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Southern California Plug-in Electric Vehicle Readiness Plan

Introductory Chapters



SOUTHERN CALIFORNIA



ASSOCIATION of
GOVERNMENTS

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Southern California Plug-in Electric Vehicle Readiness Plan

About this Document

This document was prepared for the Southern California Association of Governments (SCAG) by the UCLA Luskin Center for Innovation. It constitutes Deliverable 10 of SCAG contract 12-021-C1 to support regional planning for plug-in electric vehicle (PEV) adoption. SCAG is coordinating a multi-stakeholder group of government agencies, utilities, and university researchers to prepare multi-faceted and interdisciplinary regional PEV readiness plans. Among other purposes, these plans will help illuminate and guide strategic infrastructure investment, PEV-related economic development, and supportive policy design in Southern California.

Disclaimer

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1 Introduction

Every day, more and more plug-in electric vehicles (PEVs) can be spotted on the roads of Southern California. High gasoline prices, state zero emission vehicle programs, federal fuel economy and vehicle emissions standards, improved battery technology, and concerns over climate change and energy security have created a growing market for PEVs.

PEVs provide many benefits to different stakeholders. For drivers, PEVs are a way to save money on fuel, avoid trips to the gasoline station, contribute to energy independence, and improve air quality. For utilities, PEVs represent a new source of demand for power. For state air-quality regulators, PEVs help reduce criteria air pollutants and greenhouse gas (GHG) emissions.

Planners have a key role to play in facilitating the transition to PEVs as one of many sustainable modes of transportation. By helping create opportunities to charge at drivers' daily destinations, such as home, work, and retail centers, planners will lead the way in making PEV charging convenient and cost-efficient.

To play this new role, planners must understand new dynamics created by PEVs as well as effectively employ traditional planning tools. This Southern California Regional PEV Readiness Plan will enable planners to understand:

- Where PEVs are being driven across the region and how many more will be on local roads in order to prioritize and target planning efforts
- The travel patterns and charging needs of PEV drivers to facilitate the siting of charging opportunities that support drivers' daily travel
- The challenges of creating charging opportunities at residences, workplaces, and retail centers in order to better design technical assistance, and
- How zoning, building codes, permitting and parking regulations can drive down the soft and hard costs of charging equipment installation

In addition, this plan also provides practical planning guidance on:

- Permitting and inspecting PEV charging equipment cost-effectively
- Making building and zoning codes PEV-ready
- Regulating parking and signage for PEV charging
- Incentivizing new development to provide wiring and/or hardware for PEV charging
- Siting and pricing charging stations on public property
- Designing and providing technical assistance to commercial property owners, employers and owners of multi-unit dwellings (MUDs)
- Designing supportive utility policies, and
- Developing outreach to prospective PEV drivers and charge station site hosts

1.1 How to use this Plan

PEV planning carries with it several challenges. These include estimating how many PEVs will be driven in a given area; prioritizing PEV efforts for individual jurisdictions and land uses; and maximizing the number of electric miles driven at the lowest possible cost and at maximum convenience for drivers.

The chapters in this document help planners meet these challenges with the following tools:

- [Chapter 2](#) and [Chapter 3](#) provide **basic knowledge about PEVs**, types of charging, and the ecosystem of stakeholders that support PEV readiness.
- [Chapter 4](#) introduces methods of **assessing the local land use mix** and prioritizing the dominant land uses for targeted PEV readiness efforts.
- [Chapter 5](#), [Chapter 6](#), [Chapter 7](#), and [Chapter 8](#) feature **siting support** methods for PEV charging at single-family homes, multi-unit dwellings, workplaces, retail, and public-sector locations.
- [Chapter 9](#) discusses **financial viability**, including pricing and cost models for charge station hosts and drivers.
- [Chapter 10](#), [Chapter 11](#), [Chapter 12](#), and [Chapter 13](#) describe **measures that drive down the hard and soft costs** of installing PEV charging. These include zoning ordinances, building codes, permit and inspection streamlining, and parking policies.
- [Chapter 14](#) evaluates PEV readiness at **utilities** in the SCAG region.
- [Chapter 15](#) guides **outreach** efforts to stakeholders in single-family homes, multi-unit dwellings, workplaces and retail properties.

1.2 The Southern California Plug-in Electric Vehicle Atlas

For the first time, local planners can see **how many PEVs are registered locally** and in **what neighborhoods** PEV registrations are concentrated. The Southern California Plug-in Electric Vehicle Atlas also provides projections of PEV growth over time by council of government (COG).

Using the Southern California Association of Governments' regional travel model, local planners can also see predictions of PEV daytime travel to employment and retail destinations. For each of the 15 COGs that comprise the SCAG area, the Southern California Plug-in Electric Vehicle Atlas features the following tools:

1. A table and graph forecasting PEV growth to 2022
2. A map of neighborhood PEV registration density as of 2012
3. A map of PEV morning travel to work, providing spatial daytime PEV density
4. A map of employment centers identified by numbers of employees
5. A map overlaying employment centers on daytime PEV density
6. A map of publicly-accessible charging locations, identified by power level and number of stations per location
7. A map of multi-unit residences by number of units and density
8. A map of retail destinations, from older strip development to regional centers
9. A map overlaying retail centers on PEV mid-day travel, providing spatial retail PEV density
10. A map of stand-alone parking facilities

The Atlas provides this suite of spatial tools for PEV readiness planning for the following COGs:

| | |
|---|--|
| Arroyo Verdugo Subregion | San Bernardino Associated Governments |
| City of Los Angeles | San Fernando Valley Council of Governments |
| Coachella Valley Association of Governments | San Gabriel Valley Council of Governments |
| Gateway Cities Council of Governments | South Bay Cities Council of Governments |
| Imperial County Transportation Commission | Ventura County Council of Governments |
| Las Virgenes Malibu Council of Governments | Western Riverside Council of Governments |
| North Los Angeles County | Westside Cities Council of Governments |
| Orange County Council of Governments | |

1.3 Utility PEV growth projections

The Southern California Plug-in Electric Vehicle Atlas also provides projections of annual PEV growth over 10 years by utility service territory for the following utilities¹:

| | |
|-------------------------------------|--|
| Azusa Light and Power | Imperial Irrigation District |
| Burbank Water and Power | Los Angeles Department of Water and Power |
| Cerritos Electric Utility | Riverside Public Utilities |
| Glendale Water and Power | Southern California Edison |
| Pasadena Water and Power | Anza Electric Cooperative |
| Vernon Light and Power | City of Industry Electric Utility Service |
| Anaheim Public Utilities Department | Moreno Valley Electric Utility |
| City of Banning Electric Utility | Rancho Cucamonga Municipal Utility |
| City of Colton Utilities Services | San Diego Gas & Electric (portion within SCAG) |

These projections are designed to help regional planners and utilities locate current and future demand for PEV charging and coordinate efforts to meet that demand.

