

Alternative and Renewable Fuel and Vehicle Technology Program

FINAL PROJECT REPORT

Assessing the Multi-Unit Dwelling Barrier to Plug-in Electric Vehicle Adoption in the South Bay

Final Report

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007), created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVT Program). The statute, subsequently amended by AB 109 (Núñez) Chapter 313, Statutes of 2008), authorizes the California Energy Commission to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. The Energy Commission has an annual program budget of about \$100 million and provides financial support for projects that:

- Develop and improve alternative and renewable low-carbon fuels.
- Enhance alternative and renewable fuels for existing and developing engine technologies.
- Produce alternative and renewable low-carbon fuels in California.
- Decrease, on a full-fuel-cycle basis, the overall impact and carbon footprint of alternative and renewable fuels and increase sustainability.
- Expand fuel infrastructure, fueling stations, and equipment.
- Improve light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets.
- Expand infrastructure connected with existing fleets, public transit, and transportation corridors.
- Establish workforce training programs, conduct public education and promotion, and create technology centers.

The Energy Commission issued solicitation PON-14-603 to provide funding opportunities under the ARFVT Program for Zero Emission Vehicle (ZEV) Readiness. This first-come, first-served grant solicitation was an offer to fund projects that support new and existing planning efforts for plug-in electric vehicles (PEV's) and fuel cell electric vehicles (FCEV's). To be eligible for funding under PON-14-603, the projects needed to be consistent with the Energy Commission's *ARFVT Investment Plan*, updated annually. In response to PON-14-603, the recipient submitted application 4, which was proposed for funding in the Energy Commission's Notice of Proposed Awards January 16, 2015, and the agreement was executed as ARV-14-035 on March 19, 2015.

ABSTRACT

Governor Jerry Brown established an executive order calling for 1.5 million zero emission vehicles (ZEV) on California's roads by 2025. To achieve this ambitious goal, significant barriers must be overcome to expand and accelerate plug-in electric vehicle (PEV) adoption including the need to build out the necessary refueling infrastructure. To the point, residents of multi-unit dwellings (MUDs) are unlikely to have access to home charging (electric vehicle supply equipment or EVSE) due to the variable and often high cost of installation, as well as the low to non-existent investment motivation of the MUD renter or owner.

The purpose of the following report is to explore the MUD barrier to PEV adoption within the South Bay subregion in Los Angeles County and identify MUDs within the study area that may exhibit high latent PEV demand and low-cost EVSE installation for the purpose of targeted outreach. Researchers analyzed Los Angeles County Office of the Assessor tax parcel data to understand the MUD portfolio of the South Bay, as well as IHS-Polk Automotive new car registration data to identify census tracts in the South Bay that have exhibited high PEV demand to date. Researchers also visited 27 MUD sites within the South Bay and reviewed 19 EVSE installation cost estimates to evaluate how installation costs can vary across MUD sites.

The results confirm that the cost of EVSE installation in MUDs is variable from site to site and often high. Level 1 charging and group investments for EVSE installations may provide MUD residents access to home charging at lower costs. Policy tools such as targeted outreach to promote the PEV, as well as rebates or PEV-ready new construction codes are likely to be required to ease the MUD barrier to PEV adoption.

Keywords: Plug-in electric vehicle, PEV, multi-unit dwelling, MUD, PEV charging, EVSE, South Bay, California Energy Commission, demand, installation costs

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<p>The PEV remains a relatively new technology. Substantial sales of the battery electric vehicle (BEV) started only in 2010, and most believe we are still in the very early stages of PEV adoption. As with many new technologies, consumers have been hesitant to switch out their internal combustion engine (ICE) for a PEV. Some of this hesitation can be rooted in the comfort level drivers have with the ICE - the dominant form of private transportation for over a century whose refuel infrastructure is robust and easily accessible; and some can be the result of the uncertainty and concerns that come with a new technology, as evident with range anxiety – the fear of running out of battery mid-trip.....</p>	
<p>Outreach and education can respond to this hesitation and help introduce potential PEV drivers to the new technology by promoting its environmental and financial benefits as well as answering common questions and concerns. From an EVSE in MUD perspective, the goal with outreach and education is to drive demand for home charging among MUD residents, and shift the investment motivation from the renter to the property owner, who may be motivated to attract tenants by providing new amenities. With strong PEV adoption rates in the South Bay, as well as large number of high-value MUDs (10,013 MUD households over \$500,000 per unit), the subregion may help lead this shift in investment motivation.....</p>	
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EXECUTIVE SUMMARY

