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South Bay Cities Plug-in Electric Vehicle Deployment Plan

Prepared for the Southern California Association of Governments

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About this Document

This document was prepared for the Southern California Association of Governments (SCAG) by J.R. DeShazo, Ayala Ben-Yehuda, Norman Wong and Alex Turek of the UCLA Luskin Center for Innovation. It constitutes the final plug-in electric vehicle deployment plan for the South Bay Cities subregion as Deliverable 26 of SCAG contract 12-021-C1 to support subregional 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 subregional 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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Table of Contents

South Bay Cities Subregion Plug-in Electric Vehicle Deployment Plan

I. Introduction

The South Bay Cities subregion is a leader in the adoption of plug-in electric vehicles (PEVs) in Southern California. At the end of 2012, the subregion was home to over 1,000 PEVs, a number that is expected to grow to over 87,000 by 2022.[1]

The South Bay Cities Council of Governments (SBCOG) has engaged in planning studies and demonstration projects with PEVs and neighborhood electric vehicles (NEVs). This document supports those efforts with a detailed spatial analysis of the potential supply of, and current demand for, PEV charging opportunities in the South Bay.

The South Bay Cities PEV deployment plan is a subregional complement to the Southern California Regional PEV Readiness Plan and Atlas (DeShazo et al. 2012). These regional planning documents introduce examples of spatial analysis of PEV charging supply and demand. They present guidelines for prioritizing PEV planning efforts according to local land use opportunities as well as maps of PEV registrations and travel patterns at the subregional level.

The South Bay Cities PEV deployment plan further localizes these spatial analyses by providing:

- Inventories of land uses at the subregional and municipal level to help prioritize PEV planning efforts at three types of locations: multi-unit dwellings (MUDs), workplaces, and commercial/retail centers;
- An evaluation of the suitability of hundreds of individual parcels to host PEV charging using criteria that represent supply of parking spaces, the relative cost of installing chargers, and parcel-level demand for charging; and
- Maps of PEV registrations and travel patterns to daytime destinations within 15 South Bay cities.

This deployment plan will also serve as a model for PEV planning in other mature suburban areas in Southern California. Subregional planning organizations, also known as councils of government (COGs), have an important role to play in PEV planning. They can provide technical assistance to local governments and even implement PEV plans in the absence of dedicated staff at the local level. They

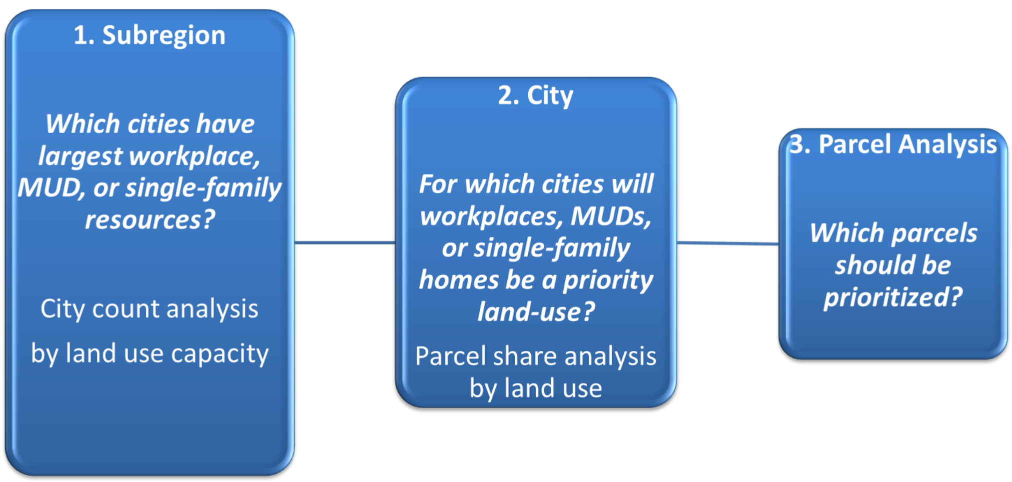
[1] UCLA Luskin Center forecast based on 2012 PEV registrations derived from R.L. Polk & Co. dataset. We define a PEV as any fully electric vehicle (including low-speed neighborhood electric vehicles and electrified trucks) or a plug-in hybrid electric vehicle (PHEV). The PHEV models counted in this analysis are the Chevrolet Volt, Toyota Plug-in Prius, Ford C-Max Energi and Fisker Karma.

can maximize the benefit of PEV planning to local drivers by leading efforts to standardize, share knowledge, and extend PEV planning to groups of neighboring cities. The South Bay Cities PEV deployment plan will demonstrate how COGs can prioritize PEV planning efforts according to dominant land uses and target cities that provide the largest numbers of charging opportunities in those land uses.

Municipal planners can also use the land use inventories and parcel suitability analyses presented here to prioritize PEV planning efforts at the local level. Municipal planners have the ability to target locally-dominant land uses for PEV-ready reforms to building and zoning codes, permitting processes, and parking and signage standards. They can also use the criteria presented here to prioritize specific locations for outreach to employers, property owners and retailers who may wish to provide PEV charging on site. Utilities can also benefit from an understanding of where demand for PEV charging is likely to grow during daytime and nighttime hours so that they can manage electricity loads and prioritize investments in transformer and distribution station upgrades.

Figure 1 describes how planners at different levels of government can use the different levels of analysis provided in this plan.

Figure 1. Levels of PEV planning supported by South Bay Cities PEV Deployment Plan



In addition to informing the placement of charging stations, the land use inventories, parcel suitability analyses and maps presented in this plan support the targeting and prioritization of four major planning activities that can have a significant impact on PEV adoption:

- **Zoning codes.** Land use regulations are the most powerful tool cities have to incentivize certain types of development, including placement of charging stations. Designating PEV charging as a land use will help ensure that different charging levels carry the appropriate type of planning review for the zones in which they are located. Developers can also be encouraged to incorporate PEV charging spaces by allowing the spaces to count towards minimum parking requirements or in exchange for other incentives such as density bonuses.

- **Building codes.** By updating building codes to require PEV-ready wiring in new construction, cities can help meet future demand for charging and reduce or eliminate retrofitting costs.

- **Permits and inspections**. Local jurisdictions are key in reducing the cost, time and uncertainty associated with installing PEV charging equipment. Cities should minimize redundant or unnecessary levels of review wherever possible. A streamlined permitting and inspection process can reduce the overall cost of installation and encourage compliance with safe installation procedures.

- **Parking and signage**. Local jurisdictions have leeway in determining signage on surface streets, providing for a certain number of PEV-ready parking spaces, and ensuring disabled access. Parking and signage policies can assist with cost recovery, accessibility to disabled drivers, facilitating turnover at charging stations, and making stations more visible and easy to locate.

The planning exercises described above can be undertaken as part of a continuum, or "ladder," of PEV deployment plan implementation and stakeholder engagement activities. Planners can begin with more passive efforts that grow into more active projects, as shown in Figure 2 below. Each highlighted implementation effort is followed by a supporting activity or analysis, most of which have been undertaken in this document.

Figure 2. Ladder of PEV planning activities supported by the South Bay Cities PEV Deployment Plan

Informational support

- Website/handouts from Building & Safety, Planning, and/or utility

Prioritize zoning, building, permitting, parking reforms according to dominant land uses

- PEV demand assessment (using maps)*
- Land use inventory*
  - Planning reforms based on absolute numbers of single-family units, MUDs, and employees
  - Or tailor to relative concentrations of PEV parking/charging opportunities

Targeted outreach/workshops for workplaces, MUDs, single-family

- PEV demand assessment*
- Land use inventory*

Demonstration projects

- Parcel suitability analysis of PEV density, employees/sales, number of units and other attributes*

* Provided in this document.