¹ Utilities not represented by the Southern California Public Power Authority and that have less than 2 PEVs attributable to their service territories have been excluded from this analysis. They are Bear Valley Electrical Service, Corona Water and Power, Needles Public Utility Authority, and Victorville Municipal Utility Services.

2 The PEV Ecosystem

2.1 Introduction

Cities, counties, and regions have a stake in the successful deployment of plug-in electric vehicles (PEVs). As highlighted in the previous chapter, PEVs can help lower greenhouse gas emissions, improve air quality, increase electric grid efficiency, and reduce fuel costs. The extent of PEV deployment, however, will depend in part on how effectively PEV infrastructure is planned.

This chapter serves to help planners understand the landscape of PEV planning by exploring the “ecosystem” of PEV stakeholders whose actions shape the technology’s viability and success. These stakeholders include consumers, manufacturers, installers, utilities, property owners, network service providers, employers, retailers, and different levels of government. The chapter will discuss the roles and choices of these stakeholders, organized by the stage of PEV experience in which they are involved.

2.2 Shopping for a PEV

For many drivers, their first exposure to PEVs will be at the consumer level, when shopping for a new vehicle and a PEV becomes a viable alternative. **Consumers** will consider a number of factors, including vehicle attributes like price, overall range, charge time, and whether to go for a full battery electric vehicle (BEV) or a plug-in hybrid (PHEV). But the decisions they ultimately make will also reflect available infrastructure, land use, and public policy.

For example, commute distance and the availability of workplace charging will help to determine the electric range needed by a consumer. The availability of residential, workplace and public charging stations may help to negate “range anxiety” when considering a BEV, or “gas anxiety” when considering a PHEV, and tip a decision in favor of one vehicle or the other.² The price of electricity relative to that of gasoline and the availability of incentives will

² Range anxiety is the fear that a BEV has insufficient range to reach its destination. Gas anxiety is the fear that a PHEV will have to run on gasoline once the electric range has been depleted.

help consumers assess the private costs and benefits of a PEV relative to a traditional vehicle. Housing type will often determine access to reliable charging at home. Many of these non-vehicle attributes that consumers consider are shaped by planners and policymakers in cities, counties, and regions. Consequently, their role in facilitating and planning for infrastructure has a significant effect on the amount of electric miles driven and greenhouse gas emissions reduced.

Much like with consumers, **manufacturers of PEVs** also respond to the changing policy and planning landscape. Automakers plan, design, engineer, manufacture, and market PEVs based on anticipated consumer demand given expected levels of infrastructure, incentives, and fuel prices, as well as regulation and the availability of technology. For example, in response to the high cost of batteries and the scarcity of public charging infrastructure, both of which limited the success of first-generation BEVs, manufacturers introduced the plug-in hybrid, which offers a smaller battery for electric driving and a gasoline engine to address range anxiety. PHEVs now represent two-thirds of PEVs sold in the U.S. since December 2010, when the Chevrolet Volt and Nissan LEAF were introduced. Manufacturers realize the importance of coordinating with planners, policymakers, utilities, and charge providers so that policy and infrastructure support the current and future supply of these vehicles.

2.3 Refueling at single-family homes

Because electricity is readily accessible from the grid and because it is more cost-effective to charge over a period of hours rather than minutes, most PEV drivers who live in single-family homes find it ideal to charge slowly overnight and incorporate the process into their daily routine. In contrast to the short and irregular pit stops needed to refuel a conventional vehicle, this home-based framework takes advantage of the fact that most cars spend a lot of idle time parked.

If a convenient outlet is available, most PEVs (and in particular PHEVs) can be charged overnight with no special equipment by using the portable cordset included with the car. However, some PEV owners may need or want to incorporate dedicated electric vehicle supply equipment (EVSE) that allows for quicker charging. There are presently a number of **EVSE manufacturers** that fill this need, including those with automaker contracts to supply and install EVSE for a fee (e.g., AeroVironment, SPX, and Leviton for Nissan, GM, and Toyota/Ford, respectively), as well as those who have received U.S. Department of Energy grants to supply and install home EVSE at no cost to select consumers: ECOtality (EV Project) and Coulomb Technologies (ChargePoint America program). EVSE manufacturers also sell home charging equipment online and at big box retailers, from which consumers can purchase the equipment for installation through their own electrician. Licensed **charge station installers**, who typically interact with planners on behalf of consumers, should be aware of relevant local building codes, permitting processes, and installation best practices relating to EVSE.

Utilities are clearly a key stakeholder in the deployment of PEVs, as they will be directly affected

by the changes in electrical load as a result of PEV charging. Although nighttime off-peak charging will help to increase grid efficiency and revenue for utilities, daytime on-peak charging can be highly demanding on the grid, particularly if provided at high power to shorten charging times. With single-family refueling, on-peak charging is less of an issue because most consumers charge overnight. This is because some utilities incentivize efficient charging behavior by offering time-of-use rates that make off-peak charging cheaper and on-peak charging more expensive. These strategies will help utilities anticipate, plan, and manage electricity loads.

The PEV ecosystem described thus far is illustrated in [Figure 2.1](#).

Figure 2.1: The PEV ecosystem for single-family homes



2.4 Refueling at multi-unit dwellings

For residents living in multi-unit dwelling (MUD) environments, charging can present a unique set of challenges. These range from physical limitations that make EVSE installation difficult to

disagreements as to who should assume responsibility for EVSE costs. Yet a large portion of Southern Californians live in MUDs. As such, **property owners and managers** of MUDs play an important role in facilitating the deployment of PEVs, and thoughtful planning can help them be responsive to PEV charging requests from residents.