In 2012, Governor Jerry Brown signed an executive order creating a goal of 1.5 million zero-emission vehicles (ZEVs) on California's roadways by 2025. To achieve this ambitious goal, a number of adoption barriers must be overcome. In the Governor's 2013 ZEV Action Plan, the first challenge addressed is the need to build out the necessary refueling infrastructure. ZEVs, and specifically PEVs, require an entirely new refuel behavior and set of equipment. In place of a 15-minute detour to a gas station, most PEV owners refuel when they are at home overnight using Level 1 or Level 2 charging (electric vehicle service equipment or "EVSE"). While this is generally a straightforward proposition for single-family homeowners, multi-unit dwelling (MUD) residents as well as owners face a number of obstacles to installing EVSE at home. Foremost is the variable and often high cost of EVSE installation. Additionally, the renter or owner exhibits a low to non-existent investment motivation: renters are unlikely to invest in a piece of immobile equipment that they may move from in the future; and owners do not yet see home PEV charging as an amenity by which to increase property value and attract tenants.

The following report seeks to explore the MUD as a barrier to greater PEV adoption in the context of the South Bay subregion, as well as to prioritize and target outreach and other policy tools for MUDs that exhibit high latent PEV demand and a low cost of EVSE installation. The South Bay's demographics and regional characteristics makes this report applicable across other regions of the State. The report represents Part 2 of 3 of the Agreement Number ARV-14-305; Part 3 of the Agreement, the "Owner's Toolkit" and report of the presentation of findings to MUD owners, are found in the appendix to this report; additionally, the appendix contains a report entitled, "South Bay MUD EVSE Proximity Siting Review" – a preliminary study to examine a complementary infrastructure development strategy that would site EVSE near clusters of high density MUDs.

The UCLA Luskin Center for Innovation analyzed land use data from the Los Angeles County Office of the Assessor and new car registration data from IHS Automotive to understand the MUD portfolio of the South Bay subregion and identify MUD parcels that are likely to exhibit latent PEV demand. Additionally, researchers visited 27 MUD sites across the South Bay with a qualified electrician and reviewed 19 EVSE installation cost estimates to evaluate the cost of providing home charging to MUD residents and identify potential low-cost home charging solutions. The UCLA Luskin Center for Innovation finds that while the cost of EVSE installation at MUD sites is indeed variable and often high, low-cost solutions may exist and policy tools can be designed to take advantage of these solutions. The key results of our findings include:

The South Bay is a leader in PEV adoption despite a significant number of MUD households:

The South Bay subregion is home to 5,657 PEV drivers and 144,132 MUD households including 33,785 MUD households in disadvantaged communities. The MUD barrier is likely serving as a significant constraint to PEV adoption in the subregion. Programs and policies aimed at expanding PEV adoption and home charging access to MUD residents are likely to find the South Bay to be a quality candidate for implementation.

EVSE installation costs are variable and often high: Level 2 EVSE installation costs ranged between \$1,800 and \$17,800 and averaged \$5,400. To contrast, single-family EVSE installations average \$1,500.

The cost of EVSE installation is positively correlated to the distance between the relevant electric panel and PEV parking spot: Of the 6 projects evaluated required a conduit run of 100 feet or greater, construction or engineering activities such as coring, trenching, and/or the x-raying of concrete, greatly increasing the cost of installation.