Step 1: Informational support. This serves stakeholders, such as single-family residents and employers, who are already interested in purchasing PEVs or installing charging equipment. Local jurisdictions can provide information on vehicle types, potential cost savings from PEV driving, electrical service, and the charging equipment installation process through passive means such as a website and/or handouts from utilities and the Building & Safety or Community Development Department.

Step 2: Prioritize planning reforms according to dominant land uses. Planners wishing to proactively plan for PEVs should use the maps and land use inventories presented in this document to prioritize dominant land uses for planning reforms. Planners at the COG level can target cities based on absolute numbers of parking opportunities at single-family homes, multi-unit dwellings, and workplaces, or target technical assistance to cities with high shares of parking opportunities at particular land uses. Municipal planners can target land uses that dominate locally for planning reforms as well as neighborhoods that demonstrate high PEV charging demand on the maps provided in the Appendix.

Step 3: Targeted technical assistance, workshops and outreach. Planners may want to approach high-value stakeholders who may be less aware of the technical or procedural aspects of installing charging and using PEVs or who may require more detailed decision support.

Local jurisdictions can host workshops for general or targeted audiences such as drivers, homeowner associations (HOAs), property owners/managers, and renters for residential charging; or for employees, employers, fleet managers, or retailers for non-residential charging.

Many potential hosts may not be interested in installing PEV charging until their employees, tenants or patrons demand it. Actively engaging large employers or property owners in the decision-making process or providing information specific to their needs can facilitate the installation of charging and use of PEVs at their site as the market matures.

Step 4: Demonstration projects. Public agencies and utilities can partner up to install charging equipment via demonstration projects in particularly challenging areas such as multi-unit dwellings.

II. PEV demand in the South Bay Cities Subregion

The South Bay Cities PEV deployment plan is intended to help planners prioritize land uses and locations for PEV readiness policies and charging infrastructure. This involves matching *demand* for PEV charging with the *supply* of available parking spaces. This section presents projected demand for PEV charging in the South Bay Cities subregion as a whole. City-level spatial demand for residential, workplace and retail PEV charging is mapped in the Appendix.

To help planners understand the scale of PEV charging demand in the subregion over the next decade, the Southern California Regional PEV Readiness Plan projected the cumulative number of PEVs that will be registered in the subregion between 2012 and 2022. Table 1 shows the numbers of PEVs registered in the South Bay Cities subregion as of December 2012, followed by growth projections to 2017 and 2022.

The numbers were calculated from disaggregated registration data purchased from R.L. Polk & Co., an automotive data vendor. The 2012 counts reflect vehicles newly registered from December 2010, when the Chevrolet Volt and Nissan LEAF were introduced, through December 2012.

The baseline growth estimate is based on the annual North American growth rate of standard Toyota Prius hybrid sales beginning in 2000. This growth rate is the baseline because standard hybrids, a product type dominated early on by the Toyota Prius, can be considered parallel in many ways to plug-in hybrid electric vehicles (PHEVs). PHEVs, which comprised 69% of the PEVs newly registered in the South Bay Cities subregion as of December 2012 according to data from R.L. Polk & Co., are similar to standard Toyota Prius hybrids, except with a plug-in battery. The ability to recharge from the grid represents the potential for significant fuel cost savings above a standard hybrid.

The baseline growth rate is a conservative estimate because PEVs are available in many more models than were standard hybrids in the first years after introduction. Because many more PEV models will become available in the coming years, we also present alternative scenarios in which this growth rate is exceeded by 5% and 10%.

Table 1. Projected PEVs in the South Bay Cities subregion, 2012-2022

	Cumulative PEV registrations		
Year	Low	Moderate	High
2012	1,020	1,020	1,020
2013	2,040	2,040	2,040
2014*	3,940	4,042	4,080
2015	6,270	6,634	6,901
2016	11,501	12,501	13,349
2017	21,785	24,305	26,621
2018	31,985	36,899	41,747
2019	49,185	58,587	68,371
2020	64,466	79,719	96,451
2021	77,969	100,403	126,299
2022	87,879	118,184	154,981

*The +5 and +10% projections begin in 2014, when uncertainty becomes greater.

Source: R.L. Polk & Co., Luskin Center projections

A closer look at the PEVs in the South Bay Cities reveals that the majority of them are PHEVs, with the 11-electric-mile-range Toyota Plug-in Prius having already outsold the 35/38-electric-mile-range Chevrolet Volt despite the Plug-in Prius having been on the market for only nine months. The trends indicate that slower, low-voltage charging may be a cost-effective solution for homes and workplaces where PHEVs are parked long enough to fully charge using standard outlets instead of dedicated charging units.

Table 2. PEV counts by model and product type in the South Bay Cities subregion, December 2012

Battery-electric vehicles (BEVs)											Plug-in hybrid electric vehicles (PHEVs)					
BMW Active E	Ford Focus Electric	Honda Fit EV	Mitsubishi i-MiEV	Nissan LEAF	smart fortwo	Tesla Model S	Tesla Roadster	Toyota RAV4 EV	NEVs	**Total BEVs**	Chevrolet Volt	Toyota Plug-in Prius	Fisker Karma	Ford C-Max Energi	**Total PHEVs**	**Total PEVs**
17	15	5	3	209	1	40	4	11	14	319	264	426	7	4	701	1,020

Source: R.L. Polk & Co.

Given that PEV consumer studies to date have shown PEV buyers residing almost exclusively in single-family homes, it can be assumed that the current counts largely reflect PEVs charging overnight in this housing type. A potential limiting factor on the actual growth of PEVs is the fact that only about half of the housing stock in the South Bay Cities subregion is comprised of single-family homes (Siembab and Boarnet 2009). Unless steps are taken to facilitate charging in multi-unit dwellings (MUDs), PEV ownership may not grow as expected.

III. Supply of PEV charging spaces: a land use/parking inventory

Plug-in electric vehicles charge while parked. Parking spaces are distributed over local land uses such as single-family residential, multi-unit residential, workplaces, and retail establishments. These parking spaces represent the potential *supply* of PEV parking spaces. Every city will have a different number of parking spaces available at these different land uses. An inventory of parking opportunities at different land uses will help planners target and prioritize PEV readiness efforts, and siting of charging stations, according to locally dominant location types.

Understanding the distribution of land uses within a jurisdiction is also helpful because different land uses are also associated with distinctive parking, electrical, and building configurations which can greatly and systematically affect the cost of installing charging equipment on that parcel. Attributes such as MUD building age and whether it is a condominium or apartment can be used as proxies for estimating potential costs (both financial and institutional) of supply. Parcel attributes that represent potential demand, supply and cost of supply are explained in more detail in Sections 4, 5, and 6. These sections present specific parcels that may be particularly suitable for PEV charging at the subregional level because they combine such attributes. Tables in the Appendix list workplaces, MUDs, and retailers at the city level that may also be well-suited to host PEV charging.

In this section, we present a land use and parking inventory of cities in the South Bay Cities subregion. First, we will present the steps and assumptions used in the preparation of the land use inventory. Then we will present the ways in which subregional and municipal planners can use the information provided in the inventory. Finally, we will present the inventory and offer conclusions about the results.

Steps and assumptions in the land use/parking inventory

First, planners must identify the availability of types of residential, workplace and retail parcels that could host charging infrastructure in their jurisdictions. Second, the number of potential PEV parking spaces at each land use type or parcel must be estimated.

Ideally, planners should estimate the number of parking spaces at each land use type in a jurisdiction based on local zoning and building code history (or, even better, a field survey of parking). However, in the absence of more refined information, we make the following simplified assumptions:

• We assume that the number of on-site parking spaces for both single-family and multi-unit dwellings (MUDs) is equal to the number of residential units on a parcel. That is, we assume the potential for one PEV charging space per dwelling unit. While in reality there may be more than one parking space per dwelling unit, the numbers vary by city. In addition, the likelihood of more than one PEV charging per home is low in the early and middle years of the PEV market.