The level of involvement for this stakeholder group will vary depending on context. For example, residents with their own EVSE may need special parking and electricity metering arrangements from their utility and property manager. Property owners may also find it prudent to invest in shared charging stations that can help make their buildings more attractive. Property owners and managers will need to work out how such EVSE installations will be funded and determine the policies on which they operate.

Owners and property managers may choose to contract with **network service providers**, also known as **electric vehicle service providers (EVSPs)**, to provide shared charging stations. Charging networks such as Coulomb's ChargePoint Network and ECOtality's Blink Network provide nationwide access to stations with a consistent method of payment and access.

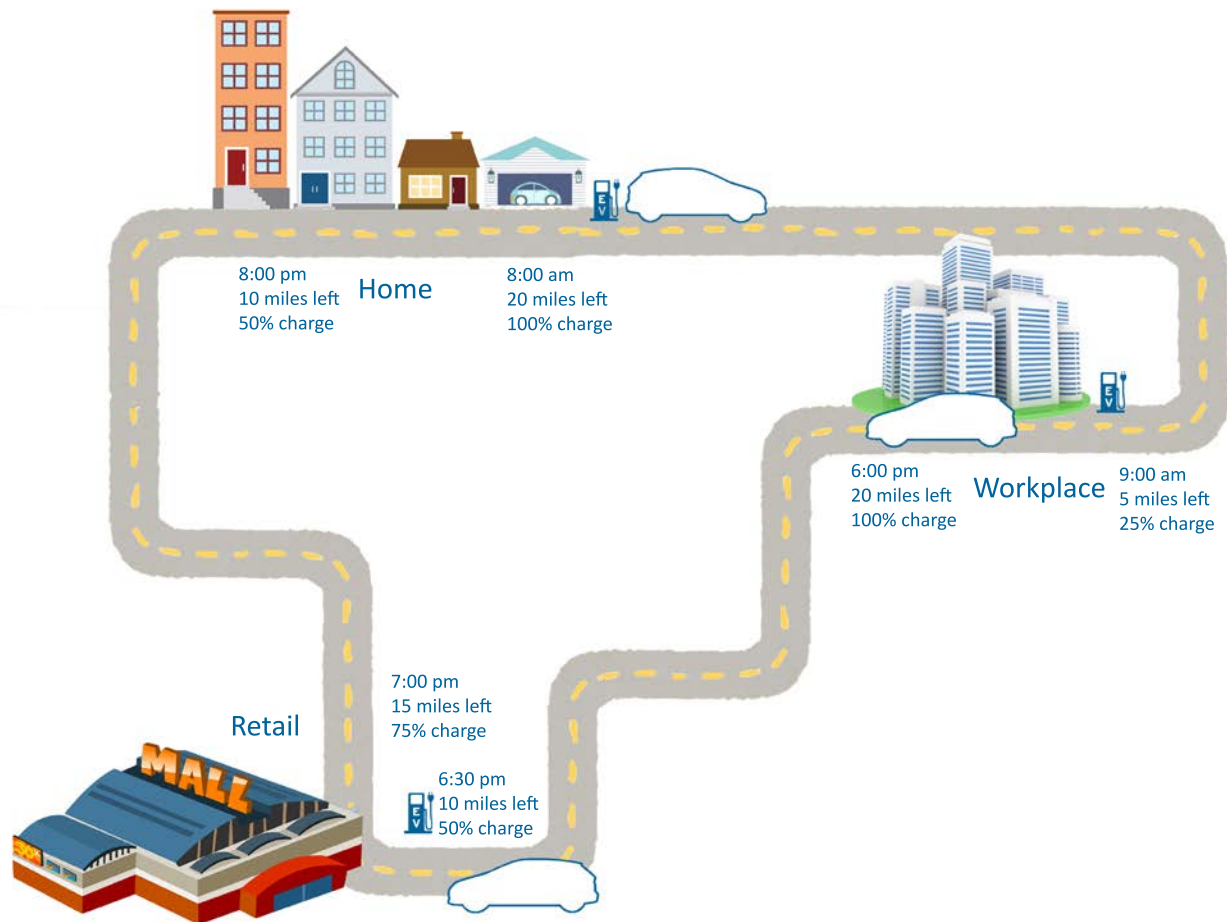
2.5 Refueling at workplaces, retail, and public places

Access to charging at work, while shopping, and in other environments outside the home helps keep PEV batteries topped off, which will minimize range anxiety with BEVs and maximize electric miles driven with PHEVs.

By offering workplace charging, **employers** can help enhance the user experience of PEVs. Workplace charging provides BEV drivers with greater confidence that they will make the return trip home. Likewise, workplace charging would allow a driver of a 20-mile range PHEV and a 40-mile round-trip commute to drive entirely on electricity. Providing a charging station at work may also help with corporate branding, fleet cost savings, and employee retention. **Retailers**, too, may find it prudent to offer PEV charging to shoppers, with the benefits of customer attraction and user fees generated possibly outweighing the costs of hardware, installation, and maintenance.

[Figure 2.2](#) illustrates the role of residential, workplace, and retail charging in the daily commute.

Figure 2.2: The Role of Charging in the Daily Commute



2.6 The role of government

As indicated earlier, plans and policies have a significant effect on the level of PEV deployment, electric miles driven, and greenhouse gas emissions reduced. Changes to different municipal procedures can help to enhance the PEV user experience and increase the likelihood of PEV adoption. Cities, regions, and states themselves can also buy PEVs and build charging infrastructure for use by the public.

Cities and counties can provide guidance for the siting, operations, and maintenance of public chargers. Changes to zoning and building codes, streamlining the permitting and inspection process, and managing access to charging through signage, parking and pricing policies can help facilitate EVSE installation. Local governments can provide incentives such as rebates for PEV and EVSE purchase, parking privileges, and discounted time-of-use rates for charging

(for municipally-owned utilities). Existing incentives and policies for single-family homes can be extended for multi-unit dwellings. Local governments can also target not only drivers, but workplace and retail site hosts.

Regional governments can also be involved by helping to plan PEV infrastructure. Councils of government, air-quality management districts (AQMDs) and metropolitan planning organizations all have a stake in supplying technical assistance to cities that advance subregional PEV readiness. They can also assist in the deployment of quick charging stations that allow for inter-regional PEV travel.