Detached parking layouts are likely to incur high EVSE installation costs: With the parking area separated from the main MUD structure, there is a high probability of needing to trench or perform some other construction activity to run wiring and conduit from the panel to the PEV parking spot.

Level 1 charging may be a feasible home charging solution for MUD residents: Most MUD parking in the South Bay (78%) was found to have access to a 110/120-volt outlet. To perform Level 1 charging, the property owner and/or electrician would need to assess the electrical capacity of the relevant panel.

Group investments of EVSE installation greatly reduce the per driver cost of installation: The high variable costs of EVSE installation and the group parking environments of some MUD parking layouts provide an opportunity for group investments to reduce per driver costs.

Governments, state agencies, and other relevant stakeholders can use these findings and others to design policies and programs moving forward. Interested stakeholders can also use the following report to gain a better understanding of the MUD barrier to PEV adoption and how it is likely constraining the South Bay subregion's full PEV adoption potential.

Proximity siting of EVSE to clusters of MUD properties may prove a complementary EV infrastructure strategy: Where MUD inventory is too old, too costly or exempt from owner compliance to upgrades, a strategy of building or encouraging EVSE development in proximity to clusters of MUD properties may prove successful to the continued development of the EV market.

CHAPTER 1:

Introduction

To achieve the goals laid out by the Governor's executive order setting a target for 1.5 million ZEVs on California's roads by 2025, a number of adoption barriers must be overcome. The first challenge addressed in the Governor's 2013 ZEV Action Plan is the need to build out the necessary refueling infrastructure including in apartment buildings and condominiums, also known as multi-unit dwellings (MUDs). ZEVs, and specifically plug-in electric vehicles (PEVs), require an entirely new refuel behavior and set of equipment. In place of a 15-minute detour to a gas station, most PEV owners refuel overnight when they are at home. While this is generally a straightforward proposition for single-family homeowners, MUD residents face a number of obstacles to installing home charging (electric vehicle service equipment or "EVSE"). Foremost is the variable and often high cost of EVSE installation at a MUD site. Additionally, the renter or owner exhibits a low to non-existent investment motivation: renters are likely not to invest in a piece of immobile equipment that they may move from in the future; and owners do not yet see home PEV charging as an amenity by which to increase property value and attract tenants.

Purpose of the Report

The goal of this report is to explore the MUD as a barrier to greater PEV adoption in the context of the South Bay subregion, as well as to target and prioritize outreach and other policy tools at MUD sites in the South Bay that exhibit high latent PEV demand and a low cost of EVSE installation. The following represents the final report for Task 2 of 3 for Agreement Number ARV-14-035; The Task 3 work product is a MUD "Owner's Toolkit" which, along with the summary and ancillary information about the presentation of the "Toolkit" and Task 2 findings can be found in the attached appendices.

The South Bay subregion of Los Angeles County is a leader in the adoption of PEVs with 5,657 total registrations.¹ Yet, like other regions of the State, it is likely that the full adoption potential of the subregion is constrained by its mix of residential land uses, specifically the significant number of MUDs. MUDs account for 144,132 total households across 15 South Bay cities and 46% of the residential land use mix.² As such, the subregion provides a quality study area to

¹ IHS Automotive New Vehicle Registration Data. Accessed February, 2016.

² Los Angeles County Office of the Assessor Secured Basic File Abstract. Accessed October, 2015.

evaluate the MUD barrier to PEV adoption, as well as to implement future policies or programs aiming to overcome this barrier. The report is organized as follows:

Chapter 2 provides an overview of the MUD portfolio in the South Bay. Researchers analyzed the Los Angeles County Office of the Assessor’s Secured Basic File Abstract to identify MUD characteristics that may influence PEV demand such as size, per unit value, vintage and ownership type. We present the most common MUD parking layouts of the South Bay because they influence the distance from a MUD’s electric panel to the PEV parking location; one of the strongest determinants of EVSE installation costs. This chapter concludes with a review of the South Bay’s 33,785 MUD households that are located within disadvantaged communities. These may be appropriate targets for clean energy investments from Greenhouse Gas Reduction Fund revenues.