• We count MUDs in terms of individual units (i.e., apartments or condominiums), not buildings, because each unit represents at least one potential PEV space. For MUDs that do not have parking, workplaces and publicly-accessible sites will become important charging options.

• We also assume that there is a parking space for every employee at a workplace.

• The aggregate land use inventories presented here do not separately consider workplace and retail (customer) spaces, as there is no reliable estimate available for the number of retail customer parking spaces in each city. Specific retail parcels are ranked at the city level in the Appendix based on annual retail sales (in thousands) and estimated number of PEVs traveling to those parcels during mid-day and early evening hours.

The third step involves deciding which types of land use and parking resources should be targeted and in which order. The fourth step, which involves evaluating and targeting specific parcels within a land use category, will be discussed in Sections 4, 5, and 6.

As the South Bay Cities subregion is home to several major employers, workplaces represent the largest parking opportunity, with far more employee spaces than combined single-family and MUD parking spaces. But while workplaces represent the dominant parking opportunity in nearly half the South Bay Cities, no single land use dominates in six other cities. The vast majority of parking opportunities in Rolling Hills, Palos Verdes Estates, and Rancho Palos Verdes are located at single-family homes. In other cities, a substantial percentage of parking opportunities (30% - 40%) are found at MUDs. The following section will describe how planners at the subregional and municipal level can use these findings.

Subregional and municipal PEV planning with the land use inventory

PEV readiness efforts and siting of charging stations should be prioritized according to the land uses that offer the highest *number* (across the subregion) or highest *share* (within a city) of potential PEV parking spaces.

Subregional planners will maximize the effectiveness of their resources by prioritizing PEV-ready reforms to zoning and building codes, permitting and signage standards in jurisdictions with the largest **absolute numbers** of the targeted site hosts and/or drivers. In doing so, the policy reforms that are implemented will affect the largest absolute number of prospective charge station site hosts and/or drivers. In order to know which municipalities to target, South Bay Cities planners will need to know how many parking spaces are located at different land uses across member cities.

Torrance has the highest absolute numbers of parking opportunities in all land uses, with Carson, Inglewood and Gardena appearing more than once in the top five positions depending on the land use. The subregional land use inventory in the next section will show how the cities compare in terms of estimated numbers of parking spaces at different land uses.

Municipal planners may wish to know what **share** of parking within their jurisdictions is tied to each land use in order to prioritize PEV planning around those most frequently-encountered land uses. These planning metrics will enable them to assess the relative importance of different land uses within their local PEV readiness plan. For example, a municipality such as El Segundo will prioritize workplace charging because this is where nearly 90% of all of its parking spaces are by land use. The municipality of Hawthorne will prioritize MUD charging because most of its residential housing is MUD, representing 40% of all parking spaces by land use. While parking space counts can describe the size of each individual land use opportunity, only data on the shares of land uses can assist the municipal planner in identifying the relative importance of specific land uses.

In the next section, we present both counts and shares of parking by land use within municipalities since these metrics will support both subregional as well as local PEV planning activities.

Another metric that may be useful is the spatial density of PEVs at land uses. Knowing where there will be spatially concentrated growth in PEVs will help local planners conduct outreach to site hosts or place public charging stations in high-demand locations where they are more likely to be utilized. Knowing where there will be spatially concentrated growth in electrical loads will help utility planners at Southern California Edison plan for investments to substation areas. As we show in the city-level maps in the Appendix, both workplaces and MUDs tend to be spatially concentrated and they could both experience rapid growth in charging equipment installations.

Parking opportunities in the South Bay Cities

Tables 3 – 8 rank each of the South Bay Cities by the estimated **number** of parking spaces in each city by land use (single-family, employee, and MUD) as well as the **share** of parking spaces within each city that are represented by a particular land use.

Out of a subregional total of over 631,000 parking spaces, employee parking spaces total more than half. As the most significant land use by absolute parking count in the subregion, workplace charging holds substantial promise in the South Bay.

Table 3. Estimated parking spaces by employee *counts*, South Bay Cities subregion

	Employee Count[2]	MUD Count[3]	Single-Family Count
Torrance	**97,325**	22,709	35,771
El Segundo	**61,492**	3,721	3,582
Carson	**49,776**	2,920	22,935
Inglewood	**28,604**	21,117	18,192
Gardena	**24,951**	9,427	12,944
Redondo Beach	**23,471**	14,175	16,091
Hawthorne	**19,411**	19,689	10,345
Manhattan Beach	**17,139**	3,215	12,044
Hermosa Beach	**5,865**	5,080	5,401
Lawndale	**5,783**	3,170	7,419
Rancho Palos Verdes	**4,713**	2,340	13,452
Rolling Hills Estates	**4,268**	156	2,928
Lomita	**3,096**	2,695	5,383
Palos Verdes Estates	**2,028**	356	4,922
Rolling Hills	**237**	0[4]	689

Table 4. Estimated parking spaces by employee *share*, South Bay Cities subregion

	% Employee	% MUD	% Single-Family
El Segundo	**89%**	5%	5%
Carson	**66%**	4%	30%
Torrance	**62%**	15%	23%

[2] Employee counts are based on U.S. Census Longitudinal Employer-Household Dynamics, Area Profile Analysis 2010, All Jobs.
[3] MUD and single-family counts are based on U.S. Census 2011 American Community Survey 5-year estimates for units in structure. Single-family homes include detached and attached (rowhouse-type) single-family units as well as mobile homes.
[4] The ACS 5-year estimates that there is one Rolling Hills housing unit located in a multi-unit dwelling. However, we have assigned a value of 0 to account for what is likely a statistical error, since by definition a multi-unit dwelling contains more than one housing unit.

Rolling Hills Estates	**58%**	2%	40%
Manhattan Beach	**53%**	10%	37%
Gardena	**53%**	20%	27%
Redondo Beach	**44%**	26%	30%
Inglewood	**42%**	31%	27%
Hawthorne	**39%**	40%	21%
Hermosa Beach	**36%**	31%	33%
Lawndale	**35%**	19%	45%
Palos Verdes Estates	**28%**	5%	67%
Lomita	**28%**	24%	48%
Rolling Hills	**26%**	0%	74%
Rancho Palos Verdes	**23%**	11%	66%

Source: U.S. Census Bureau

Table 5. Estimated parking spaces by single-family *counts*, South Bay Cities subregion

	Single-Family Count	MUD Count	Employee Count
Torrance	**35,771**	22,709	97,325
Carson	**22,935**	2,920	49,776
Inglewood	**18,192**	21,117	28,604
Redondo Beach	**16,091**	14,175	23,471
Rancho Palos Verdes	**13,452**	2,340	4,713
Gardena	**12,944**	9,427	24,951
Manhattan Beach	**12,044**	3,215	17,139
Hawthorne	**10,345**	19,689	19,411
Lawndale	**7,419**	3,170	5,783
Hermosa Beach	**5,401**	5,080	5,865
Lomita	**5,383**	2,695	3,096
Palos Verdes Estates	**4,922**	356	2,028
El Segundo	**3,582**	3,721	61,492
Rolling Hills Estates	**2,928**	156	4,268
Rolling Hills	**689**	0	237

Source: U.S. Census Bureau

Table 6. Estimated parking spaces by single-family *shares*, South Bay Cities subregion

	% Single-Family	% MUD	% Employee
Rolling Hills	**74%**	0%	26%
Palos Verdes Estates	**67%**	5%	28%
Rancho Palos Verdes	**66%**	11%	23%
Lomita	**48%**	24%	28%
Lawndale	**45%**	19%	35%

Rolling Hills Estates	**40%**	2%	58%
Manhattan Beach	**37%**	10%	53%
Hermosa Beach	**33%**	31%	36%
Carson	**30%**	4%	66%
Redondo Beach	**30%**	26%	44%
Gardena	**27%**	20%	53%
Inglewood	**27%**	31%	42%
Torrance	**23%**	15%	62%
Hawthorne	**21%**	40%	39%
El Segundo	**5%**	5%	89%