State and federal government can provide incentives that encourage PEV adoption and use. Various subsidies from states and the federal government have helped to reduce the costs of PEV ownership.

The following chart summarizes the types of policies available to California drivers that incentivize PEV purchasing and refueling.

| Expenditure | Policy | Stakeholder |
|---|------------------------------------|---|
| Vehicle purchase | Tax credit | Federal government |
| | Rebate | Local, regional, and state government |
| | Employee cash incentives | Businesses |
| Charging equipment | Rebates and subsidies | Utilities and regional, state, and federal government |
| Electricity costs | Time-of-use rates and discounts | Utilities |
| Installation soft costs (permitting and inspection) | Permit and inspection streamlining | Local government |
| Installation hard costs (retrofitting) | Building code changes | Local government |

3 PEVs and Charging Basics

3.1 Introduction

The plug-in electric vehicle (PEV) landscape of today is evolving at a rapid pace. Rising gas prices and heightened concerns over climate change have led to an increase in demand for more efficient, less polluting vehicles, while recent advances in technology have led to the ability to supply PEVs in volume. This convergence of supply and demand has created a growing marketplace for PEVs. Cities, counties, and regions across California are responding to this development by laying the groundwork for PEV charging infrastructure. This chapter serves to explain for planners the basics of PEVs by looking at emerging vehicle trends as well as charging types.

3.2 Emerging PEV trends

The last major attempt to commercialize PEVs was during the 1990s, after California passed zero-tailpipe-emission vehicle (ZEV) regulations to address the high levels of pollution in its metropolitan areas. Manufacturers responded by offering a small fleet of lease-only battery electric vehicles (BEVs), which run entirely on electricity stored in batteries. This generation of BEVs never quite reached large-scale commercial success. The high cost of technology and low anticipated demand gave manufacturers little incentive to produce these vehicles, while high prices, limited driving range, and the low price of gasoline limited their appeal with consumers. Automakers discontinued major commercialization efforts, arguing for hybrid and hydrogen fuel cell electric vehicles instead.

Beginning in 2010, a new generation of PEVs built by major automakers emerged, owing to higher gas prices, environmental concerns, alternative fuel policies, manufacturer initiative, and the aforementioned advances in technology. These second-generation PEVs use lithium-ion batteries as opposed to lead-acid or nickel-metal hydride cells, which weight less, charge more quickly, use energy more efficiently, and are more practical than before. The concurrent development of the plug-in hybrid electric vehicle (PHEV), which uses gasoline in conjunction with grid electricity to overcome many of the limitations of BEVs, further expanded consumers' choices within the PEV marketplace. A range of PEV body types is shown below.

Image 3.1: 2013 Ford Fusion Energi PHEV (© Ford Motor Company)



Image 3.2: 2013 Chevrolet Volt (© General Motors)



Image 3.3: Mitsubishi Concept PX MiEV-II (© Mitsubishi Motors North America)



3.2.1 Battery electric vehicles

Manufacturers will continue to release new battery electric vehicle (BEV) models. The California Air Resources Board's ZEV regulations require approximately 7,500 BEV or fuel cell vehicles be brought for sale in California between 2012 and 2014. Tens of thousands of ZEVs per year are required starting in 2015, with the number of ZEVs brought for sale each year reaching the hundreds of thousands in the next decade. In response, many manufacturers have, or will soon, release limited-availability BEVs to meet that requirement. These models are sometimes referred to as "compliance cars." Other manufacturers who have invested substantially in BEVs have indicated a commitment to high-volume production of BEVs. Cumulative sales of the Nissan LEAF, for example, exceed 18,000 vehicles in the U.S., a large share of which can be found in California.

3.2.2 Plug-in hybrid electric vehicles

PHEVs allow drivers to incorporate miles of electric driving without the "range anxiety" of BEVs, the fear that a vehicle will have insufficient charge to reach its destination. PHEVs feature a battery that is recharged by plugging in to a wall outlet or charging unit. As the battery becomes depleted, a gasoline engine runs to extend the driving range of the vehicle. Depending on how often drivers charge their vehicles, PHEVs allow consumers to drive primarily on electricity while having a gasoline engine available whenever needed.

Owing to the lack of range anxiety, PHEVs have since become very popular, accounting for 70% of PEVs registered in the SCAG region from December 2010 to September 2012 according to R.L. Polk data obtained by the Luskin Center. Judging by the list of current and future cars in [Table 3.1](#), PHEVs are expected to make up the majority of PEVs sold in the near future, until battery technology becomes significantly cheaper or the network of charging infrastructure is sufficiently built out.

Table 3.1: PEV models: current and planned for U.S. release through 2013

| Model (in order of U.S. market release where available) | Year | Type | EPA electric range (mi.) | EPA MPG equivalent | Current Base MSRP |
|---|------|------|--------------------------|--------------------|-------------------|
| Nissan LEAF | 2010 | BEV | 73 | 99 | \$35,200 |
| Chevrolet Volt | 2010 | PHEV | 38 | 98 | \$39,145 |
| smart fortwo electric drive | 2011 | BEV | 68 | 107 | \$25,750 |
| Fisker Karma | 2011 | PHEV | 33 | 54 | \$102,000 |
| Mitsubishi i (aka IMiEV) | 2011 | BEV | 62 | 112 | \$29,125 |
| Ford Focus Electric | 2012 | BEV | 76 | 105 | \$39,200 |
| Toyota Prius Plug-In | 2012 | PHEV | 11 | 95 | \$32,000 |
| Coda Sedan | 2012 | BEV | 88 | 73 | \$37,250 |
| Tesla Model S (85 kWh) | 2012 | BEV | 265 | 89 | \$77,400 |
| Honda Fit EV | 2012 | BEV | 82 | 118 | \$36,625 |
| Toyota RAV4 EV | 2012 | BEV | 103 | 78 | \$49,800 |
| Ford C-MAX Energi | 2012 | PHEV | 21 | 100 | \$33,745 |
| Honda Accord Plug-In | 2013 | PHEV | 13 | 115 | \$39,780 |
| Ford Fusion Energi | 2013 | PHEV | | | \$39,495 |
| FIAT 500e | 2013 | BEV | | | |
| Chevrolet Spark EV | 2013 | BEV | | | |
| BMW i3 | 2013 | BEV | | | |
| Cadillac ELR | 2013 | PHEV | | | |
| Mitsubishi Outlander PHEV | 2013 | PHEV | | | |
| Porsche 918 Spyder | 2013 | PHEV | | | |

Source: Manufacturer websites and press releases

3.3 Charge levels

Currently, there are three major levels of PEV charging: Level 1 (120 volts), which utilizes standard 3-prong household outlets; Level 2 (240 volts), which typically requires additional charging equipment; and DC fast charging (up to 500 volts, direct-current), which requires a specialized high-voltage commercial quick charger.³ Some residential circuits (including special outlets for dryers) supply power at 240 volts and many commercial buildings use 208-volt rather

³ The U.S. standard household nominal voltage is 120V and 240V. However, voltage sags can bring Level 1 voltage down to 110V, which is typically the lowest acceptable limit, at the outlet level.

than 240-volt circuits.