Chapter 3 identifies MUDs in the South Bay that may exhibit high latent PEV demand. Using the results of Chapter 2 and IHS Automotives’s new vehicle registration data, researchers identified census tracts with a 50% MUD residential land use mix or more, as well as high PEV adoption rates. Moreover, our PEV demand analysis provides parcel level information: we calculated a propensity to purchase score using the historical adoption rate of PEVs in each census tract, as well as the PEV adoption rate of individuals living in households of a certain value. Those MUD parcels that result in a higher propensity to purchase score should be targets for future outreach efforts or other policy interventions.

Chapter 4 presents the costs associated with Level 1 and Level 2 EVSE installation at MUD sites in the South Bay. Using empirical evidence from visiting MUD sites and obtaining installation cost estimates from a qualified electrician, this chapter investigates how installation costs vary based on the electrical and structural configuration of the MUD building, and highlights potential low-cost installation solutions.

Chapter 5 offers policy tools that help alleviate the MUD barrier to PEV adoption. Potential policy solutions include designing rebates to reduce the cost of EVSE installation, implementing PEV ready new construction codes, siting public charge programs to benefit MUD residents and prioritizing outreach and education to increase PEV adoption.

Appendices include the MUD “Owner’s Toolkit” for understanding the electric vehicle marketplace; observations and findings regarding the state of EVSE in South Bay MUD properties; the rules and regulations that effect MUD owners regarding EVSE installation; and, resources, rebates and incentives for the installation of EVSE. The appendices also include summaries of the marketing and workshops that were conducted as well as a review on the theory of siting EVSE in proximity to areas of high concentration of MUD housing.

Intended Audience

This report is intended for a wide audience of decision makers and advocates seeking to advance PEV adoption in MUDs and specifically, those in the South Bay. Those that may find the report most useful include regional, subregional, and municipal planners; state agencies; utility representatives; MUD property owners; members of homeowner associations; as well as PEV and potential PEV drivers.

Regional, subregional and municipal planners should use this report to facilitate PEV adoption where latent demand is greatest and installation solutions are needed. By outlining the subregion's MUD portfolio, the report empowers planners to strategically conduct targeted outreach and prioritize MUD sites for policy interventions.

State agencies should use this report to understand the MUD barrier to PEV adoption and consider policy tools that reduce the cost of installing EVSE at MUD sites such as rebates.

Utility representatives should use this report to identify and plan for where PEV demand and related electrical load may grow most rapidly in the subregion. Southern California Edison (SCE), the predominant electric utility in the South Bay, recently received approval for Phase 1 of their Charge Ready program to install charging infrastructure at long dwell-time sites where PEV drivers will be parked for at least four hours, including MUDs. SCE should use this report to help identify census tracts and specific parcels to prioritize outreach for this and other PEV programs.

Property managers and members of homeowner associations (HOAs) should use this report to gain an understanding of the elements of their building's electrical systems and to better predict the cost of installing PEV home charging options.

PEV and prospective PEV drivers should use this report to better understand the challenges and costs of installing PEV charging infrastructure at home.

1.1 Methodology

The guiding objective of UCLA Luskin Center researchers was to prioritize outreach by 1) understanding the MUD portfolio of the South Bay, 2) identifying high latent demand for residents of MUDs in the South Bay, and 3) identifying low cost MUD types for the installation of EVSE. Those MUD parcels that exhibited high latent demand as well as low-cost installation would represent the low-hanging fruit properties for outreach or other policy interventions. The following reviews the methodology conducted to achieve the goals of the research.

1) Understating the multi-unit dwelling portfolio of the South Bay

Researchers analyzed Los Angeles County Office of Assessor Secured Basic File Abstract data across a number of parcel specific variables. Most importantly, the data provided researchers the assessor identification number, number of units, the land and improvement value (“total value”), year built (“vintage”) and ownership type (i.e. rental or condominium). Researchers assessed the spatial distribution of South Bay MUDs using geographic information systems (GIS).