Source: U.S. Census Bureau

Table 7. Estimated parking spaces by MUD *counts*, South Bay Cities subregion

	MUD Count	Employee Count	Single-Family Count
Torrance	**22,709**	97,325	35,771
Inglewood	**21,117**	28,604	18,192
Hawthorne	**19,689**	19,411	10,345
Redondo Beach	**14,175**	23,471	16,091
Gardena	**9,427**	24,951	12,944
Hermosa Beach	**5,080**	5,865	5,401
El Segundo	**3,721**	61,492	3,582
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Carson	**2,920**	49,776	22,935
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Rancho Palos Verdes	**2,340**	4,713	13,452
Palos Verdes Estates	**356**	2,028	4,922
Rolling Hills Estates	**156**	4,268	2,928
Rolling Hills	**0**	237	689

Source: U.S. Census Bureau

Table 8. Estimated parking spaces by MUD *shares*, South Bay Cities subregion

	% MUD	% Employee	% Single-Family
Hawthorne	**40%**	39%	21%
Inglewood	**31%**	42%	27%
Hermosa Beach	**31%**	36%	33%
Redondo Beach	**26%**	44%	30%
Lomita	**24%**	28%	48%
Gardena	**20%**	53%	27%

Lawndale	**19%**	35%	45%
Torrance	**15%**	62%	23%
Rancho Palos Verdes	**11%**	23%	66%
Manhattan Beach	**10%**	53%	37%
El Segundo	**5%**	89%	5%
Palos Verdes Estates	**5%**	28%	67%
Carson	**4%**	66%	30%
Rolling Hills Estates	**2%**	58%	40%
Rolling Hills	**0%**	26%	74%

Source: U.S. Census Bureau

Conclusions

Planners should consult other sections in this document for guidance on which parcels in each city may be particularly well-suited to PEV charging in land uses that are locally important. These include workplaces (Section 4), MUDs (Section 5) and retail (Section 6). These sections will feature rankings of specific parcels at the subregional level by number of employees, number of units, annual sales (in thousands), and PEV density. In addition, the Appendix of this document contains city-level tables and maps that show where PEV densities are concentrated in terms of registrations, as well as at morning and mid-day travel destinations.

The land use inventories, parcel tables and maps were created using different data sources, including Census estimates, county assessor databases, commercial employment databases, and aerial photography. Planners should keep in mind that some level of error exists in every data source, and should view the tools presented in this deployment plan as guidelines that complement each other and that should be validated with local knowledge.

The following recommendations summarize and build upon the guidance provided in this chapter on assessing local land use opportunities.

1. Cities should target their PEV readiness efforts by assessing their land uses and the relative shares of parking supply that are accounted for by single-family homes, MUDs, and workplaces.

2. Regions and COGs should target PEV technical assistance to cities by assessing counts of parking by land use in absolute numbers or by the relative dominance of particular land uses within each city (i.e., target technical assistance on workplace charging to cities that either have the highest employee counts or the highest concentrations of employee parking relative to parking for other purposes).

3. Local, subregional and regional planners should assess their existing supply of charging stations and their dominant land uses to understand where gaps may need to be filled and where obsolete hardware may need to be replaced or removed.

IV. Workplace charging

Workplaces present a significant, and largely untapped, opportunity for PEV charging. After residences, they are the single most important environment for electric refueling. Vehicles are generally parked at workplaces for several hours every weekday, making it possible for them to completely recharge before the commute home. This is especially important for maximizing the electric miles driven by PHEVs, which use gasoline when their batteries are depleted. The ability to charge at work may also encourage PEV adoption by those for whom residential charging is cost-prohibitive or logistically difficult, particularly residents of multi-unit dwellings. Workplace charging thus represents the “missing link” between residential and publicly accessible charging.

This section will help planners assess workplace charging opportunities across and within local jurisdictions. It will describe how planners can use the maps and tables provided in the Appendix that accompanies this document to prioritize parcels for targeted workplace charging assistance.

Assessing the workplace charging opportunity

After conducting the land use inventory (Section 3), planners can further target specific employers based on number of employees at the workplace and PEV density in the employer’s neighborhood during weekday morning rush hour. Additionally, white-collar employees and high-tech workplaces may indicate PEV charging demand by employees.

The subregional table in this section and the city-level tables in the Appendix will help planners and utilities answer the following questions:

- What are the largest employers and where are they located?
- Which employers are located in neighborhoods where current PEV owners drive on weekday mornings?
- Which employers have the highest numbers of white-collar and high-tech workers?

Workplaces with large numbers of employees may be better-positioned than small businesses to recover costs from offering PEV charging due to higher potential usage. Determining which employers are the largest will help planners target outreach efforts and help utilities prioritize locations for transformer and power distribution upgrades.

Tables 9 and 10 rank the top 40 workplaces in high-PEV and medium-PEV areas in the South Bay Cities subregion by number of employees. High PEV density means that there are 13 or more PEVs that are parked during morning rush hour (6:00 a.m. to 9:00 a.m.) in the neighborhood where the workplace is located. Medium PEV density means there are 6-12 PEVs parked in the employer’s neighborhood during that time. Where available, information is provided about whether an employer is in a high-tech or related sector or if at least 50% of its employees are white-collar. These attributes could further indicate potential demand, as high-tech firms have been early adopters of PEV workplace charging and studies indicate PEV ownership is currently correlated with higher incomes and levels of education.

Employer data was obtained from 1) the South Coast Air Quality Management District's April 2013 database of employers subject to Rule 2202, which mandates that workplaces of at least 250 employees take measures to reduce emissions from employee commutes; and 2) commercially available Infogroup data from 2008 on employer size (i.e., number of employees), location, and information on whether the business is in a high-tech sector and whether its employees are mostly white-collar (where available).[5]

PEV density is predicted according to SCAG's 2008 regional travel model[6] as applied to 2012 registration data from R.L. Polk & Co. Using surveys of household travel behavior, SCAG's travel demand model estimates the number of trips from home to work, school, and other destinations by time of day.[7] By counting the number of PEVs from each *origin* TAZ that feed into each of the daytime *destination* TAZs, we were able to predict the locations and densities of PEVs traveling to work on weekdays from 6:00 a.m. to 9:00 a.m. It is important to note that these morning peak destination TAZs receive vehicles from outside the city.

For city-level rankings of employers, their weekday morning PEV densities and other attributes, please see the Appendix.

Table 9. Largest workplaces in neighborhoods of high PEV density during weekday mornings, South Bay Cities subregion

Company	Address	City	Employees	High Tech	White Collar
Boeing Satellite Systems	1950 E Imperial Hwy	El Segundo	4,899	Y	Y
Torrance Memorial Medical Center	3330 Lomita Blvd	Torrance	3,018	N	Y
Aero Space Corp	2350 E El Segundo Blvd	El Segundo	2,820	Y*	Y*
Directv Inc	2230 East Imperial Highway	El Segundo	1,823	Y	Y
Mattel Inc	333 Continental Blvd	El Segundo	1,609	N	Y*
American Honda Motor Co	1919 Torrance Blvd	Torrance	1,602	N	Y
Space Exploration Technologies[8]	1 Rocket Road	Hawthorne	1,186	Y*	Y*
BP-Arco	2350 E 223rd St	Carson	1,075		
Robinson Helicopter Co Inc	2901-31 Airport Dr	Torrance	961	Y	Y
Herbalife International of America	950 190th St	Torrance	939	N	Y
Hi-Shear Corporation	2600 Skypark Dr	Torrance	865	N	N
Rhythm & Hues, Inc	2100 E Grand Ave	El Segundo	704		N
L-3 Communications Electron Tech Inc	3100 W Lomita Blvd	Torrance	621	Y	Y
Moog, Inc	20263 S Western Ave	Torrance	445	Y	Y
Leiner Health Products	901 E 233rd St	Carson	381		
Virco Mfg Corp	2027 Harpers Blvd	Torrance	372	N	N
Teledyne Controls	501 Continental Blvd	El Segundo	371	Y*	N

[5] The UCLA Luskin Center has made an effort to reclassify certain companies along these attributes where appropriate.
[6] http://www.scag.ca.gov/modeling/pdf/MVS08/MVS08_Chap05.pdf
[7] http://www.scag.ca.gov/modeling/index.htm
[8] While the travel model does not predict high PEV density for the neighborhood in which SpaceX is located, it has been included here.

