerebate.org/eng/fleet. Additionally, the Carl Moyer Memorial Air Quality Standards Attainment Program offers incentives for several vehicle categories and is open to public agencies https://www.arb.ca.gov/msprog/moyer/moyer.htm.

STEP 2. Consider Charging Station Options

What charging speeds, controls and billing capabilities do you require? You will want to consider the demand and dwell times of visitors to your location to select appropriate charging equipment. The table below provides a summary of charging stations types. Levels 1-3 offer increasing charging speed but with added cost and complexity. Level 1 may be adequate to serve employee vehicles parked for many hours at a time, while Level 2 and Level 3 (DC Fast Charging) are typically appropriate for visitors at public locations or daily high-mileage fleet vehicles.

Tool 5: EV Charging Information

The U.S. Department of Energy maintains a clearinghouse of information and resources for alternative fuels, including EV charging: https://afdc.energy.gov/fuels/electricity.html

Charging Station Types Summary

	Level 1	Level 2	Level 3 (DC Fast Charging)
Charging Speed	3-5 miles of range/hour	10-54 miles of range/hour	75-300 miles of range/hour
Typical Locations	Single-family homes Townhomes Multi-family dwellings Office buildings	One and two-family homes Townhomes Multi-family dwellings Office buildings	Public access Retail shops Highway corridors Hospitality & recreation facilities
Equipment Description	Standard 120 VAC outlet and cord set charger that typically comes with EV Metering and billing not available	240 VAC outlet and wall-mounted or bollard style charging port Networked units available, allowing for advanced controls, billing options	Commercial-grade 208, 440 or 480 VAC converted into direct current (DC) through large standing unit Often requires upgrades to a site's electrical service Not all EVs can utilize

An important consideration is the number of charging stations that you will install at your location. If providing EV drivers will want reliable access to a charger for at least a portion of their workday. Charging stations intended to serve fleet vehicles may need to be separated from public access unless they only need an occasional charge. If visitors only occasionally utilize charging stations, 1-3 public access charging ports may be enough, but the number will also depend on the level of equipment selected. Faster charging speeds means more vehicles can be served by the same charging stations, and strategically locating units between parking spaces can help facilitate switching cords between vehicles. In general, you want to provide enough charging stations that users are frequently able to charge, but not so many that the charging stations are underutilized. Due to the rapid adoption of EVs, and the fact that charging stations have an expected useful life of at least 10 years, you may want to consider increasing the size of your planned installation to meet future demand. One way to go about this is to install more in-ground infrastructure (often called stub-ups) than chargers. Another strategy is to install a mix of DC Fast Charging and Level 2 or Level 1 charging, depending on fleet needs and available funds.

Ownership Models

Public Agency/Property Manager owns equipment

Benefits	Considerations
• Host dictates whether charging is free or fee-based • Host determines the fee for charging (if applicable) • Host keeps all revenue, perhaps recovering cost of electricity (if charging for a fee) • Host can determine station users	• Host must buy equipment • Host must pay construction costs • Host must manage payments • Host must properly maintain equipment

Electric Vehicle Service Provider (EVSP) owns equipment

Benefits	Considerations
• No or limited equipment or installation cost to host • EVSP manages and maintains the station • EVSP shares revenue from the station with host	• Host usually remains customer of record on utility bill and must pay electricity costs upfront before EVSP pays host back • PEV drivers need to have membership fees to use stations

STEP 3: Estimate Cost

The cost of installing EV charging varies considerably based on specific site requirements. Aside from the actual cost of the EV charging equipment, often referred to as electric vehicle supply equipment (EVSE), typical installation costs include trenching for electrical conduit and upgrades to the site's electrical service.

Tool 6: EV Charging Cost Report

The U.S. Department of Energy has prepared a report on average equipment and installation costs for non-residential EV charging projects:
https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

The table below provides a simplified estimation tool based primarily on costs provided in the Department of Energy report. It includes average potential costs that may or may not apply to every project. Early consultations with your utility and charging stations providers will help refine these estimates.

Charging Station Installation Cost Estimator

Cost Driver	Average Costs	Example
Installation Costs		**2x Dual Port (4 Ports)**
Equipment – Level 2 (Non- Networked)	$500 - $2,000 x Ports	=
Equipment – Level 2 (Networked)	$1,500-$6,000 x Ports	= *$3,000 x 4 Ports*
Equipment – DC Fast Charging Equipment	10,000-$40,000 x Units	=
Installation – Level 2 Equipment	$3,000 - $6,000 x Ports	= *$3,800 x 4 Ports*
Installation – DC Fast Charging Equipment	$8,500 - $51,000 x Units	=
Trenching for Electrical Conduit	$100 x Feet	= *$100 x 45 feet*
Transformer Upgrade	$10,000-$25,000	=
	Total Estimated Cost:	= *$31,700*

Additionally, site hosts must consider the ongoing costs of EV charging. These consist primarily of the cost of electricity and any other impacts to utility bills, such as increased service or demand charges, but may also include monthly or annual payments to network service providers.

STEP 4. Evaluate Cost Recovery

Installing EV charging will often require a considerable up-front capital expenditure. Site hosts may wish to recover the costs of installation and ongoing use from employees and visitors based on individual usage or elect to absorb the cost themselves and provide EV charging as a free amenity. California law (AB 2414) specifies that providing free EV charging is not a gift of public funds. No matter what cost recovery strategy you choose, there are additional resources that can provide funding for eligible EV charging installation projects, as listed below.

Tool 7: AFDC Incentive Listing Tool

The U.S. Department of Energy's Alternative Fuel Data Center (AFDC) hosts a comprehensive listing of currently available EV incentives within the state of California. Please note that certain programs (ex. CALeVIP) are time-limited: https://afdc.energy.gov/fuels/laws/ELEC?state=ca

Tool 8: Add Solar photovoltaics to EV infrastructure

The National Renewable Energy Laboratory created a summary of considerations for adding distributed solar PV with EV charging: https://www.nrel.gov/docs/fy14osti/62366.pdf. Solar Sage provides an easy online calculator for estimating solar panel costs based on electricity demand.

STEP 5. Contact Utility

Once you taken time to consider the items listed in Steps 1-4 of the checklist, you'll be well prepared to begin speaking with your utility, EV service providers and electrical contractors who will be able to recommend solutions suited to the needs and constraints of your location. These experts can also help refine cost estimates and potential recovery strategies. The utility specifically can help walk you through any necessary electrical service upgrades, potential electricity bill impacts, and other technical aspects of the project.

STEPS 6 & 7: Contract with Vendors & Hire Installers

Charging stations equipment and network providers offer a variety of products, services, and unit ownership arrangements. Speaking with several vendors and reviewing case studies is important before finalizing a contract.

Tool 9: CALeVIP Connects

CALeVIP Connects is provided as part of the CALeVIP incentive program. It is a free online directory that allows you to connect directly with EV service providers and request information for potential EV charging projects. https://calevip.org/find-an-evsp

STEP 8: Implement Management Policies

Once your charging stations is operational, you will want to take steps to ensure it is well utilized and enhances your site. Communication with site stakeholders, staff and visitors will be key to success. Distributing a written use and management policy and installing signage to direct potential users to charging units are two important steps. You may also want to set a schedule to review utilization and ongoing costs to decide whether your current charging stations and services are still serving your needs.

Tool 10: Veloz Accessibility and Signage Guide

Veloz provides several charging stations-related resources on its website, including a report with recommendations on parking management, accessibility and signage.
https://www.veloz.org/resource/accessibility-signage-for-pev-charging-infrastructure/

Case Studies

City of Sacramento

https://www.cityofsacramento.org/Public-Works/Electric-Vehicle-Initiatives

Sacramento currently has nearly 500 public and workplace charging stations. The seventy-eight public chargers at City-owned parking facilities are free apart from one DC fast-charger. Fees at private chargers are determined by the operator or host. The City also has an interactive charging map mobile application. In 2018, the City began implementing a curbside charging trial program downtown for on-street and public right-of way charging.