To estimate the most frequently observed MUD parking layouts, researchers conducted a random sample of 900 MUD parcels across six different cities and all four city groupings³ For each city, researchers randomly selected 30 parcels for each size category (duplex/triplex, 4 to 9-unit, 10 to 19-unit, 20 to 49-unit, more than 50 units; 150 total parcels for each city random sample) and recorded the parking layout and year built.

Researchers scaled the random sample results using the observed parking layouts and observed vintage, and the vintage category (pre-1970, 1970-1989, 1990 and after) distribution for each city. For example, if during the random sampling exercise of Manhattan Beach’s 4 to 9-unit MUD size category, 9 of 30 observations were built prior to 1970 and 3 of 9 (33%) of these showed a dingbat with door parking layout, then 33% of all of Manhattan Beach’s 4 to 9-unit MUDs built prior to 1970 were assumed to have the dingbat with door parking layout.

2) Estimating plug-in electric vehicle demand for multi-unit dwelling residents

To identify high latent PEV demand, researchers used census tract PEV registration data from IHS Automotive, census tract socioeconomic data from the United States Census Bureau and parcel level Los Angeles County Office of the Assessor’s data. PEV registration data includes monthly registration data from December 2010 until January 2016 for all battery electric vehicle and plug-in hybrid electric vehicle make and models. Researchers mapped the PEV registrations across the South Bay and overlaid the MUD spatial distribution. The intuition here is MUD residents living in census tracts with high PEV adoption should also have high PEV demand.

Researchers then constructed a PEV propensity to purchase model to assign a score to specific MUD parcels. Researchers downloaded census data on income by home value for each census tract and used this to create measures of the probability someone living in a home with a given value has of being at a certain income level. Researchers then downloaded survey data from California Clean Vehicle Rebate Program (CVRP) and computed the proportion of PEV purchases that went to each income group (0-\$24,999; \$25,000-\$49,999; \$50,000-\$74,999; \$75,000-

³ The city groupings were defined as: Beach Cities, Inland Cities, Hybrid Cities, and Peninsula Cities.

\$99,999; \$100,000 and more). Researchers then estimated a measure of the number of PEV purchases over the next year by census tract assuming an equal amount of vehicles had been purchased in the tract over the previous 12 months.

For each census tract, researchers multiplied the total number of expected PEVs by proportion of PEVs bought by each income group to create an expected number of new PEVs to be bought by each income group within each census tract. Researchers then divided this number by total number of households in a given income group per tract to create a tract by income group specific propensity to purchase PEV for the coming year.

Finally, using per unit value parcel data, researchers assigned each parcel to a home value bin based on census tract info (<\$30,000; \$30,000-\$69,999; \$70,000-\$99,999; \$100,000-\$249,999; \$250,000-\$499,999; >\$500,000). For each home-value bin, researchers created census-tract specific propensity to purchase by multiplying the probability that an individual living in a parcel with a given value has a certain level of income by that income level's estimated propensity to purchase a PEV. The result is a per parcel propensity to purchase PEV score for each MUD in the South Bay.

3) Identifying multi-unit dwelling types with low-cost installation

With the South Bay Cities Council of Governments, researchers released a Request for Information for qualified electricians in Los Angeles County with experience installing EVSE in MUD. Researchers requested 30 MUD site visits to assess Level 1 and Level 2 charging readiness, and to estimate the cost of installing a single Level 2 EVSE unit, as well as EVSE installation for 25% and 50% of parking spots. After receiving at least three responses, researchers selected On Target Electric, which held strong experience installing EVSE and particular experience with installing EVSE in MUD.

With the selected electrician, researchers visited 27 MUD sites across the South Bay. Due to the difficulty of finding property owners and property ownership groups as willing partners, researchers were unable to visit all 30 sites. Additionally, researchers were unable to attain permission from the property owner or from the utility to evaluate the service being dropped into the MUD, resulting in not knowing whether an MUD was receiving enough power from the utility to provide Level 2 charging for one or more vehicles. Due to this limitation, the electrician partner was hesitant to provide cost estimates using such a significant assumption but agreed to provide estimates for 19 sites.