The power being transferred at these various levels depends on how much current (Amperes [A]) flows in the circuit (power equals voltage times amperage). Thus, charging can demand differing levels of power even within a given charging level category, limited by how much current the circuit and charging equipment (on- and off-board the vehicle) supply. PEVs typically come with either 3.3- or 6.6-kilowatt (kW) chargers onboard the vehicle.

3.3.1 Level 1

Level 1 charging provides the slowest rate of charge and lowest power draw, typically about 1.4 kW (120V at 12A). However, Level 1 charging may be sufficient for: most PHEVs; BEVs with relatively smaller batteries; and even PEVs with larger batteries that are not fully depleted every day. All of these can be fully charged at 120V overnight. Furthermore, Level 1 charging does not require special electric vehicle supply equipment (EVSE) apart from the portable cordset that comes with the vehicle and a standard single-phase household outlet. Thus, the costs to entry for Level 1 charging are considerably lower, and it becomes a potentially cost-effective option for when there is a long “dwell time,” such as at home or at work, where vehicles spend a lot of idle time parked.

3.3.2 Level 2

Level 2 charging typically does require additional electric vehicle supply equipment (EVSE) but charges at a faster rate. Level 2 allows most PEVs currently on the road to take advantage of their 3.3 kW charging capability, and newer models can charge at double that rate at 6.6 kW or even 19.2 kW—the upper limit of Level 2 (240V at 80A). Typical amperages for Level 2 current are 15-30A.

[Table 3.2](#) illustrates the number of electric miles of range that can be recharged per hour at different charging levels.

Table 3.2: Variations in charge times and electric miles per hour of charge by charging level and PEV type

| Charging Level | Power Supply | Charger Power | Miles of Range for 1 Hour of Charge | Charging Times From Empty to Full* | |
|-------------------------------|---|--|--|---|-------------------------------------|
| | | | | BEV | PHEV |
| Level 1 | 120VAC Single Phase | 1.4 kW @ 12 amp (on-board charger) | ~ 3 - 4 miles | ~ 17 Hours | ~ 7 Hours |
| Level 2 | 240VAC Single Phase up to 19.2 kW (up to 80 amps) | 3.3 kW (on-board) | ~ 8 - 10 miles | ~ 7 Hours | ~ 3 Hours |
| | | 6.6+ kW (on-board) | ~ 17 - 20 miles | ~ 3.5 Hours | ~ 1.4 Hours |
| DC Fast Charge Level 2 | 200 - 500 VDC up to 100 kW (approximately 200 amp) | 45 kW (off-board) | ~ 50 - 60 miles (~ 80% per 0.5 hr charge) | ~ 20 - 30 Minutes (to ~ 80%) | ~ 10 Minutes (to ~80%) |

Source: Adapted from California PEV Collaborative (CG#-3).

3.3.3 DC fast charging

DC fast charging uses an external high-voltage charger to supply direct current (DC) to PEV batteries. Typically, DC fast charging can charge common BEVs (with less than 100 miles of range) to 80% full in 20 or 30 minutes. Most PEVs on the road that are capable of DC fast charging use the CHAdeMO connector, developed in Japan. However, SAE International has released, and most American and European automakers have chosen to adopt, a new hybrid connector for fast charging that adds high-voltage DC power to the standard J1772 connector used for Level 1 and Level 2 charging. Tesla has introduced its own proprietary connector for their private network of DC fast charging stations.

3.3.4 Multi-armed chargers

In addition to aforementioned single-armed chargers that charge one vehicle at a time, multi-armed chargers are becoming increasingly available. These chargers can have between two and six cords which enable all of the connected vehicles to charge at once. The arms on these chargers can offer either Level 1 or 2 charging. Some versions of these chargers are “smart” in that they can be programmed to operate in response to the different charging needs of vehicles and constraints on the power that is available to the charge station. The potential advantage of multi-armed chargers is that, when fully utilized by several vehicles, they more cheaply deliver power to PEVs than could an equivalent number of single armed chargers. The economies of scale in charging that they offer could provide very cost effective charging opportunities in both MUDs and workplaces once there are multiple PEVs at these locations.

3.4 Charging environments

PEVs can be charged at different times of day at home, work, and other locations. However, each of these charging environments has advantages and disadvantages. Overnight residential charging is the most cost-effective charging scenario, as it takes advantage of the long periods of time that the PEVs are parked. Many utilities offer discounts for charging overnight and in the early morning, as it is less demanding on the grid and helps the utility sell the excess electricity that can be produced during overnight hours. On-peak afternoon and evening charging, on the other hand, can be highly demanding on the grid and relatively expensive, though drivers may still find it worthwhile to charge at these times of day to increase their range or electric miles driven. Early data indicate that PHEVs tend to be charged more frequently than BEVs, despite the option to run on gasoline. This may be both because their batteries tend to be smaller and thus depleted more quickly, but also because of what is sometimes referred to as “gasoline anxiety,” the desire to avoid or minimize the use of the gasoline engine (with associated lower vehicle fuel economy, higher fuel costs, and environmental impact).

[Table 3.3](#) summarizes the typical “dwell times” (length of time a vehicle is parked) and charging characteristics for each of type of charging site type. Most PEV charging takes currently takes place at home, while workplace and retail charging provide the opportunity to “top off” the battery throughout the day.