Costco Wholesale	2751 Skypark Dr	Torrance	368	N	N*
Wal-Mart	19503 S Normandie Ave	Torrance	338	N*	N*
R. R. Donnelley & Sons Co	19681 Pacific Gateway Dr	Torrance	337		
Huck Intl Inc. DBA Alcoa Fastening Sys.	900 Watson Center Rd	Carson	331		

*Reclassified by Luskin Center

Sources: South Coast Air Quality Management District, Infogroup, Luskin Center application of data from R.L. Polk & Co. and SCAG regional travel model

Table 10. Largest workplaces in neighborhoods of medium PEV density during weekday mornings, South Bay Cities subregion

Company	Address	City	Employees	High Tech	White Collar
Raytheon Company	2000/2101 E El Segundo Blvd	El Segundo	7,110	Y*	Y
L.A. County Harbor-UCLA Medical Center	1000 W Carson St	Torrance	3,699		
Prov Health Sys/Little Co Mary Medical Ctr	4101 Torrance Blvd	Torrance	1,997		
Honeywell International Inc	2525 W 190th St	Torrance	1,200	Y*	Y*
Alcoa Global Fasteners, Inc	3000 W Lomita Blvd	Torrance	990	N	Y
Torrance City	3031 Torrance Blvd	Torrance	980	N	N
Redondo Beach City	415 Diamond St	Redondo Beach	695	N	N
ExxonMobil Oil Company	3700 W 190th St	Torrance	680	N	Y
International Rectifier Corp	222-348 Kansas St	El Segundo	558	Y	Y*
Pelican Products	23215 Early Ave	Torrance	466	N	N
Southern Section Lifeguard	1200 the Strand	Hermosa Beach	454	N	N
US Post Office	955 Deep Valley Dr	Rolling Hls Ests	300	N	N
El Segundo Parks & Recreation	401 Sheldon St	El Segundo	230	N	N
Bel Air Patrol	21171 S Western Ave	Torrance	201	N	Y
Classic Components Corp	23605 Telo Ave	Torrance	201	N	Y
Durham School Svc	16627 Avalon Blvd # A	Carson	200	N	N
Satco Inc	1601 E El Segundo Blvd	El Segundo	200	N	Y
Avega Health Systems Inc	200 N Sepulveda Blvd # 600	El Segundo	200	Y	Y
Team One Advertising	1960 E Grand Ave # 700	El Segundo	200	N	Y
Southwest Offset Printing	13650 Gramercy Pl	Gardena	200	N	N

*Reclassified by Luskin Center

Sources: South Coast Air Quality Management District, Infogroup, Luskin Center application of data from R.L. Polk & Co. and SCAG regional travel model

Conclusions

The 20 largest employers located in high-daytime PEV neighborhoods are found in only three cities: El Segundo, Torrance, and Carson. This suggests that employers in these cities may be early adopters of workplace charging. While these same three cities also dominate the list of employers located in medium-daytime PEV neighborhoods, the second list also includes Redondo Beach, Hermosa Beach, and Gardena, suggesting areas where employers may adopt workplace charging as the market matures.

The industries represented by the top employers may present challenges and opportunities. Defense contractors are important sources of technology research and development; workplace PEV charging may thus align with the mission, interest and image of the companies and their employees, some of whom may be PEV drivers. However, security protocols may make it difficult for planners to conduct employee outreach or establish on-site demonstration projects. Oil companies' business models would appear to discourage them from offering workplace charging, but they may wish to demonstrate an interest in sustainability. Other employers, particularly in the health, technology and public sector, may wish to accommodate or attract employees and clients that drive PEVs.

V. MUD Charging

Multi-unit dwellings, which include apartments, condominiums, cooperatives, and other planned developments with common parking areas, make up nearly 40% of the residential parking opportunities in the South Bay Cities subregion. As such, they represent a large potential source of PEV adoption in the future. However, due to the significant physical and institutional barriers to MUD charging, encouraging PEV adoption in this housing type will require a focused planning effort to establish PEV-ready wiring by code, by negotiation with developers, or through targeted outreach and demonstration projects.

While the planning metrics discussed in Section 3 can help characterize MUD charging potential at the subregional and city level, they do not show exactly where such opportunities are located spatially. Tables 10 and 11 rank the largest MUDs across the South Bay Cities that are located in neighborhoods of high- and medium-PEV registration density, respectively. The city-level maps and tables in the Appendix show the neighborhoods and parcels with the highest suitability to host PEV charging based on MUD size (number of units), PEV density, and other criteria discussed below.

Planners can use the maps and tables in this Plan to identify specific MUDs or owners that could potentially host on-site charging. Utilities can use this information to anticipate where upgrades may be needed for transformers and distribution stations to accommodate PEV charging at MUDs.

The tables below and in the Appendix are designed to help answer the following questions:

- What are the largest MUD buildings and where are they located?
- Which MUDs are located in neighborhoods where there are registered PEVs?
- What other attributes may affect demand or the cost to supply PEV charging at the MUD?

Larger MUDs are better candidates for hosting more PEV charging, given that they have more parking spaces (including visitor spaces). Landlords and condominium associations may also be better-positioned to achieve economies of scale and recover their costs with more residents using the charging units.

However, number of units is not the only factor that may affect demand for and cost (financial and logistical) to supply PEV charging. While most early PEV adopters reside in single-family homes due to the lower physical and institutional barriers associated with single-family charging, MUDs could represent substantial middle-market PEV demand. The number of PEVs registered in the neighborhood where the MUD is located may indicate unmet demand for PEVs by MUD residents that may be similar to nearby single-family homeowners but for the difficulty in charging at an MUD. PEV density (high or medium) indicates the relative quantity of PEVs (13+ or 6-12) that are registered to residences in the neighborhood where the MUD is located.[9]

Whether the MUD is a condominium[10] could indicate possible institutional barriers to installing PEV charging due to deeded or assigned parking. However, condominiums experience less turnover than rental properties and unit owners may be more likely than landlords to install hardware for their long-term use. Higher unit values could also indicate higher demand for PEV charging.

Knowing the age of a building, in conjunction with other attributes such as size of the electrical panel and parking configuration, can help planners assess the hard and soft costs involved in providing charging at that MUD. Building age may be correlated with panel size and distance between the electrical panel and where vehicles are parked. Building age may also indicate the likelihood of an MUD not having any on-site parking as well as other parking, construction or electrical features that may be typical of MUDs built in a city at a certain point in time. An understanding of MUD building vintages may help planners consider potential permitting and installation streamlining measures that may be needed.

A forthcoming study by California Department of Housing and Community Development will address the relationship between MUD parking configurations and installation cost of PEV-ready wiring. Below are some general guidelines about how to assess the PEV charging suitability of an MUD along certain attributes.

Panel size

Cities generally adopt state or national model codes for building and electrical standards, sometimes with changes that reflect local conditions and preferences. These codes specify minimum requirements for electrical panel sizes in certain types of buildings. Because the first full statewide building code for California was not published until 1989, individual California cities adopted or adapted standards from the National Electrical Code at different times over the years. It is therefore difficult to use year of construction as a definitive indicator of the cost of supplying PEV charging. Even if the year of

[9] Registration data was purchased from R.L. Polk & Co., an automotive data vendor. The counts in the maps and parcel-specific tables reflect vehicles newly registered from December 2010, when the Chevrolet Volt and Nissan LEAF were introduced, through September 2012.