CHAPTER 2:

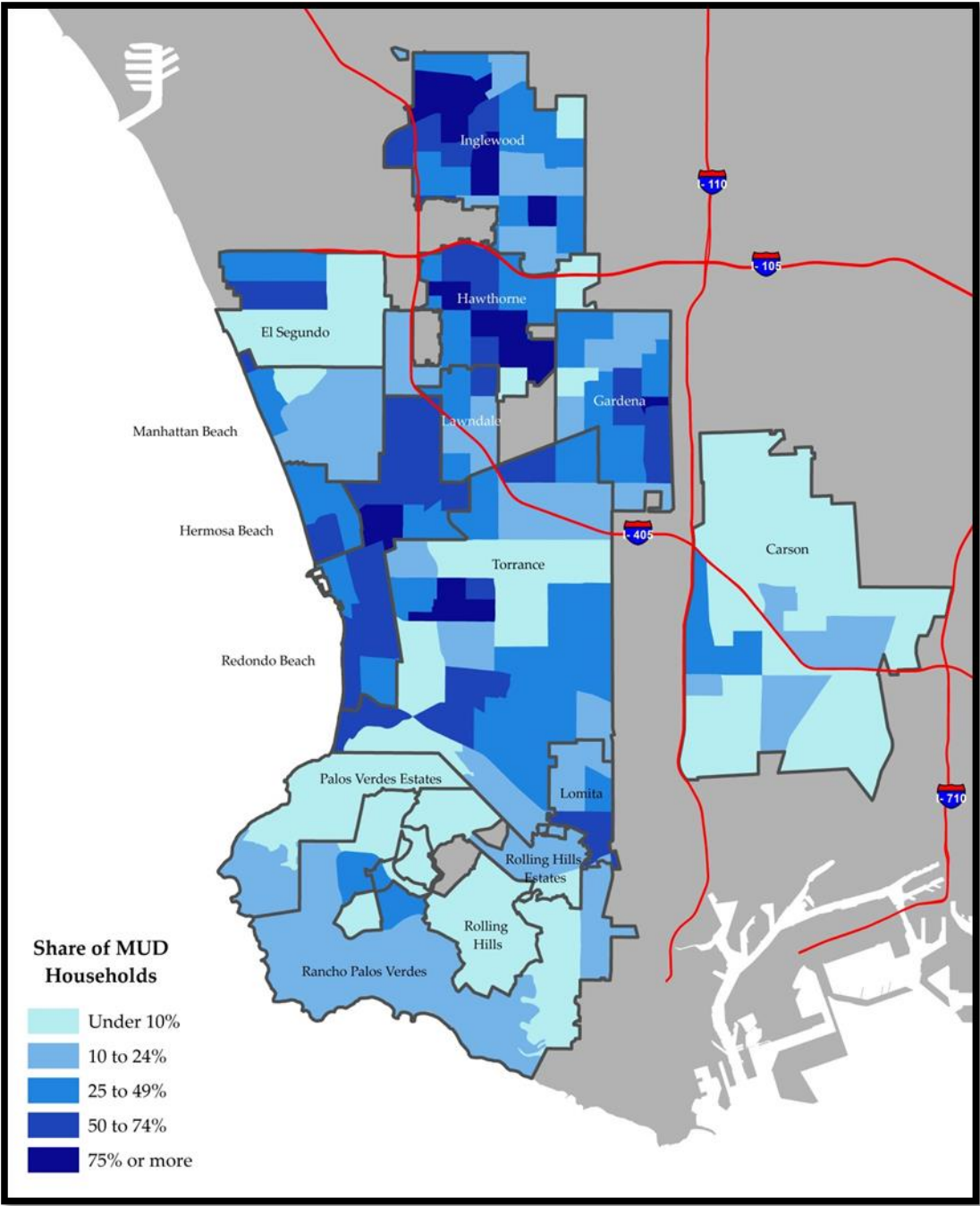
The Multi-Unit Dwellings of the South Bay Subregion

The South Bay is home to nearly 150,000 MUD households, making up 46% of the subregion's residential land use. Although the South Bay is driving PEV adoption for Southern California, this land use mix may very well be constraining the full potential of the area's PEV uptake. The MUDs present a series of hurdles to installing charging infrastructure (electric vehicle supply equipment or EVSE) at home - the preferred refueling choice for early adopters of PEVs - including the variable and often high costs of installation.