Fresno County Solar Charging

http://www.envisionsolar.com/fresno-county-unveils-countywide-solar-powered-ev-charging-program-using-envision-solars-ev-arc/

Fresno County has installed 13 solar powered EV charging stations in rural unincorporated communities, 12 of which are disadvantaged. All stations are free to charge. These stations also have energy storage to provide emergency power during a grid failure and have rotating solar arrays to maximize daily electricity generation.

Colorado Mountain Travel Corridor

http://cleanairfleets.org/programs/charge-ahead-colorado

With grant funding from the Colorado Energy Office's Charge Ahead program, towns in Colorado's mountain region have installed public charging stations and created an electric vehicle travel corridor. Participating towns include Montrose, Durango, Ouray and Mountain Village. Mountain Village has a free-to-park and free-to-charge Level 2 station for recreational visitors installed near a ski gondola connecting to Telluride. Ninety-three additional public stations should be funded by Charge Ahead Colorado beyond the 145 already completed.

Additional Resources

Alternative Fuels Data Center (AFDC) – The U.S. Department of Energy's AFDC is an information clearinghouse with useful resources like case studies, an EV charging locator and a list of relevant laws and incentives. https://afdc.energy.gov/fuels/electricity.html

Veloz/PEV Collaborative – Veloz provides many useful resources including case studies, templates and fact sheets on their website. https://www.veloz.org/veloz-resources/

California GoBiz – The Governor's Office of Business provides several EV-related resources, including an extensive Community Readiness Guidebook to help local governments facilitate charging stations installation with templates, tools and resources. http://businessportal.ca.gov/zero-emission-vehicle-program/zev-resources/

Appendix A3
ZEV Charging Infrastructure Toolkit – Residents

Why Make the Switch to an Electric Vehicle?

Electric vehicles (EVs) have many potential advantages over traditional internal combustion engine vehicles (e.g., reduced environmental impact [greenhouse gas emissions], cost savings [upfront incentives, lower lifecycle cost, lower fuel cost, lower maintenance cost], and a very responsive driving experience [instant power and torque]). The most common perceived barriers to buying an electric vehicle is range confidence and availability of charging. The infrastructure to combat range anxiety for electric vehicles (and improve range confidence) is the electric grid which is available almost anywhere; and can typically facilitate charging at home, work or in transit. People tend to follow a charging hierarchy that starts at home. Most individual passenger cars remain parked for eight to 12 hours at night, and home charging can be easy and often cheaper than charging elsewhere. Electric vehicle charging infrastructure is being sited in the Region more every year. As of September 30, 2018, 29 locations in the Region had public charging (Level 2 or Direct Current Fast Charging).

Electric vehicle adoption is experiencing rapid growth. In 2018, nearly 8% of new car sales in California were EVs.[1] The number of Plug-In Electric Vehicles in the Central Sierra Region is projected to be between 1,548 and 2,233 by 2025.[1] California policy, such as Governor Brown's 2018 Executive Order (EO) B-48-18, set ambitious targets for EV adoption and supportive infrastructure. Individuals switching to electric vehicles for personal transportation will play a crucial role in transforming California's transportation sector to zero emission vehicles.

Zero Emission Vehicle Technology

[1] Mobile Source Emission Inventory (EMFAC) Volume III – Technical Documentation (2018). https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf

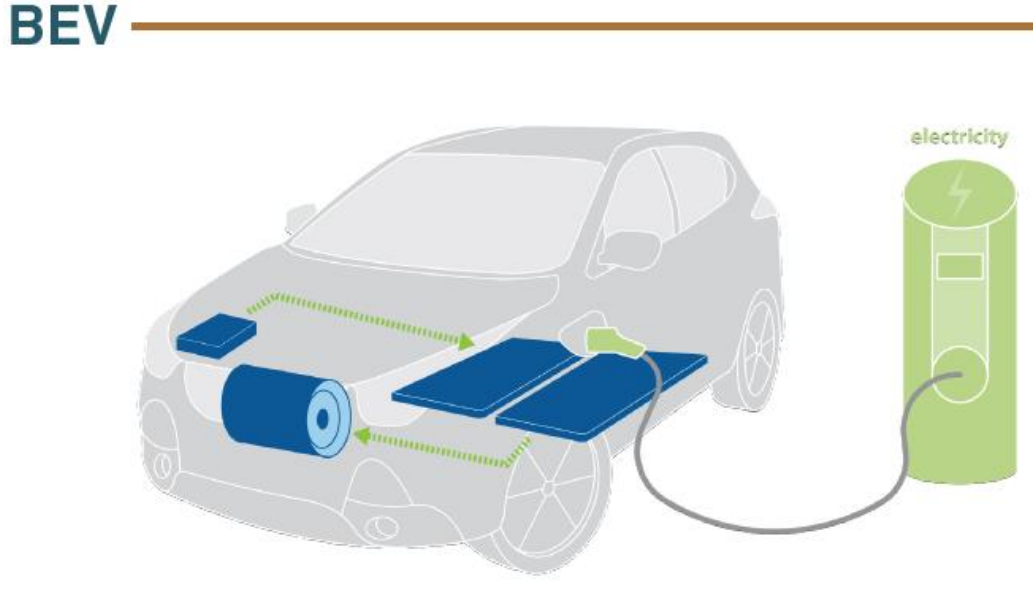
Plug-in Electric Vehicle (PEV)

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. It is commonly referred to as just an electric vehicle (EV). There are two types of plug-in 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 a gasoline tank that is used when the car's battery is depleted. Electric vehicles come in all shapes and sizes. They are no longer limited to light-duty passenger vehicles:

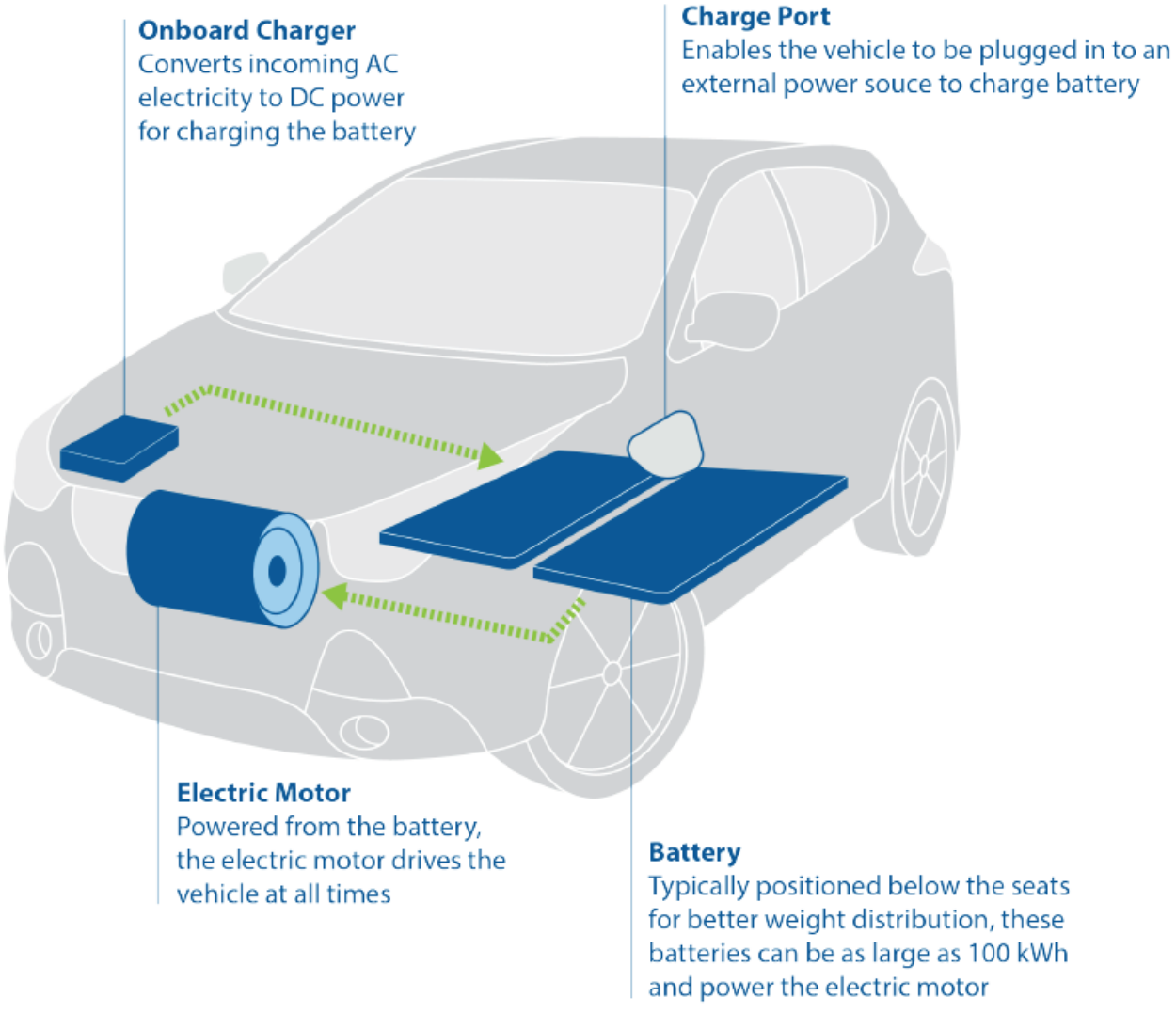
- Passenger vehicles
- Vanpool shuttles
- Pickup trucks
- Medium-duty vehicles
- Transit buses
- Forklifts
- Low-speed vehicles (golf carts and similar)