Table 3.3. Typical dwell times for charging environments

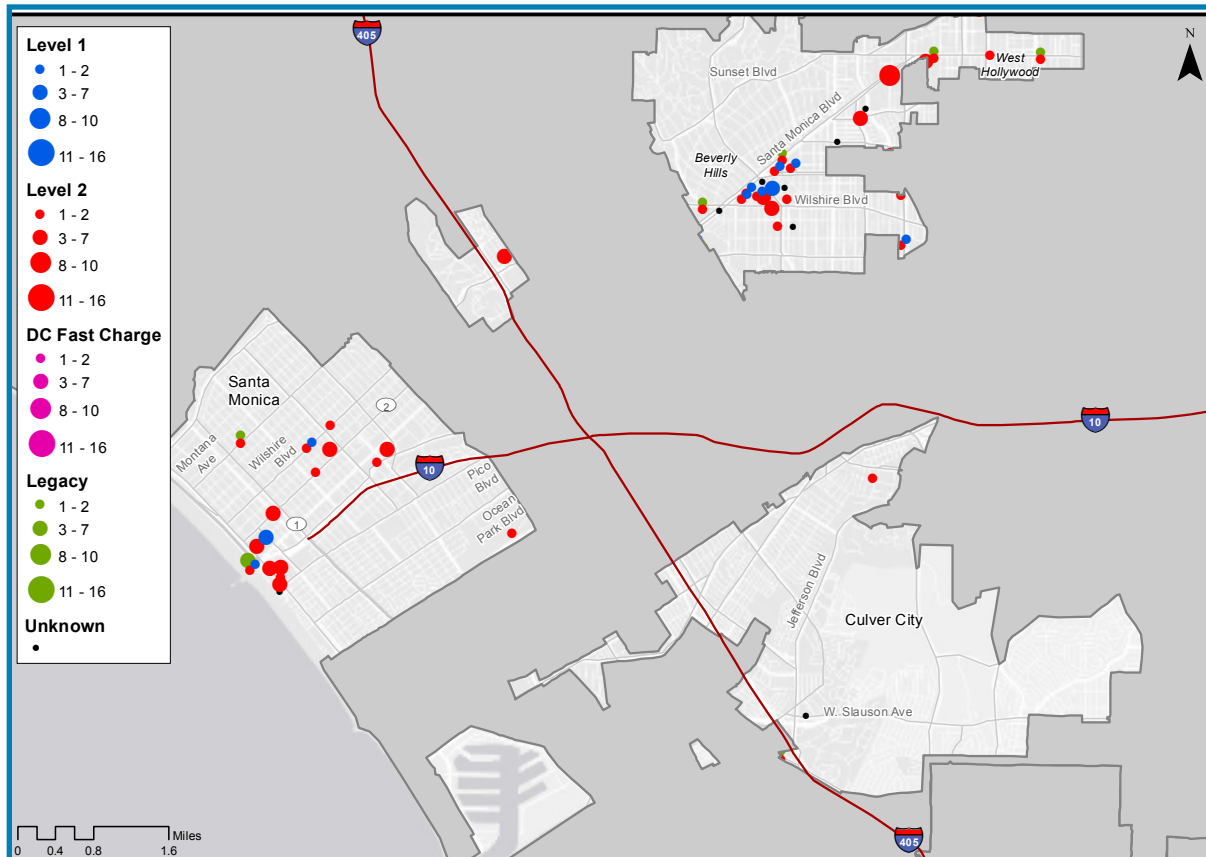
| Site Type | Typical Dwell Times (hours)* | Charging Hours | Average Electricity Cost |
|-------------|------------------------------|------------------------|--------------------------|
| Residential | 14 | 10 pm - 6 am (optimal) | Low |
| Workplace | 8-9 | 9 am - 2 pm (optimal) | Medium |
| Retail | 1-3 | 11 am - 8 pm | High |

**UCLA Luskin Center estimates*

3.5 Finding charge stations

Planners can assess the local supply of existing publicly-accessible charging stations using the maps provided in the Southern California PEV Atlas that accompanies this document. They can compare the location of existing publicly-accessible charge stations with the locations of employment centers, retail centers and PEV daytime destinations. An example map is shown on the next page [[Map 3.1](#)].

Map 3.1: Publicly-accessible PEV charging stations, Westside Cities Council of Governments



PEV drivers have many sources of information for finding out where to charge their vehicles. Planners can use these sites to stay up-to-date on new charging stations in their local jurisdictions:

- The U.S. Department of Energy’s Alternative Fuels Data Center lists PEV charging locations by geography, ownership type, charge levels and payment systems. http://www.afdc.energy.gov/fuels/electricity_locations.html
- Network providers such as ChargePoint https://na.chargepoint.com/index.php/charge_point and Blink <http://www.blinknetwork.com/blinkMap.html> display their charge stations with information on pricing and real-time availability. Members can reserve a charging station in advance of their arrival at the location.
- Recargo www.recargo.com and PlugShare www.plugshare.com are user-generated sites to which drivers can add new charge location listings, offer their private chargers for public use, and alert other drivers about whether equipment at publicly-accessible locations is non-operational.

3.6 References

California Plug-in Electric Vehicle Collaborative. 2012. PEV Charging: Where and When? Communication Guide 3. http://www.pevcollaborative.org/sites/all/themes/pev/files/Comm_guide3_122308.pdf.