The following chapter provides an overview of the South Bay's MUD portfolio, including MUD characteristics that can influence the cost of EVSE installation and the investment motivation such as size (i.e. number of units), per unit value, vintage, ownership type, parking layout and locational attributes such as those MUDs located in disadvantaged communities. Subregional and city planners and other interested parties can review this chapter to understand the MUD composition of the subregion at large and where the MUD might most significantly be constraining PEV adoption.

Two-thirds (66.4%) of the South Bay's MUD households can be found in four cities: Hawthorne, Inglewood, Redondo Beach and Torrance. Figure 1 shows the MUD's share of residential land use per census tract and a high MUD density in the northern Inland Cities such as Inglewood and Hawthorne, as well as along the coast in the Beach Cities as seen with Redondo Beach.

Figure 1. Share of MUD Households across the South Bay Cities



Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 1. MUD Household Count and Share for the South Bay Cities

City	MUD Household Count	% MUD
Hermosa Beach	6,476	46%
Manhattan Beach	5,072	22%
Redondo Beach	20,778	57%
Carson	6,136	23%
Gardena	11,017	48%
Hawthorne	23,033	68%
Inglewood	25,618	60%
Lawndale	7,516	53%
Lomita	4,429	47%
Palos Verdes Estates	352	7%
Rachos Palos Verdes	2,831	17%
Rolling Hills	0	0%
Rolling Hills Estates	106	3%
El Segundo	4,518	57%
Torrance	26,250	42%
Total	144,132	46%