Battery Electric Vehicles (BEV)

For drivers who want to achieve zero tailpipe emissions and have access to charging opportunities. A battery electric vehicle (BEV) doesn't use gasoline and produces zero tailpipe emissions. Instead, it has a large battery that powers one or more electric motors. 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. BEVs can be plugged in at home, work or public charging stations. In addition, there is limited maintenance; the vehicle will never require an oil change.



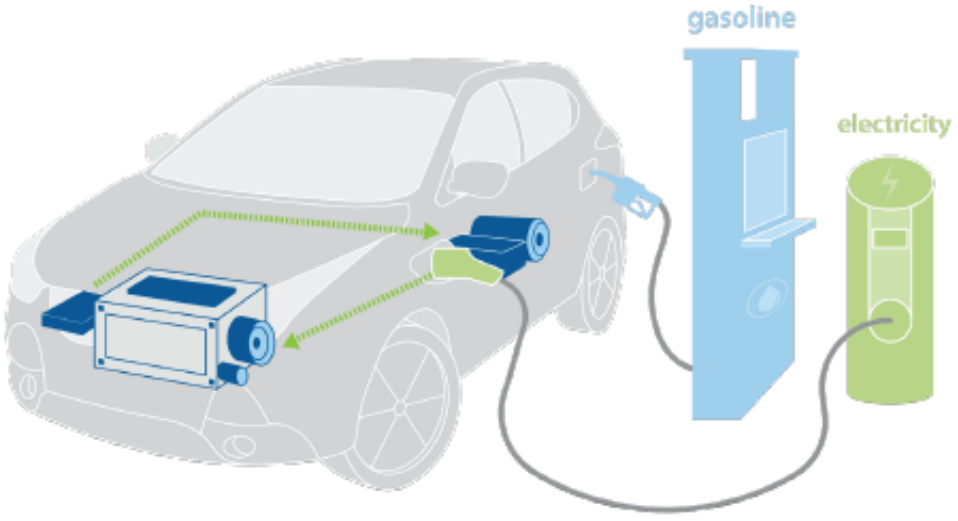
BEV



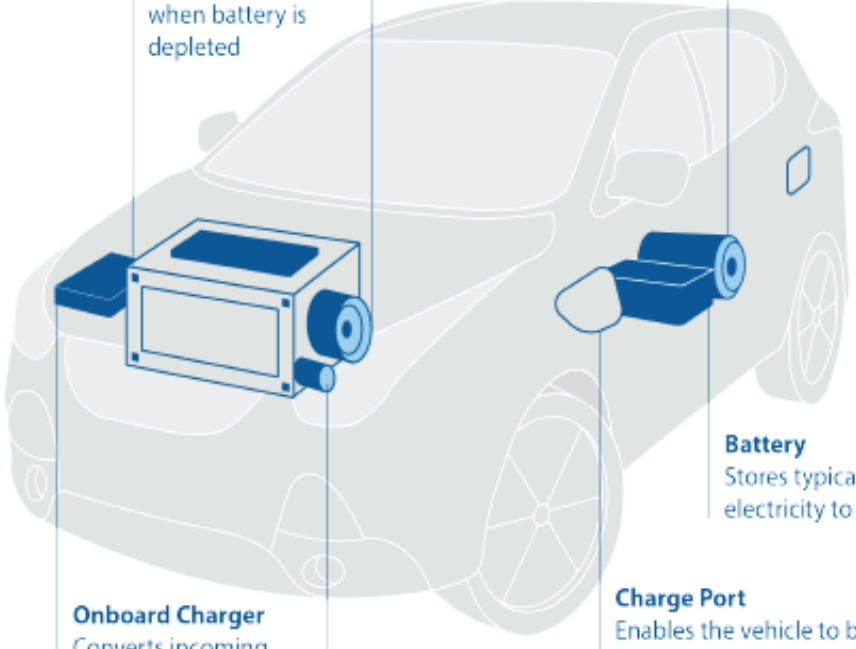
Plug-In Hybrid Electric Vehicle (PHEV)

For drivers who want an electric-only mode, but still need the option of gas to meet all their needs. A plug-in hybrid electric vehicle (PHEV) offers both gas only and electric-only driving – even at relatively high speeds. PHEVs have smaller batteries than BEVs, but still enjoy many of the same benefits. A plug-in hybrid electric vehicle runs on electricity and a gasoline. The vehicle's onboard battery is charged using electricity from the grid, and when the battery is depleted, the gasoline engine is used.

PHEV



PHEV



Engine
Assists electric motor when driving at high speeds, and powers the vehicle when battery is depleted

Electric Motor
Powered from the battery, the electric motor drives the vehicle up to high speeds

Gas Tank
Smaller gas tank than conventional cars

Battery
Stores typically between 8-16 kWh of electricity to power the electric motor

Charge Port
Enables the vehicle to be plugged in to an external power source to charge battery

Onboard Charger
Converts incoming AC electricity to DC power for charging the battery

Electric Generator
Captures energy from regenerative braking and transfers to battery