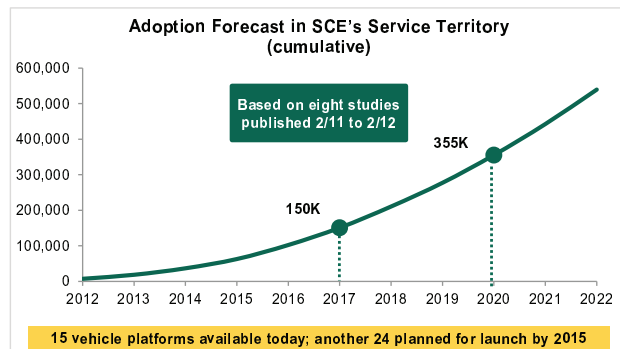
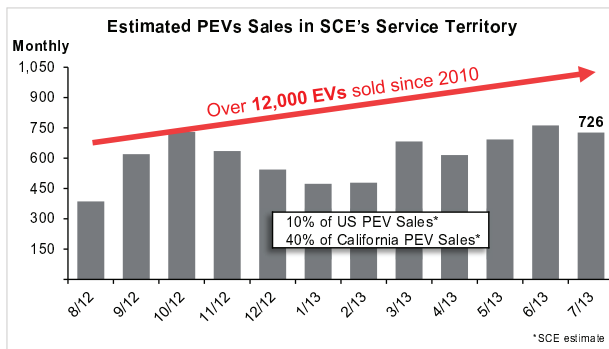
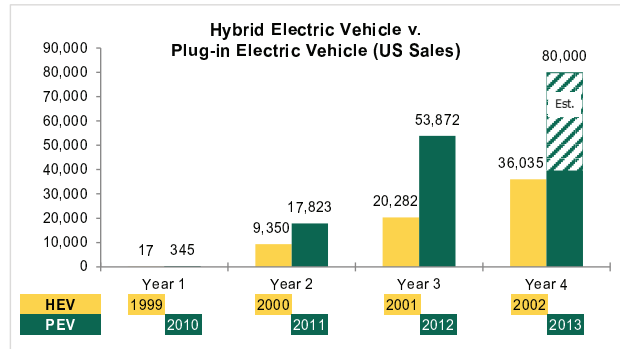
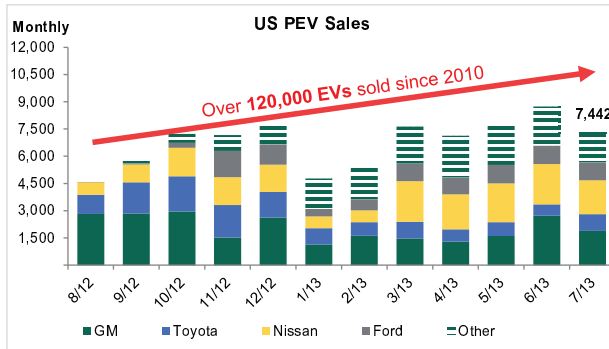
Electric Vehicles and the Utility

Transportation Electrification
 Southern California Association of Governments (SCAG)
 Energy and Environment Committee Briefing

September 12, 2013



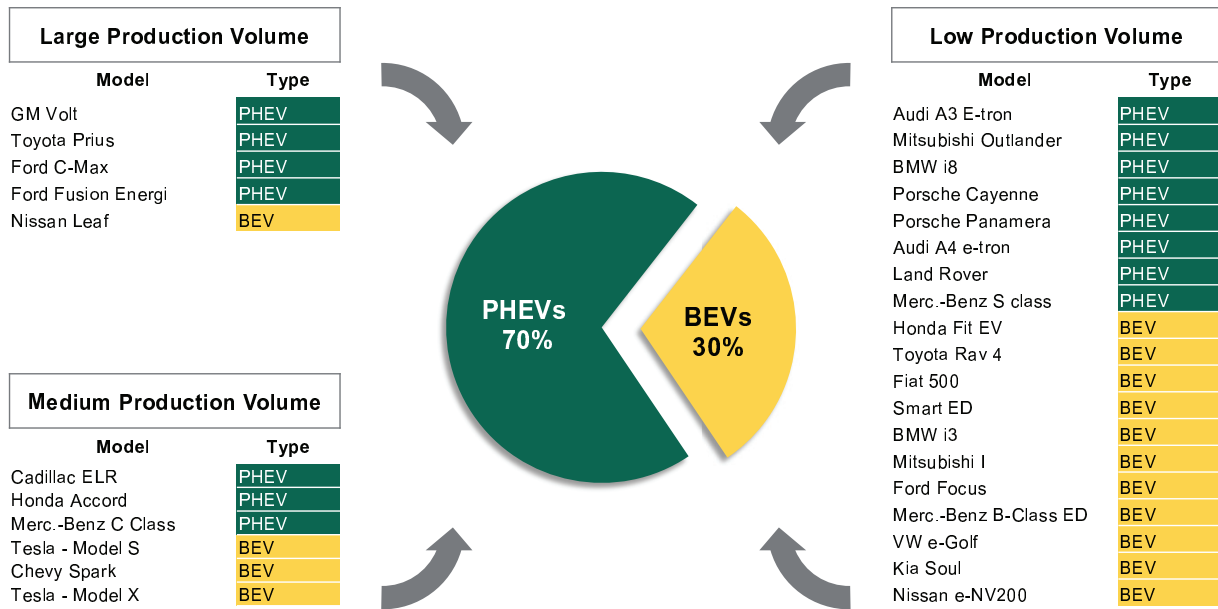
EV adoption is on the rise, in particular in SCE's service territory



Eight PEVs have a lease price of \$139 - \$285 per month for 36 months (Honda Fit EV, Nissan Leaf, Fiat 500e, Chevy Spark, Ford Focus, Smart ED, Chevy Volt, and Mitsubishi i)



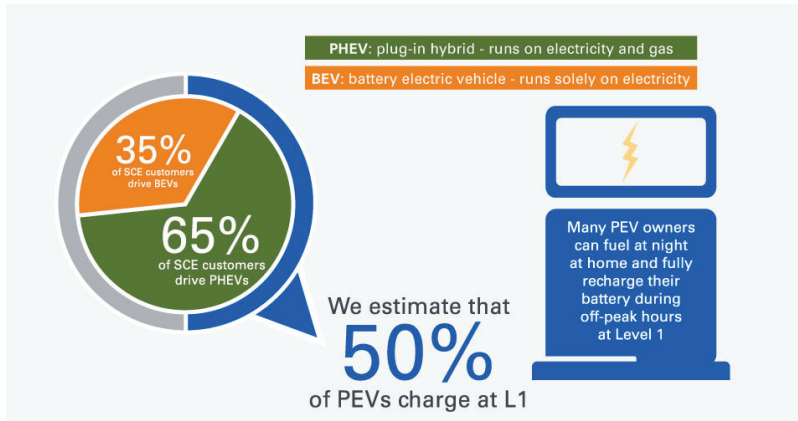
Anticipated Production Volume by 2015



Charged Up: Southern California Edison's Key Learnings about Electric Vehicles, Customers and Grid Reliability