[10] Information on ownership type, year-built and unit value were obtained from the Los Angeles County Assessor's 2007 Secured Basic File Abstract. Average unit values for non-condos were obtained by dividing the assessed value of the property by the number of units. Unit values for condos are the assessed value of one example condo unit on the property and may not be representative of all the units on the property. Year-built information is omitted where not listed in the Assessor file.

construction is known, a site visit or permit search may be required to verify the building's actual electrical panel size, as it may have been upgraded over the years.

A study by PEV consulting firm Clean Fuel Connection sampled single-family homes in Southern California Edison's service territory to describe charging installation cost as a function of factors including building age and existing panel size. The results indicated that homes built in 1970 or later faced lower installation costs (Joffe 2010). In a sample of 192 single-family homes, 20% - 30% of customers with 100 amperes of service needed an upgrade to accommodate a PEV. However, none of those with 200 amperes needed an upgrade.[11] The small sample size and the fact that these results were for single-family homes may limit their applicability to MUDs.

Energy efficiency

Most MUD parking area panels are sized to serve the minimum lighting, HVAC, or other electrical needs of the parking area, without enough extra capacity to provide Level 2 charging. Buildings constructed prior to 1978, when California's first energy efficiency standards for new buildings went into effect, may benefit from energy efficiency upgrades that would free up electrical capacity to provide Level 2 charging.

Parking configuration

Other information about an MUD, such as the type of parking (subterranean, podium, carport, or detached), may also help determine the hard and soft costs of PEV charging at that location. Subterranean and podium parking structures are frequently built with some 120V outlets for general maintenance and service needs, even where not required by code. These outlets could be available for Level 1 charging and may circumvent the need (in the short run) to install a Level 2 charger and the accompanying panel upgrade that may be needed for Level 2. Carports, on the other hand, are not usually built with electrical outlets.[12] Installing a charger in a detached garage is often more expensive than installing one in an attached garage, due to the increased length of conduit needed to connect to the electricity source (Clean Fuel Connection and Co. 2011).

Table 10. Largest MUDs in areas of high PEV registration, South Bay Cities subregion

Address	City	ZIP	Units	Condo	Year Built	Average Value/Unit
415 Herondo St	Hermosa Beach	90254	286	N	1973	$249,187
2442 Pacific Coast Hwy	Torrance	90717	91	N	1963	$46,022

[11] Enid Joffe, personal communication, June 18, 2013.
[12] Interview with Osama Younan, chief of the Green Building and Mechanical Engineering Section, Los Angeles Department of Building and Safety, June 13, 2013.

25940 Rolling Hills Rd	Torrance	90505	77	N	1971	$38,288
3107 Newton St	Torrance	90505	76	N	1969	$33,280
6600 Beachview Dr	Rancho Palos Verdes	90275	57	N	1970	$273,789
6568 Beachview Dr	Rancho Palos Verdes	90275	57	N	1970	$273,789
32636 Nantasket Dr	Rancho Palos Verdes	90275	53	N	1968	$588,906
3400 N Valley Dr	Manhattan Beach	90266	48	N	1991	$94,418
420 2nd St	Hermosa Beach	90254	44	N	1971	$1,497,545
25220 Tandem Way	Torrance	90505	43	N	1963	$333,357
1910 Manhattan Beach Blvd	Redondo Beach	90278	40	N		$106,846
26130 Narbonne Ave	Lomita	90717	39	Y	1975	$350,000
1150 Tennyson St	Manhattan Beach	90266	38	N	1963	$124,604
2205 Farrell Ave	Redondo Beach	90278	36	N	1972	$113,711
3650 Newton St	Torrance	90505	36	N	1963	$41,791
1900 Dufour St	Redondo Beach	90278	33	N	1970	$121,671
25909 Rolling Hills Rd	Torrance	90505	30	N	1970	$120,133
1601 Artesia Blvd	Manhattan Beach	90266	21	N		$21,909
24065 Neece Ave	Torrance	90505	21	N	1968	$33,455
2110 Farrell Ave	Redondo Beach	90278	20	N	1970	$103,240

Sources: R.L. Polk & Co., Los Angeles County Assessor

Table 11. Largest MUDs in neighborhoods of medium PEV registration, South Bay Cities subregion

Address	City	ST	ZIP	Units	Condo	Year Built	Average Value/Unit
6728 Los Verdes Dr	Rancho Palos Verdes	CA	90275	136	N	1970	$116,174
6910 Los Verdes Dr	Rancho Palos Verdes	CA	90275	132	N	1972	$120,103
5520 W 190th St	Torrance	CA	90503	122	N	1971	$87,524
1780 Plaza Del Amo	Torrance	CA	90501	116	N	1963	$66,791
1304 Park View Ave	Manhattan Beach	CA	90266	104	N	1997	$30,569
1300 Park View Ave	Manhattan Beach	CA	90266	104	N	1997	$40,944
6700 Los Verdes Dr	Rancho Palos Verdes	CA	90275	97	N	1969	$146,341
5711 Ravenspur Dr	Rancho Palos Verdes	CA	90275	88	N	1970	$57,360
512 Avenue G	Redondo Beach	CA	90277	78	N	1964	$114,533
28125 Peacock Ridge Dr	Rancho Palos Verdes	CA	90275	76	N	1971	$263,510
5530 W 190th St	Torrance	CA	90503	70	N	1972	$31,198
5762 Ravenspur Dr	Rancho Palos Verdes	CA	90275	69	N	1964	$108,232
4001 W 242nd St	Torrance	CA	90505	60	N	1959	$38,730
1735 Lincoln Ave	Torrance	CA	90501	57	N	1963	$35,694
6507 Ocean Crest Dr	Rancho Palos Verdes	CA	90275	57	N	1973	$237,284
1721 Aviation Blvd	Redondo Beach	CA	90278	54	N	1969	$105,626

28129 Peacock Ridge Dr	Rancho Palos Verdes	CA	90275	54	N	1971	$144,623
28151 Highridge Rd	Rancho Palos Verdes	CA	90275	53	N	1972	$143,605
1821 Pacific Coast Hwy	Hermosa Beach	CA	90254	52	N	1972	$197,175
3929 W 242nd St	Torrance	CA	90505	48	N	1961	$156,060

Sources: R.L. Polk & Co., Los Angeles County Assessor

Conclusions

The top MUDs by unit size in both high- and medium-PEV density neighborhoods are located in five cities: Hermosa Beach, Rancho Palos Verdes, Torrance, Redondo Beach and Manhattan Beach. Given that only 11% of the parking opportunities in Rancho Palos Verdes are at MUDs, the fact that there are several large MUD developments in areas where PEVs are registered could indicate latent demand for MUD charging in Rancho Palos Verdes.

What is also striking is that PEV registrations are concentrated along specific *streets* with large MUDs. Pacific Coast Highway, Rolling Hills Road, Ravenspur Drive, Peacock Ridge Drive, Park View Avenue, Los Verdes Drive, 242nd Street, Farrell Avenue, and Beachview Drive each have more than one large MUD. This may help planners serve outreach and demonstration efforts to clusters of MUDs that show potential demand for PEV charging. It is possible that large MUDs clustered in the same areas have the same owners, which would allow planners to focus planning efforts even further.

VI. Retail charging

Most plug-in electric vehicle (PEV) charging occurs at home, followed by charging at the workplace. However, the proliferation of plug-in hybrid electric vehicles (PHEVs) has increased the demand for more sporadic charging outside of home or work. To maximize their electric miles driven, many PHEV drivers find it valuable to charge when visiting retail destinations.

Whether charging at public-sector and retail sites is cost-effective for PEV drivers and financially viable for charge station operators will depend upon several factors. These include where stations are located, how much demand there is for charging, and how much it costs to use or own the charge station.[13] This section will help planners assess retail charging opportunities across and within jurisdictions. We present a streamlined process for screening potential retail PEV charging sites and then present more specific information that retailers and planners should obtain about parking on the site to determine actual suitability for PEV charging.