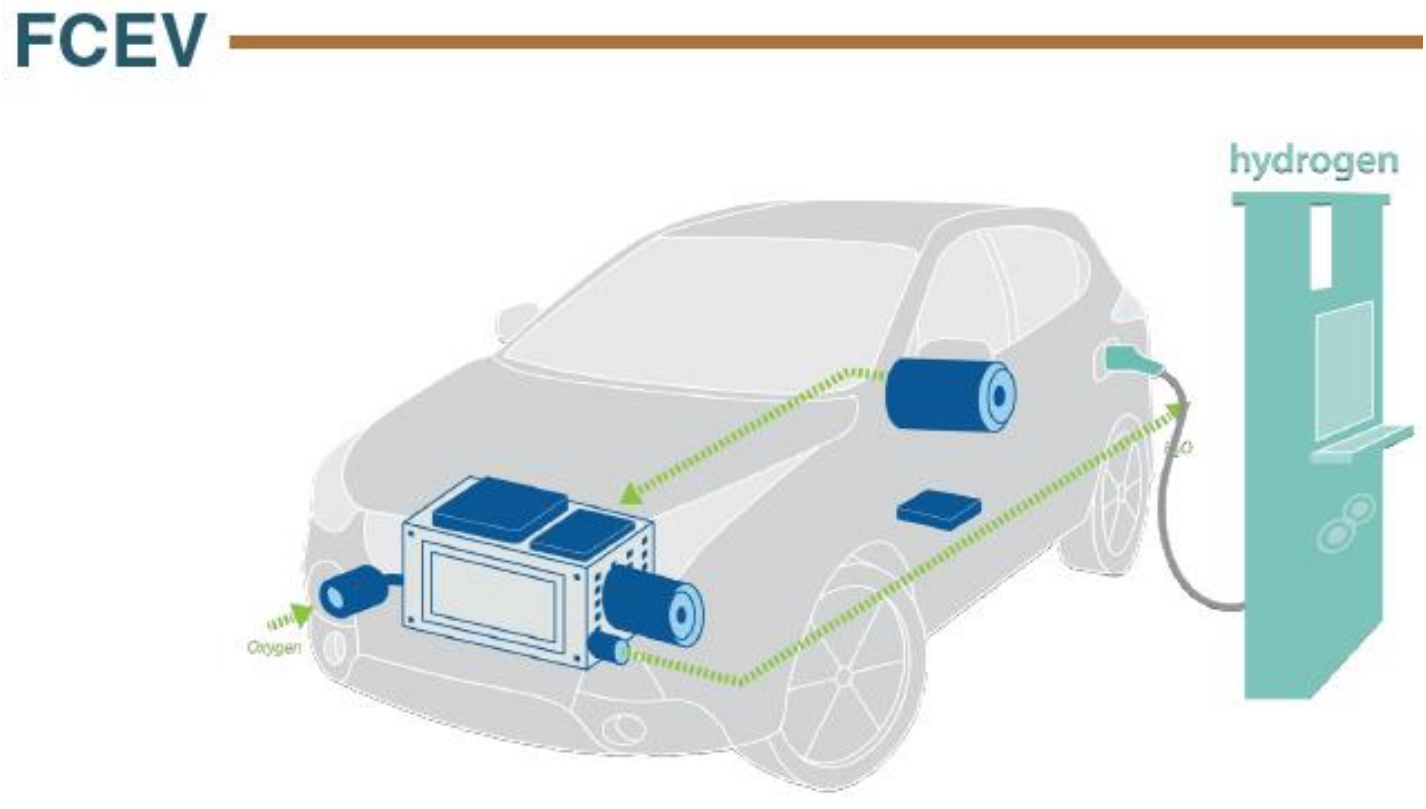
Fuel-Cell Electric Vehicles (FCEV)

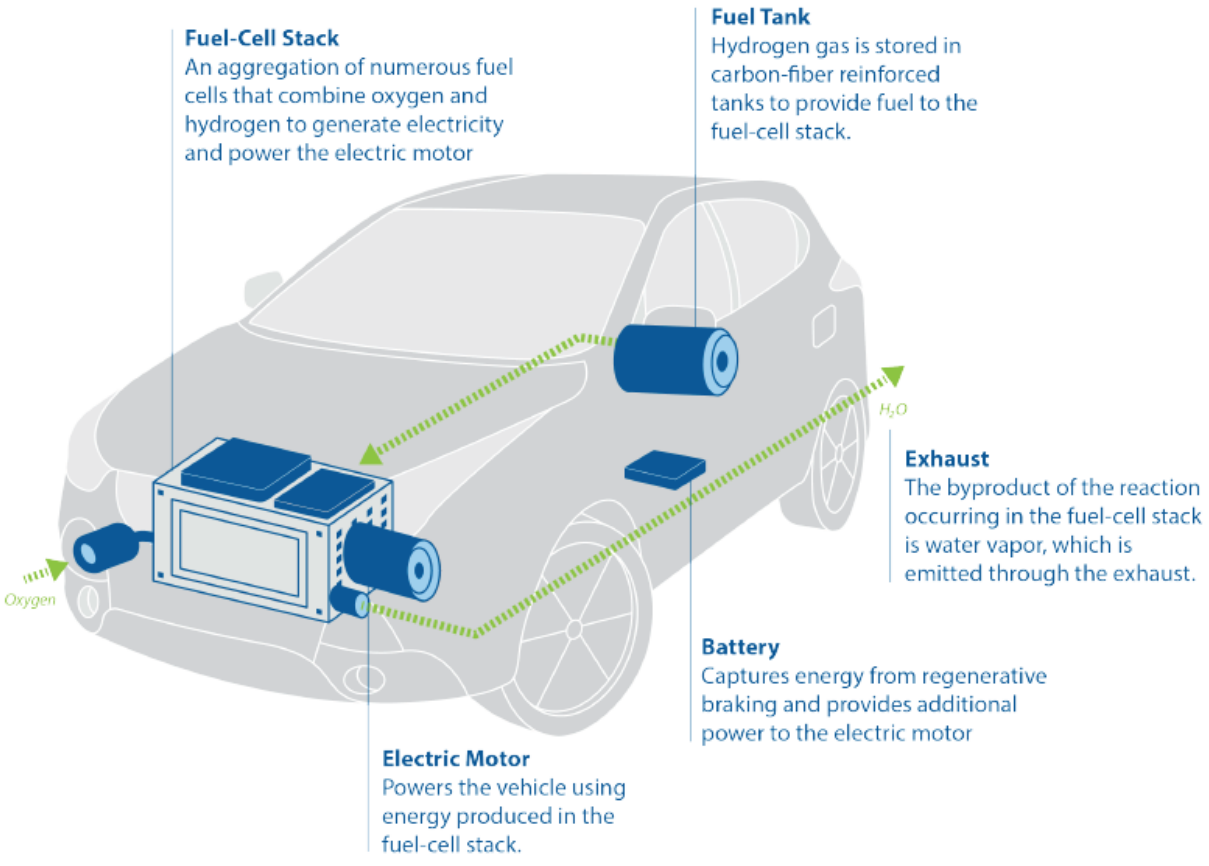
A hydrogen fuel cell electric vehicle (FCEV) is a vehicle that is powered by hydrogen. Hydrogen is pumped into pressurized cylinders in the vehicle. The fuel cell converts the hydrogen into electrical energy to drive the motor. Hydrogen is found in organic matter and in water. Most of the hydrogen for transportation is produced by extracting it from natural gas. Hydrogen can also be extracted from water; however, this is a more energy intensive method.

Fuel cell vehicles are zero-emission vehicles that emit water vapor and warm air as exhaust.

For drivers who want to combine the zero-emission driving of a battery electric car with the quick and easy refueling of hydrogen. Refueling takes less than ten minutes, and most manufacturers provide free fueling for the first three years.

According to the Department of Energy (DOE), a full tank of compressed hydrogen will cost around $50 (and provide a range of approximately 300 miles). The DOE also estimates that the future costs will fall to $30 to fill a tank of hydrogen. The target price for hydrogen is $4.00/gallon of gasoline equivalent.





Electric Vehicle Charging Technologies

Electric vehicle charging stations (EVCS) are typically classified by three "levels" of power delivery: Level 1, Level 2 and direct current (DC) fast charging. The primary distinction between these levels is the input voltage – Level 1 uses a household 110/120 volts, Level 2 uses the same 208/240 volts as a clothes dryer, and DC fast chargers (DCFC) use between 208 and 480 volts, and usually requires three-phase power input. Various manufacturers produce each level of EVCS, with a variety of products with varying prices, applications and functionality.

LEVEL 1

- Standand current
- 8-12 hours to fully charge, although larger batteries could take 1-2 days
- Standard outlets and standard J1772 coupler
- In-vehicle power conversion

LEVEL 2

- Requires installation of charging equipment and may require utility upgrades
- 4-8 hours to fully charge
- Inside or outside locations
- Public use, often requiring payment and provider network interfaces

DCFC

- Requires installation of charging equipment and may require utility upgrades
- 80% charge in as little as 30 minutes
- Relatively high-cost compared to Level 2 chargers
- Requires utility upgrades and dedicated circuits

Level 1 Charging

In general, Level 1 charging is cost efficient when an existing 110V/120V outlet is present. In this case, an EV driver can use their original equipment manufacturer branded Level 1 charging cord set that comes with most EVs. The power output of Level 1 charging varies slightly, but typically is between 12 amps and 16 amps of continuous power output. At these levels of power output, a Level 1 charger will deliver between 3.5 and 7 miles of range per hour of charging. These charging rates can be satisfactory for drivers who do not drive more than 30-40 miles daily and who charge overnight.