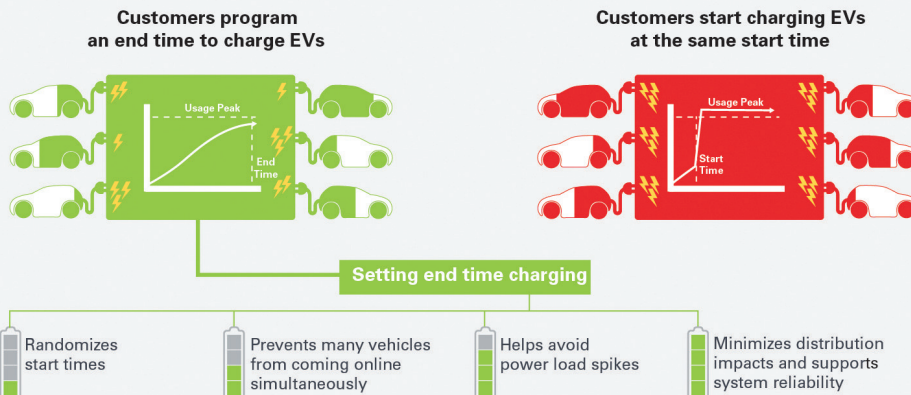
- Our approach to managing plug-in electric vehicle (PEV) impact is meeting our customers' needs
- Using the "end charge time" programming feature is good for our EV customers and their neighbors
- What our customers want to know most about EVs
- Initial findings show early adopters of battery electric vehicle (BEV) technology demonstrate consistent and predictable behavior
- Multi-unit residents may face complex challenges
- SCE and the cities we serve are charged up and ready to go

SCE's Approach to Managing PEV Grid Impacts is Meeting our Customers' Needs

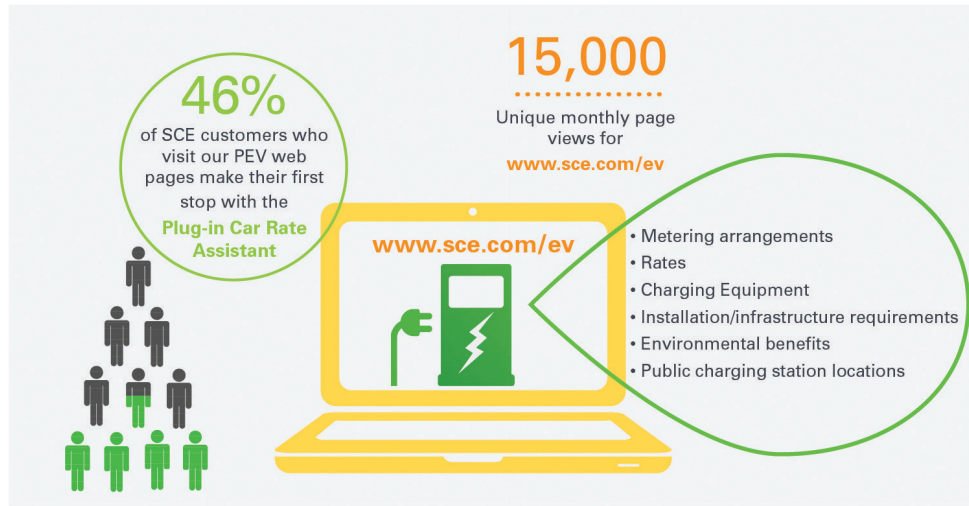


Using the "End Charge Time" Programming Feature is Good for Our EV Customers and Their Neighbors

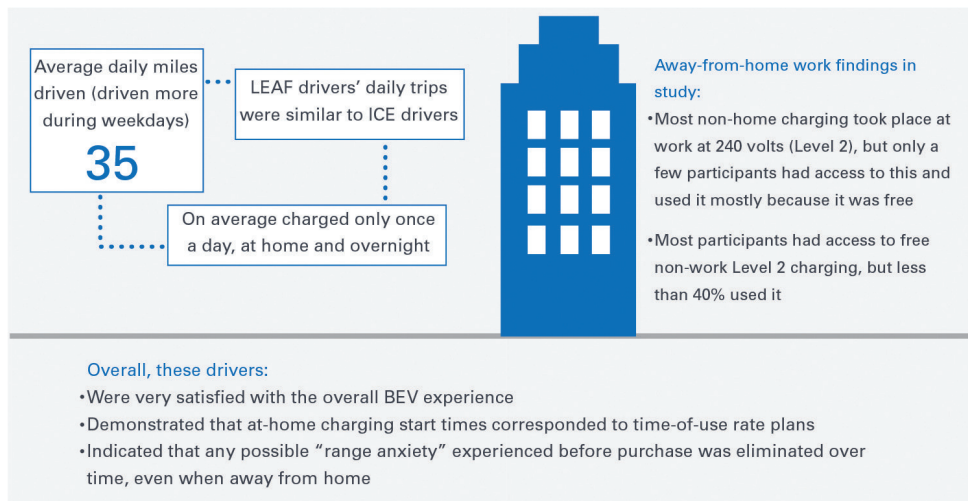
Programming home PEV end charging times, vs. start charging times, is better for grid reliability and neighborhood circuits. Why?



What Our Customers Want to Know Most About EVs



Early Adopters of BEV Technology Seem to Demonstrate Consistent and Predictable Behavior



Multi-Unit Residents May Face Complex Challenges

< 5%
Building owners/condo associations considering installing the necessary infrastructure

High interest among condo/townhome residents in purchasing a PEV within **5 years**

Obstacles included:

- Widely varying PEV installation costs
- Dedicated charging stations in assigned parking spaces vs. community stations for all residents
- Decisions on who carries costs of charging equipment, installation and ongoing maintenance
- Inaccessibility to electricity in parking spaces
- Costs and payments for charging when it's not connected to an individual customer meter



Cities Charged up and Ready to go

180 Cities

Helping residents plug in and meeting green objectives by:

- ★ Streamlining permitting processes and infrastructure
- ★ Supporting SCE's work to provide a positive experience for PEV drivers

50 Cities and Counties with a Verified Plan

Implementing best PEV practices:

- ★ SINGLE-DAY city permits and inspections for homes
- ★ Inspections for businesses within 24 HOURS

7 "Champion Cities"

- ★ Beverly Hills
- ★ Lancaster
- ★ Rancho Cucamonga
- ★ Rolling Hills Estates
- ★ Santa Barbara
- ★ Santa Monica
- ★ Seal Beach





SOUTHERN CALIFORNIA
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UCLA Luskin School *of* Public Affairs

Luskin Center for Innovation

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