Planners can use the subregional maps provided in the Southern California PEV Atlas or the city-level maps provided in the Appendix of this document to identify the retail parcels in their respective jurisdictions. The maps also overlay retail centers of different sizes with densities of PEVs traveling between 9:00 a.m. and 3:00 p.m. Planners and utilities can use these maps to compare the spatial

[13] Guidance on pricing use of retail charging stations is provided in Chapter 8 of the Southern California PEV Readiness Plan http://164.67.121.27/files/Downloads/luskincenter/ev/PEV_Readiness_Plan.pdf.

distribution of retail centers and mid-day travel destinations for PEVs. Those retail locations are classified by store type (from regional mall to small storefront) and parking configuration as described in Table 12. Planners can then conduct a land use inventory to estimate how large a share of parking spaces in their jurisdiction are made up by those retailers.

Table 12. SCAG retail land use classifications (as mapped in the Appendix)

DESCRIPTION	KEY ATTRIBUTE
Regional Shopping Center	Department store with surrounding parking
Retail Centers (Non-Strip With Contiguous Interconnected Off-Street Parking)	Magnet store with in-front parking
Modern Strip Development	Small businesses with parking on-street and on one side
Older Strip Development	Small businesses with on-street parking

Another way to evaluate the potential of a site host to supply PEV charging is by ranking retailers by annual sales volume. Retailers with higher annual sales may be better equipped to absorb the upfront infrastructure investment of providing PEV charging. Higher annual sales may indicate higher aggregate demand for PEV charging, though the amount of time customers spend parked at the site will be of key importance in determining how much PEV charging is used and whether it can be provided at a price that is cost-effective for both the retailer and the driver.

Tables 13 and 14 below and the city-level table provided in the Appendix are designed to help answer the following questions:

- What are the largest retailers by sales and where are they located?
- Which retailers are located in neighborhoods where PEVs are parked during mid-day hours?

Tables 13 and 14 list the top retailers in the South Bay by annual sales (in thousands) as provided in Infogroup's 2008 database.[14] Retailers are defined as businesses classified under the following North American Industrial Classification System descriptions: retail trade; arts, entertainment and recreation; accommodation and food services; and other services (i.e., dry cleaners and beauty salons). PEV density (high or medium) indicates the relative quantity of PEVs that are parked during mid-day hours (9:00 a.m. to 3:00 p.m.) in the neighborhood in which the retailer is located. A high PEV density indicates that at least 13 PEVs are parked in the neighborhood, while medium density indicates the presence of 6-12 PEVs.

[14] Significant retailers not listed in Infogroup's database are also listed separately by city in the Appendix. These include gyms, the Home Depot Center in Carson, etc.

We estimated mid-day PEV density by applying Census tract-level PEV registration data to SCAG's 2008 regional travel model. Census tracts closely follow the boundaries of travel analysis zones (TAZs), which are the geographic areas used by SCAG to model vehicle travel. SCAG's travel demand model estimates the number of trips from home to work, school, and other destinations by time of day. By counting the number of PEVs from each *origin* TAZ that feed into each of the midday *destination* TAZs, we are able to predict the number of PEVs traveling to neighborhoods from 9:00 a.m. to 3:00 p.m.

Table 13. Top retailers in high-PEV neighborhoods at mid-day, South Bay Cities subregion

Company	Address	City	Annual Sales (in thousands)
Fry's Electronics	3600 S Sepulveda Blvd	Manhattan Beach	$90,440
Nordstrom	1835 Hawthorne Blvd	Redondo Beach	$56,700
Pacific Sales Inc	2080 Washington Ave	Torrance	$55,600
Auto Nation Infinity	3035 Pacific Coast Hwy	Torrance	$54,976
Power Acura South Bay	25341 Crenshaw Blvd	Torrance	$51,540
Torrance Toyota	2955 Pacific Coast Hwy	Torrance	$45,000
Macy's	3400 N Sepulveda Blvd	Manhattan Beach	$40,500
Best Buy	3675 Pacific Coast Hwy	Torrance	$39,729
LA Car Guy	2900 Pacific Coast Hwy	Torrance	$34,360
Ted Green Chevrolet	23505 Hawthorne Blvd	Torrance	$32,642
Ralphs	2700 N Sepulveda Blvd	Manhattan Beach	$30,875
Kohl's Department Store	25375 Crenshaw Blvd	Torrance	$29,970
Costco	2451 Skypark	Torrance	$29,970
Ralphs	1413 Hawthorne Blvd	Redondo Beach	$27,170
Martin Chevrolet	23505 Hawthorne Blvd	Torrance	$27,100
Whole Foods Market	405 N Pacific Coast Hwy	Redondo Beach	$25,441
Marriott-Manhattan Beach	1400 Park View Ave	Manhattan Beach	$19,600
REI	1800 Rosecrans Ave # E	Manhattan Beach	$18,500
Mervyns	1799 Hawthorne Blvd	Redondo Beach	$17,010
Barnes & Noble Booksellers	1815 Hawthorne Blvd # 332	Redondo Beach	$10,640

Sources: R.L. Polk & Co., Infogroup

Table 14. Top retailers in medium-PEV neighborhoods at mid-day, South Bay Cities subregion

Company	Address	City	Annual Sales (in thousands)
Target	1200 N Sepulveda Blvd	Manhattan Beach	$69,540
Target	3433 Sepulveda Blvd	Torrance	$64,050
Power Volvo South Bay	3010 Pacific Coast Hwy	Torrance	$55,835
Lexus South Bay	3215 Pacific Coast Hwy	Torrance	$51,540

Bristol Farms	837 Silver Spur Rd	Rolling Hls Ests	$45,695
Mercedes-Benz of South Bay	3233 Pacific Coast Hwy	Torrance	$42,400
Pavilions	7 Peninsula Ctr	Rolling Hls Ests	$37,050
Integrated Data Svc	2141 Rosecrans Ave # 2050	El Segundo	$36,358
Pacific Porsche	2900 Pacific Coast Hwy	Torrance	$34,360
South Bay BMW	18800 Hawthorne Blvd	Torrance	$34,360
Whole Foods Market	2655 Pacific Coast Hwy	Torrance	$30,875
Land Rover South Bay	900 N Pacific Coast Hwy	Redondo Beach	$30,065
Albertsons	1516 S Pacific Coast Hwy	Redondo Beach	$29,640
Dolb's International Svc Inc	444 N Nash St # 237	El Segundo	$26,000
Jaguar of South Bay	3111 Pacific Coast Hwy	Torrance	$25,000
Ralphs	500 N Sepulveda Blvd	El Segundo	$24,700
Ralphs	2909 Rolling Hills Rd	Torrance	$24,700
Albertsons	21035 Hawthorne Blvd	Torrance	$22,230
Awr Corp	1960 E Grand Ave # 430	El Segundo	$20,580
Abercrombie & Fitch	550 Deep Valley Dr # 189	Rolling Hls Ests	$15,810

Sources: R.L. Polk & Co., Infogroup

The retailers listed above tend to fall into three categories: car dealerships, supermarkets, and large retail chains (general purpose and specialty). These retailers may have different customer demographics, vehicle dwell times, and energy costs associated with their typical operation. Planners and retailers should consider these and other factors that will help determine demand and relative cost-effectiveness for each potential PEV charging location after initially screening retailers by annual sales and mid-day PEV density. These additional criteria are described in the next section.