Currently, there are only a few third-party manufacturers of Level 1 EVCS designed for commercial use. However, hosts can offer charging by offering easily accessible 110V or 120V outlets that drivers can use with the cord sets that came with their vehicles.

Level 2 Charging

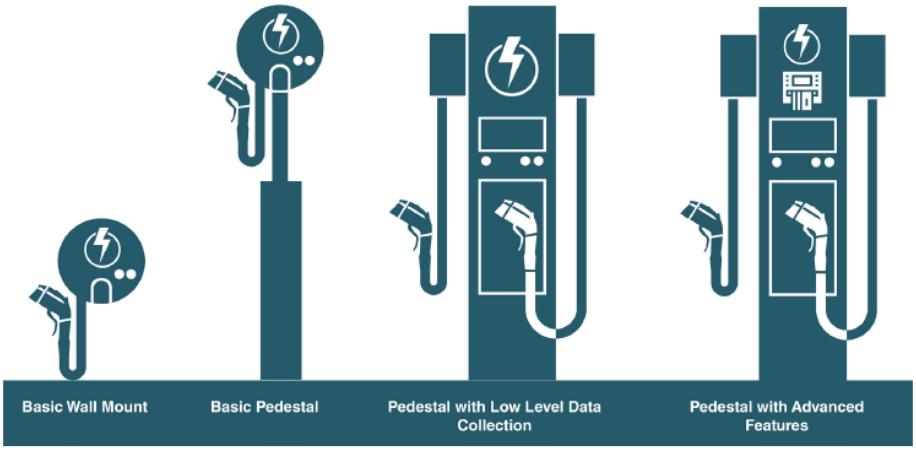
Level 2 EVCS offer higher power output than Level 1 EVCS and have additional functionality that is not available with Level 1 EVCS. Level 2 EVCS may be designed for indoor or outdoor use (e.g., NEMA 3R, NEMA 6P, NEMA 4x rated) and typically produce between 16 and 40 amps of power output, which will deliver between 14 and 35 miles of electric range per hour of charging. In general, Level 2 EVCS are distinguished between non-networked EVCS (colloquially referred to as "dumb" EVCS) and networked EVCS (referred to as "smart" EVCS).

Non-networked (Dumb) Level 2 EVCS

Non-networked Level 2 EVCS serve a similar function as Level 1 EVCS, however, if an electrical permit is going to be obtained to install a dedicated circuit for EV charging, it is most often a better value to have a 240-volt circuit installed for Level 2 charging. Nonnetworked EVCS are typically available at slightly lower cost than networked/smart EVCS, but typically do not offer data monitoring.

Networked (Smart) EVCS

Networked EVCS are commonly used in workplace/public settings where payments are required or at MUDs where the property's electricity bill is shared by multiple tenants. Some of the "smart" features include remote access/control via Wi-Fi or cellular connection, access control/ability to accept multiple forms of payment, and load balancing across multiple EVCS.



Networked EVCS are useful for owners that need to monitor electricity usage across multiple EVCS, have multiple drivers sharing a single EVCS, require payment for use of EVCS, or in situations where electricity capacity is constrained or requires load balancing. Some models of smart EVCS participate in demand response programs which limit charging to certain hours and allows the operator to maximize a time-of-use (TOU) electricity rate structure and only allow charging when electricity is the cheapest. While the initial capital investment for a networked EVCS is higher than non-networked EVCS, they provide valuable data to the owner that can result in long-term cost savings through better management or by applying innovative charging solutions.

DC Fast Charging

DC fast chargers (DCFC) are the highest-powered EVCS on the market. They are commonly used as range extenders along major travel corridors for long-distance trips, as well as in urban environments to support drivers without home charging or very high-mileage drivers. At present charging speeds, these chargers are ideal for places at which a person would spend 30 minutes to an hour, such as short-dwell destinations (e.g. restaurants and retail locations).

Current DCFC stations typically require three-phase, 480V input at 100+ amps (50-60 kW) and can produce a full charge for an EV with a 100-mile range battery in slightly more than 30 minutes (averaging 178 miles of electric drive per hour of charging). Most DCFC-compatible vehicles currently on the market can only accept a maximum power delivery of 50kW, though this is rapidly increasing. To future-proof infrastructure against further improvements in power acceptance rates, the newest generation of DC fast chargers, such as those being installed by Volkswagen's Electrify America program, can output 150-350 kW of power. Tesla's Superchargers are capable of charging at speeds of 120-135kW with upgrades to existing electrical infrastructure.

It is important to note not every EV model is capable of DC fast charging, and therefore these stations cannot be utilized by every EV driver. Furthermore, there are multiple standards for connectors for DC fast charging, whereas there is only one common standard for Level 1 and 2 charging (SAE J1772). There are three types of DC fast charging connectors: CHAdeMO (typically used by Japanese-manufactured vehicles), Tesla (proprietary connector), and CCS (all other vehicles). As of March 2019, Tesla connectors are the most common connector type in the United States, totaling 5,659 ports; followed by CHAdeMO and CCS with 2,752 and 2402, respectively. These numbers are rapidly changing with many vendors making major investments in fast charging across the US.

Electric Vehicle Benefits and Considerations[2]

Energy Security

In 2017, the United States imported about 19% of the petroleum it consumed. Because transportation accounts for nearly three-fourths of total U.S. petroleum consumption, using more energy efficient vehicles like hybrid and plug-in electric vehicles can have a direct impact. This not only supports the U.S. economy but helps diversify the U.S. transportation fleet and reduce the impact of international supply disruptions. All of this adds to our nation's energy security.

Fuel Economy

PHEVs typically achieve better fuel economy and have lower fuel costs than similar conventional vehicles. For example, the 2018 Honda Accord Hybrid has an EPA combined city-and-highway fuel economy estimate of 47 miles per gallon, while the estimate for the conventional 2018 Accord (four cylinder, automatic) is 33 miles per gallon. Use the Find A Car tool on FuelEconomy.gov to compare fuel economy ratings of individual hybrid and conventional models.

PHEVs and EVs can reduce fuel costs dramatically because of the high efficiency of electric-drive components. Because PHEVs and EVs rely in whole or part on electric power, their fuel economy is measured differently than that of conventional vehicles. Miles per gallon of gasoline equivalent (mpge) and kilowatt-hours (kWh) per 100

[2] DOE Alternative Fuels Data Center. Available at https://afdc.energy.gov/fuels/electricity_benefits.html

miles are common metrics. Depending on how they're driven, today's light-duty EVs (or PHEVs in electric mode) can exceed 100 mpge and can drive 100 miles consuming only 25-40 kWh.

Infrastructure Availability

PHEVs and EVs have the benefit of flexible fueling: Since the electric grid is near most locations where people park, PEVs can charge overnight at a residence, as well as at a fleet facility, workplace, or public charging station when available. PHEVs have added flexibility, because they can also refuel with gasoline or diesel (or possibly other fuels in the future) when necessary.

Public charging stations are not as ubiquitous as gas stations, but charging equipment manufacturers, automakers, utilities, Clean Cities coalitions, municipalities, and government agencies are rapidly establishing a national network of charging stations. The number of publicly accessible charging stations reached about 18,000 in 2018, offering about 50,000 outlets. To find electric charging stations near you, please visit the AFDC electric vehicle charging station locator.

Costs

Although fuel costs for hybrid and plug-in electric vehicles are generally lower than for similar conventional vehicles, purchase prices can be significantly higher. However, prices are likely to decrease as production volumes increase and battery technologies continue to mature. Also, initial costs can be offset by fuel cost savings, a federal tax credit, and state incentives. The federal Qualified Plug-In Electric-Drive Motor Vehicle Tax Credit is available for PHEV and EV purchases until manufacturers meet certain thresholds of vehicle sales. It provides a tax credit of $2,500 to $7,500 for new purchases, with the amount determined by the size of the vehicle and capacity of its battery.

Use the Vehicle Cost Calculator to compare lifetime ownership costs of individual models of PHEVs, EVs, and conventional vehicles.

Emissions

Hybrid and plug-in electric vehicles can have significant emissions benefits over conventional vehicles. PHEV emissions benefits vary by vehicle model and type of hybrid power system. EVs produce zero tailpipe emissions, and PHEVs produce no tailpipe emissions when in all-electric mode.

The life cycle emissions of an EV or PHEV depend on the sources of electricity used to charge it, which vary by region. In geographic areas that use relatively low-polluting energy sources for electricity production, plug-in vehicles typically have a life cycle emissions advantage over similar conventional vehicles running on gasoline or diesel. In regions that depend heavily on conventional fossil fuels for electricity generation, PHEVs and EVs may not demonstrate a strong life cycle emissions benefit. Use the Vehicle Cost Calculator to compare life cycle emissions of individual vehicle models in a given location.

Batteries

The advanced batteries in plug-in electric vehicles are designed for extended life but will wear out eventually. Several manufacturers of plug-in vehicles are offering 8-year/100,000-mile battery warranties. Predictive modeling by the National Renewable Energy Laboratory indicates that today's batteries may last 12 to 15 years in moderate climates (8 to 12 years in extreme climates).

Check with your dealer for model-specific information about battery life and warranties. Although manufacturers have not published pricing for replacement batteries, some are offering extended warranty programs with monthly fees. If the batteries need to be replaced outside the warranty, it may be a significant expense. Battery prices are expected to decline as battery technologies improve and production volumes increase.

Resident EV Checklist

This section summarizes common steps to help you consider options and understand how and when to engage the experts – your local utility, licensed contractors and charging stations vendors. This toolkit provides general information and resources for each step of the following checklist.

This checklist is presented in a linear format, but the process of installing charging stations will be dynamic, with various interrelated considerations. Steps 1-3 will be preliminary explorations of issues that can be revisited with expert help once you've decided to move forward and contacted your utility and/or charging stations vendors. Actions listed are from the perspective of the project lead for your site. Your utility, vendors, and contractors will guide you through actual installation steps and more detailed considerations.

STEP 1: Consider and document driving habits, charging requirements, and budget

- ☐ **1.** How far do you frequently drive?
- ☐ **2.** What is your budget?

STEP 2: Consider Charging Options

- ☐ **3.** Consider appropriate charging equipment types based on estimated demand (Level I typically suit low mileage & long dwell, Level II mid/long mileage & mid/long dwell).
- ☐ **4.** Examine if 240V charger is needed.
- ☐ **5.** Examine charging station availability in areas where frequently traveling and spending time (workplace, shopping, etc).

STEP 3: Estimate Capital Costs

- ☐ **6.** Determine which vehicle you would like to purchase and search for cost estimates
- **7.** Determine type of charging station you want to install (if 240V charger is needed).
- ☐ **8.** Determine if your electrical service/panel requires an upgrade (engage utility or technology provider, if 240V charger is needed).
- ☐ **9.** Have technology provider estimate operations & maintenance costs (e.g., electricity use, demand charges, networking fees).

STEP 4: Contact Utility (PG&E, Liberty Utilities, Kirkwood Utilities Department or Tuolumne Public Power Agency) to verify suitability, check for incentive programs or time-of-use programs (TOU).

STEP 6: Contract with Vendors - Choose from offered equipment and service contracts

STEP 7: Hire Installers - Work vendors to plan, permit, and install EV charging

STEP 8: Monitor Energy Use

- ☐ **10.** Set vehicle charging times to off-peak (or equivalent) hours when electricity rates are lower.
- ☐ **11.** Evaluate adding renewable energy and battery storage onsite.

Charging-Specific Electric Vehicle Resources

Most electric vehicle owners will be able to meet their daily driving range requirements by charging overnight with Level 1 equipment, requiring no additional cost or installation, provided that a power outlet on a dedicated branch circuit is available. For increased range and reduced charging time, Level 2 charging equipment can be purchased and installed. State incentives may be available to help offset the cost of installing charging equipment.

Networked, or "smart" Level 2 products are ideal because they have features such as data collection, user interface systems, enhanced displays, charging timers, communications capabilities, and keypads that give greater visibility and control over the system operation. Typically, networked chargers also let you schedule charging in accordance with your schedule or based on favorable electricity rates.

Installation contractors or qualified electrician will evaluate electrical capacity for vehicle charging. Some homes might have insufficient electric capacity for Level 2 equipment. However, homeowners may have a qualified electrician add circuits to accommodate the capacity needed. The following resources support decision-makers during residential installations.

Tool 1: Evaluate Electrical Load Capacity

The Governor's Office of Planning and Research developed an electrical load calculator to help homeowners/renters calculate the existing electrical load for their electrical panel. This can be used to calculate if there's excess capacity for electric vehicle charging: http://www.opr.ca.gov/docs/L2_Load_Calculator.pdf

Tool 2: Electric Vehicle Cost Calculator

The Alternative Fuels Data Center developed a great resource for estimating costs for charging electric vehicles and a comparison of energy costs per mile for electric versus gasoline-fueled vehicles. DOE: https://afdc.energy.gov/calc/ and https://avt.inl.gov/sites/default/files/pdf/fsev/costs.pdf

Tool 3: EV Charging Location Maps

Use these maps to see where nearby chargers are located, how many chargers are available, and their rates and access rules. Keep in mind that demand will continue to grow. PlugShare: https://www.plugshare.com/. U.S. DOE: https://afdc.energy.gov/stations/#/find/nearest.

Tool 4: Add Solar photovoltaics to EV infrastructure

The National Renewable Energy Laboratory created a summary of considerations for adding distributed solar PV with EV charging: https://www.nrel.gov/docs/fy14osti/62366.pdf. Solar Sage provides an easy online calculator for estimating solar panel costs based on electricity demand.

APPENDIX A4
EV Charging Infrastructure Toolkit – Workplaces

Why Install Electric Vehicle Charging?

Electric vehicle (EV) adoption is experiencing rapid growth. In 2018, nearly 8% of new car sales in California were EVs. The number of Plug-In Electric Vehicles (PEV) in the Central Sierra Region is projected to be between 1,548 and 2,233 by 2025. California policy, such as Governor Brown's 2018 Executive Order (EO) B-48-18, set ambitious targets for EV adoption and supportive infrastructure. Local governments play a crucial part of transforming California's transportation sector to zero emission vehicles.

Installing EV charging stations (EVCS) at your business or workplace has numerous benefits. Providing EV charging demonstrates your business's commitment to reducing the environmental impact of its operations. Showing that value and reducing commuting costs for your employees can help attract and retain high-value employees. EV charging at the workplace is highly prized by drivers – it allows them to get to work and back with confidence. For drivers without reliable access to charging at home, it can be a must-have. In addition, EVCS can contribute to corporate sustainability goals and count toward Leadership in Energy and Environmental Design (LEED) certification[1]. Additionally, the San Joaquin Valley Air Pollution Control District Rule 9410 (Employee Trip Reduction Planning) mandates that workplaces with over 100 employees select a certain number of approved actions to implement – one of which can be installing on-site EVCS.

Benefits of EV Charging

- **Attract Top Employees**
- **Stregthen Brand & Environmental Image**
- **Reduce Operational Impacts**
- **Enhance Employee Programs**
- **Enhance Property Value**

[1] USGBC Leadership in Energy and Environmental Design. https://www.usgbc.org/credits/schools-new-construction/v4-draft/ltc8

Site Owner EV Charging Checklist

While each installation is unique, many properties have similar questions and challenges when planning for EVCS. This document summarizes common steps to help you consider options and understand how and when to engage the experts – your local utility, licensed contractors and EVCS vendors. The toolkit provides general information and helpful resources to guide you through each step of the checklist provided below.

While this checklist is presented in a linear format, the process of installing EVCS will be dynamic, with various interrelated considerations. Steps 1-4 will be preliminary explorations of issues that can be revisited with expert help once you've decided to move forward and contacted your utility and/or EVCS vendors. Actions listed are from the perspective of the project lead for your site. Your utility, vendors, and contractors will guide you through actual installation steps and more detailed considerations.