Evaluative criteria for the selection of retail charging sites

Planners will want to consider a variety of criteria when prioritizing a site or group of sites. Many of these criteria relate to a site's potential demand for charging or its relative cost-effectiveness in hosting a station. These factors include:

- Potential demand for PEV charging
- Frequency of visits per week
- Time of day when charging
- How long cars are parked (a.k.a. "dwell time")
- Cost of electricity (and demand charges)
- The value of non-PEV parking spaces to the site host
- Driver's cost of waiting
- "Green" reputation for site host

Sites and areas with high potential demand for charging

One of the most important criteria is that the site be a place where PEVs are or will be parked. Several types of current driver-specific, site-specific, and neighborhood-specific criteria can be used to assess current- and near-term potential **demand** for charging. The most reliable evidence on potential charge station utilization comes from those drivers currently using parking at a site. Indeed, the best site-specific evidence is the actual presence of PEVs parked on or adjacent to the site. Customer surveys (or driver surveys in the case of public-sector sites) of PEV ownership and the intent to purchase a PEV can also be a good predictor. Future demand for PEVs is often associated with the current ownership of hybrids, so a higher-than-average concentration of hybrids in a parking lot may be a good predictor. Planners could also use demographics associated with early-market PEV adopters. These characteristics include customers with higher educational achievement, moderate to higher incomes, willingness to innovate, and often attitudes that are pro-environment or pro-oil independence (CCSE 2012; Nixon and Saphores 2011; Landy 2011). In the South Bay, REI or Whole Foods shoppers may fit these criteria.

The **frequency** and **total level of visitation** to a site can also be an important factor. Planners might also ask where the site supports parking for 1) routine daily travel (work, school, gyms, etc.), 2) routine weekly travel (stadiums, theaters, churches, etc.) or 3) occasional travel (hotels, major vacation destination charging or freeway-adjacent stations). We discuss specific site types in greater detail in the following sections.

Other site-specific characteristics, such as size and location, may be useful but should be used to make a choice between competing sites that have been prioritized based on customer- or driver-specific evidence of potential demand. With all else equal, sites with larger parking capacity (for example, big-box retailers such as Target) are more likely to host PEVs. Similarly, prioritizing sites near high-volume freeways or arterials might incrementally increase site utilization.

Selecting sites that offer the lowest possible cost of charging will benefit not only the site host (by increasing utilization rates) but also PEV drivers (who will pay lower prices for charging). Sites that provide the lowest possible cost per kilowatt-hour (kWh) to PEVs will typically have the following features:

Sites on which PEVs are ***parked for longer periods of time*** (longer “dwell times”) enable slower rates of charging, which may enable the use of less costly Level 1 charging rather than more costly Level 2 or fast charging. The longer the dwell time, the more miles of electric range can be added. At Level 1, an hour of charge can add five to 10 miles of range, depending on the capacity of the vehicle’s onboard charger. At Level 2, an hour of charge adds between 10 to 20 miles of range, depending on the capacity of the vehicle’s onboard charger. Longer PEV dwell times also enable multi-armed smart chargers to deliver lower costs per kWh delivered over a larger numbers of vehicles. Slower charging, enabled by long dwell times, may also help site owners to avoid electricity demand charges.

Planners may also want to balance factors like average trip distance and frequency of travel to a site with the dwell time for each particular site type. While routine destinations may see greater use, shorter trips may benefit less from charging than would longer trips with longer dwell times. Drugstores, for example, would have shorter dwell times than theaters or recreational areas, but may have more patrons on an average day.

Some car dealerships may allow PEV drivers to charge their vehicles even if the driver did not purchase the vehicle that particular dealership, though the service may not be available to drivers of other PEV makes. Unless the driver is bringing a vehicle to the dealer for service, he or she would likely only be using the site for charging, similar to a DC Fast station.

A feature related to the land use or type of site is time of PEV arrival at the site, which determines the t***ime of day when charging would occur***. Charging that occurs before 12:00 p.m. and after 9:00 p.m. will enable most site hosts to provide lower-cost electricity to PEVs because of electricity rates that are lower during these periods. Charging between 12:00 p.m. and 9:00 p.m. is not only the most expensive, but more likely to incur demand charges for the site host.[15] Unfortunately, many types of retail sites are only open between 10:00 a.m. and 9:00 p.m., which is the period when electricity costs are highest and demand charges are most likely. In addition, dwell times are often the lowest for many types of retail destinations, making them the least cost-effective type of land use to host charging. Supermarkets, which already have high energy use during peak daytime hours due to refrigeration, may be inclined to provide PEV charging if it does not significantly increase their electricity cost.

The ***value of regular parking spaces to the site host*** is another factor to consider. For many sites, there is no value lost by replacing a regular parking space with a charging space, because most sites have many unused parking spaces. On sites where there is a shortage of parking, charging stations can also be located in places within parking facilities that are the last to fill up in order to avoid the appearance (to the other employees or customers) of displacement.[16] Sites can also experiment with dual-use and time-of-day split use of spaces for both parking and charging. For example, charging spaces intended for government employees during the day can be made available to the general public at night.

The second type of cost that may vary across public-sector and retail sites is the ***driver's time*** while charging. In most instances, PEV drivers will not choose to charge at a site unless there is no additional time associated with charging. Planners should expect the PEV driver will be busy with whatever motivated his or her visit to that destination. Only in the rare case that a PEV driver is in danger of running out fuel are they likely to be willing to spend time refueling, and then they are likely to choose to refuel quickly with gasoline if they own a PHEV. Chargers should be located at sites where drivers would normally stop for at least 1 to 2 hours or more unless they are refueling along interstate corridors during inter-regional travel.

Two other factors may affect the value proposition of hosting a charge station at retail sites. The first is that, for a few types of retail sites that price charging lower than what drivers would pay at home, charging stations may attract customers that would have otherwise gone to another retail site. Second,

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[15] Demand charges are added to the electricity bills of non-residential customers to reflect the additional cost of delivering power to them during the customer's peak usage times.

[16] Placement of the first charging space may be constrained by disabled access requirements.

some site hosts want to support or be associated with "**green**" values or energy independence. These are likely to be retail establishments that incorporate these values into the corporate brand identities. Again, Whole Foods Market and REI would fit this criteria.

Typical dwell times

Based on the above criteria, we identify several broad categories of sites. We use an analysis of 2009 National Household Transportation Survey data (Krumm 2012) to common travel destinations that tend to require at least moderate travel distance. Based on this analysis, the list below features some examples of retail site types where vehicles tend to be parked for about two hours on average:

Commercial parking facilities

Major retail malls

Sporting events and arenas

Major pedestrian-oriented commercial thoroughfares

Bars and evening entertainment venues

Gyms and sports clubs

Finally, Table 15 describes retail sites that have been documented to have relatively shorter travel distances and shorter dwell times (Krumm 2012).

Table 15. Retail sites with short dwell times

Destination	Average dwell time (minutes)
Gas stations	10
Video rental/cleaners/post office/bank	19
Coffee/ice cream/snacks	20
Grocery, hardware, clothing store	36
Attorney/accountant office	41
Meals/restaurants	46
Day care	65
Grooming, hair, nails	67
Medical/dental services	68

Source: Krumm (2012)

Charging in stand-alone parking facilities

Areas rich in small stores and businesses may represent demand for charging curbside or in stand-alone parking structures. Parking lots and structures greater than 2.5 acres that are not attached to other land uses are mapped at the city level in the Appendix. Operators of stand-alone parking facilities will have different cost recovery goals depending on whether they are government-owned or commercial pay parking lots. Publicly-accessible parking facilities can fill a gap in PEV charging, particularly in older urban cores where retail stores and even some workplaces and multi-unit dwellings do not have dedicated parking.

Conclusions

Due to potentially short dwell times and high charges for electricity during peak daytime hours, it may be a challenge for many retailers to provide PEV charging at a price that is cost-effective for both the host and driver. However, the South Bay features many retailers in areas where high and moderate numbers of PEVs are parked during mid-day hours. Planners and retailers must consider many factors in evaluating retail locations for PEV charging, including current demand, vehicle dwell times, level and frequency of visitation, and electricity costs. Retailers with high sales may be in the best position to supply a higher number of parking spaces and absorb the upfront cost of providing PEV charging.

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