STEP 1: Estimate Demand

- ☐ **1.** Survey employees to determine who currently owns an EV, who plans to purchase an EV, typical daily driving distance, the importance of workplace charging availability, and similar data to inform decision-making.
- ☐ **2.** Look at similar sized workplaces with charging to evaluate demand/EVCS needs.
- ☐ **3.** Estimate volume of customer/visitor drivers with EVs to evaluate if public charging is warranted.

STEP 2: Consider EVCS Options

- ☐ **4.** Consider appropriate charging equipment types based on estimated demand. Explore Level I solutions for employees that do not have long daily travel needs and will charge overnight. Explore Level II solutions for employees with long daily commutes. Direct Current Fast Chargers (DCFCs) are not typically recommended for workplaces.
- ☐ **5.** Examine physical siting constraints (e.g., access to electrical infrastructure, accessibility, visibility etc.).
- ☐ **6.** Weigh EVCS ownership models - tenant, property owner, or third-party vendor.
- ☐ **7.** Determine if you want to measure EVCS use and require payment from users. This will lead to other considerations such as EVCS software, networked vs. non-networked EVCS, in-house or third-party payment companies, using pricing to drive parking space turnover, etc.
- ☐ **8.** Consider increasing the installation of EV-ready/make-ready spaces to account for growing demand, reducing future capital costs related to site development (e.g. trenching, wiring).
- ☐ **9.** Decide if electricity will be supplied from tenants' individual meters or from a common load meter. If common load, determine how users will be billed.
- ☐ **10.** Determine who will maintain ownership of the EVCS (e.g. property owner, tenants, etc.).

STEP 3: Estimate Capital Costs

- ☐ **11.** Determine the number and type of EVCS you want to install on-site.

- ☐ **12.** Measure distance to EVCS location from power point of connection to estimate make-ready costs, which cover laying the infrastructure needed for the immediate installation of a charging station in the future (e.g., trenching and conduit installation).
- ☐ **13.** Determine if your electrical panel requires an upgrade to handle increases in load, or to separately meter EVCS from other electrical demand (engage utility or technology provider).
- ☐ **14.** Have the EVCS technology provider(s) estimate operations & maintenance costs (e.g., electricity use, demand charges, networking fees).

STEP 4: Evaluate Cost Recovery Options

- ☐ **15.** Research available incentive and funding programs (e.g., PG&E Fast Charge Program, EV Charge Network Program, etc.) Note that some programs (e.g., CALeVIP) require approval prior to equipment purchase to guarantee coverage.
- ☐ **16.** Consider contracting with an EVCS network provider to recover ongoing charging costs.
- ☐ **17.** Look into vendors offering free charging for advertising space.

STEP 5: Contact Utility (PG&E, Liberty Utilities, Kirkwood Utilities Department or Tuolumne Public Power Agency) to Conduct Site Evaluation

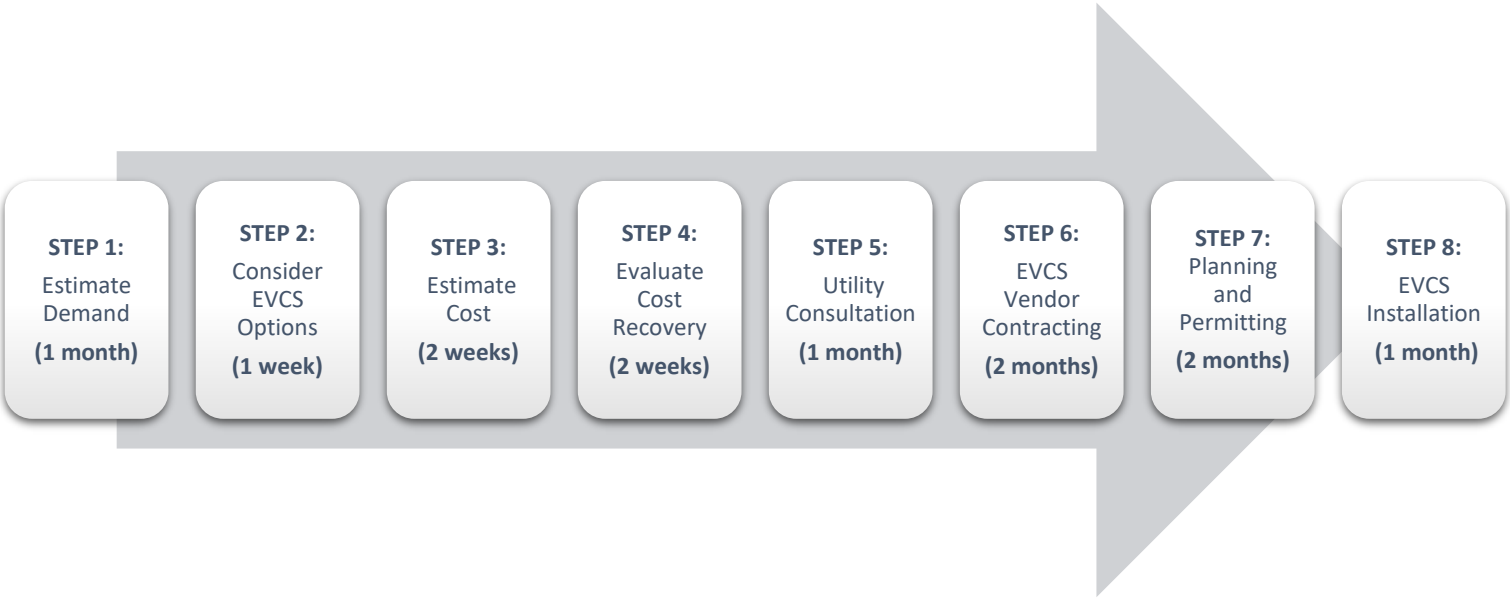
STEP 6: Contract with Vendors - Choose from offered equipment and service contracts

STEP 7: Hire Installers - Work with utility and vendors to plan, permit, and install EV charging

STEP 8: Implement Management Policies

- ☐ **18.** Ensure compliance with ADA regulations, consider general parking and traffic flow issues.
- ☐ **19.** Contact insurer regarding potential liability issues.
- ☐ **20.** Consider installing signage guiding visitors to EV charging.
- ☐ **21.** Communicate with site tenants and other stakeholders regarding installation and use of EVCS.
- ☐ **22.** Set schedule to review EVCS usage and contracts with third parties to consider adjustments.

EV Charging Installation Timeline



EV Charging Resources

STEP 1. Estimate Demand

What is your current EV charging need, and how will it grow into the future? Weighing the need for EVCS at your workplace will require reaching out to stakeholders at your site and researching existing EV charging locations nearby. A simple first step is to contact each tenant or property stakeholder at the site to inquire about EV charging interest or their employees or visitors. A key question will be evaluating the typical vehicle dwell times at your site to consider the appropriate charging speed.

Tool 1: EV Charging Demand Sample Survey

The U.S. Department of Energy has prepared a sample survey for workplaces to gather information on employee EVCS demand. This may not be appropriate for tenants at your site unless they have many employees, but it gives a good idea of what types of questions to consider: https://afdc.energy.gov/files/u/publication/WPCC_sample_employee_survey_0816.pdf

Tool 2: EV Charging Location Maps

Use these maps to see where nearby chargers are located, how many chargers are available, and their rates and access rules. Keep in mind that demand will continue to grow. PlugShare: https://www.plugshare.com/. U.S. DOE: https://afdc.energy.gov/stations/#/find/nearest.

STEP 2. Consider EVCS Options

What charging speeds, controls and billing capabilities do you require? You will want to consider the demand and dwell times of employees and visitors at your location to select appropriate charging equipment. The table below provides a summary of EVCS types. Levels 1-3 offer increasing charging speed but with added cost and complexity.

Tool 3: EV Charging Information

The U.S. Department of Energy maintains a clearinghouse of information and resources for alternative fuels, including EV charging: https://afdc.energy.gov/fuels/electricity.html

	Level 1	Level 2	Level 3 (DCFC)
Charging Speed	3-5 miles of range/hour	10-54 miles of range/hour	75-300 miles of range/hour
Typical Locations	Single-family homes Townhomes Multi-family dwellings Office buildings	One and two-family homes Townhomes Multi-family dwellings Office buildings	Public access Retail shops Highway corridors Hospitality & recreation facilities
Equipment Description	Standard 120 VAC outlet and cord set charger that typically comes with EV Metering and billing not available	240 VAC outlet and wall-mounted or bollard style charging port Networked units available, allowing for advanced controls, billing options	Commercial-grade 208, 440 or 480 VAC converted into direct current (DC) through large standing unit Often requires upgrades to a site's electrical service Not all EVs can utilize

An important consideration is the number of EVCS that you will install at your location. California green building codes for new construction currently require that 6% of parking spaces be EV-ready, meaning with electrical

capacity and raceway to support future charging. Charging stations placed in 3-6% of spaces is appropriate for an initial installation, with future expansion based on demand. When trenching to install conduit for chargers, it is cost-effective to install additional conduit to support future charging.

STEP 3: Estimate Cost

The cost of installing EV charging varies considerably based on specific site requirements. Aside from the actual cost of the EV charging equipment, often referred to as electric vehicle supply equipment (EVSE), typical installation costs include trenching for electrical conduit and upgrades to the site's electrical service.

Tool 4: EV Charging Cost Report

The U.S. Department of Energy has prepared a report on average equipment and installation costs for non-residential EV charging projects:
https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

The table below provides a simplified estimation tool based primarily on costs provided in the Department of Energy report. It includes average potential costs that may or may not apply to every project. Early consultations with your utility and EVCS providers will help refine these estimates.

EVCS Installation Cost Estimator

Cost Driver	Average Costs	Example
Installation Costs		**2x Dual Port (4 Ports)**
Equipment – Level 2 (Non- Networked)	$500 - $2,000 x Ports	=
Equipment – Level 2 (Networked)	$1,500-$6,000 x Ports	= *$3,000 x 4 Ports*
Equipment – DCFC Equipment	10,000-$40,000 x Units	=
Installation – Level 2 Equipment	$3,000 - $6,000 x Ports	= *$3,800 x 4 Ports*
Installation – DCFC Equipment	$8,500 - $51,000 x Units	=
Trenching for Electrical Conduit	$100 x Feet	= *$100 x 45 feet*
Transformer Upgrade	$10,000-$25,000	=
	Total Estimated Cost:	= *$31,700*

Additionally, site hosts must consider the ongoing costs of EV charging. The primary ongoing cost for EV charging stations is the cost of electricity used to charge EVs, and demand charges. You can choose to provide charging as a free amenity or select a networked charging solution by which electricity usage is tracked and EV owners pay for the cost of electricity associated with their individual charging. In this case, you may need to cover ongoing network operation and data fees.

STEP 4. Evaluate Cost Recovery

Installing EV charging will often require a considerable up-front capital expenditure. Appropriate cost recovery strategies will depend on the ownership situation of your business site and who will be covering the costs of installation. A site owner has different options than a business leasing space. In an office park environment with multiple businesses, property owners may find it most efficient to provide EV charging for multiple businesses in an open-access area.

Site hosts may wish to recover the costs of installation and ongoing use from tenants and visitors based on individual usage, incorporate these costs into rent or lease terms, or elect to absorb the cost themselves and provide EV charging as a free amenity. No matter what cost recovery strategy you choose, there are additional resources that can provide funding for eligible EV charging installation projects, as listed below.

Tool 5: AFDC Incentive Listing Tool

The U.S. Department of Energy's Alternative Fuel Data Center (AFDC) hosts a comprehensive listing of currently available EV incentives within the state of California. Please note that certain programs (.e.g., CALeVIP) are time-limited and/or location specific: https://afdc.energy.gov/fuels/laws/ELEC?state=ca

Tool 6: Add Solar photovoltaics to EV infrastructure

The National Renewable Energy Laboratory created a summary of considerations for adding distributed solar PV with EV charging: https://www.nrel.gov/docs/fy14osti/62366.pdf. Solar Sage provides an easy online calculator for estimating solar panel costs based on electricity demand.

STEP 5. Contact Utility

Once you taken time to consider the items listed in Steps 1-4 of the checklist, you'll be well prepared to begin speaking with your utility, EV service providers and electrical contractors who will be able to recommend solutions suited to the needs and constraints of your location. These experts can also help refine cost estimates and potential recovery strategies. The utility specifically can help walk you through any necessary electrical service upgrades, potential electricity bill impacts, and other technical aspects of the project.

Tool 7: Pacific Gas & Electric EVCS Resources

Explore PG&E's EVCS-related programs and resources, such as the EV Charge Network and a contractor search tool. Contact your account representative for additional support.
https://www.pge.com/en_US/small-medium-business/small-medium-business.page

Tool 8: Liberty Utilities EVCS Resources

Explore Liberty Utilities' EVCS-related programs and resources, such as their EV Charging Station Incentive program. Contact your account representative for additional support.
https://california.libertyutilities.com/portola/residential/evolve/electric-vehicle-program.html

STEPS 6 & 7: Contract with Vendors & Hire Installers

EVCS equipment and network providers offer a variety of products, services, and unit ownership arrangements. Speaking with several vendors and reviewing case studies and past projects is an important step before finalizing a contract with your chosen provider.

Tool 9: CALeVIP Connects

CALeVIP Connects is provided as part of the CALeVIP incentive program. It is a free online directory that allows you to connect directly with EV service providers and request information for potential EV charging projects. https://calevip.org/find-an-evsp

STEP 8: Implement Management Policies

Once your EVCS is operational, you will want to take steps to ensure it is well utilized and enhances your site. Communication with property stakeholders, staff and visitors will be key to success. Distributing a written use and management policy to staff and property stakeholders and installing signage to direct potential users to

charging units are two important steps. You may also want to set a schedule to review utilization and ongoing costs to decide whether your current EVCS and services are still serving your needs.

Tool 10: Veloz Accessibility and Signage Guide
Veloz provides a number of EVCS-related resources on its website, including a report with recommendations on parking management, accessibility and signage.
https://www.veloz.org/resource/accessibility-signage-for-pev-charging-infrastructure/

Workplace Charging Examples

Shenandoah Vineyards Winery – Plymouth, CA

http://sobonwine.com/green/

In 2014, Shenandoah Vineyards Winery installed a Solar Powered - Level 2 - 32A (7.7kw) 240V Electric Vehicle Charging Station. The USA-built Clipper Creek HCS-40 allows guests and employees to charge their EVs from the site's solar panels at no cost.

Kirkwood Mountain Resort – Kirkwood, CA

Kirkwood offers 8 free Level 2 chargers: 6 Tesla chargers and 2 J1772 plugs. These are available for both guest and employee usage as necessary.

Jackson Civic Center – Jackson, CA

https://ci.jackson.ca.us/PDF/EV_Press_Release.pdf

Two Clipper Creek J1772 charging stations were installed in downtown Jackson, CA, nearby the Civic Center core, and are available for $1 per hour. Though intended for visitor usage, due to its convenient location there is high potential for usage as a workplace charging site.

Additional Resources

Alternative Fuels Data Center (AFDC) – The U.S. Department of Energy's AFDC is an information clearinghouse with useful resources like case studies, an EV charging locator and a list of relevant laws and incentives. https://afdc.energy.gov/fuels/electricity.html

Veloz/PEV Collaborative – Veloz provides many useful resources including case studies, templates and fact sheets on their website. https://www.veloz.org/veloz-resources/

San Joaquin Valley Clean Cities Coalition – Based in Bakersfield and operated by Project Clean Air, the Clean Cities Coalition and Electric Vehicle Partnership offer a variety of support services to help connect businesses interested in EVCS with the support they need. http://projectcleanair.us/sjvccc/