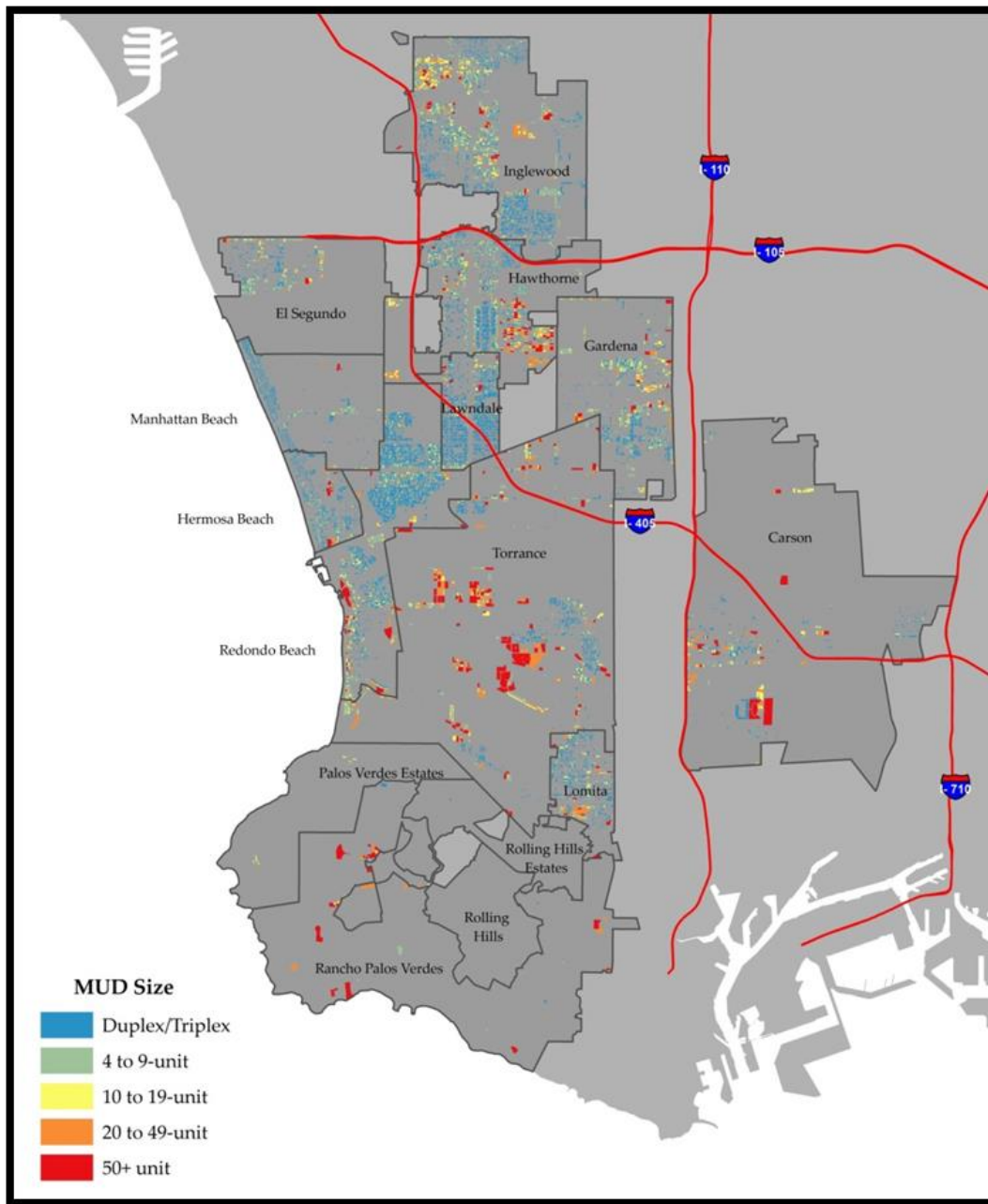
Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

In total, MUDs in 69 of the subregion's 141 census tracts make up 50% or more of the residential land use. In 21 census tracts, MUD density is very high (75% or more of residential land use). Sixteen of the very high MUD density census tracts are in the Inland Cities, with six tracts classified as disadvantaged communities. Alternatively, the Peninsula Cities are made up mostly of single-family households. Only Rancho Palos Verdes has more than 500 MUD households.

2.1 Size

MUDs can range in size from two to over 100 units. Figure 2 presents MUD sizes and their spatial distribution per city.

Figure 2. MUD Sizes across the South Bay Cities



Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 2. MUD Sizes for the South Bay Cities

City	Duplex/Triplex	4 to 9-unit	10 to 19-unit	20 to 49-unit	50+ unit	Total
Hermosa Beach	2,961	1,756	514	291	954	6,476
Manhattan Beach	3,303	1,063	338	160	208	5,072
Redondo Beach	7,081	6,193	2,204	2,331	2,969	20,778
Carson	964	693	762	1,258	2,459	6,136
Gardena	2,017	4,072	2,034	1,911	983	11,017
Hawthorne	3,856	5,781	2,780	6,219	4,397	23,033
Inglewood	5,773	8,960	4,781	3,738	2,366	25,618
Lawndale	4,273	1,330	734	697	482	7,516
Lomita	1,291	961	609	1,029	539	4,429
Palos Verdes Estates	19	133	155	45	0	352
Rancho Palos Verdes	18	73	70	524	2,146	2,831
Redondo Beach	7,081	6,193	2,204	2,331	2,969	20,778
Rolling Hills Estates	2	0	18	86	0	106
El Segundo	834	2,141	709	646	188	4,518
Torrance	2,624	3,741	2,898	6,541	10,446	26,250
Total	35,016	36,897	18,606	25,476	28,137	144,132

Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

The South Bay subregion is home to a large number of duplexes and triplexes (two and three units, respectively). For the Beach Cities, these are the most common size of MUD. For example, duplexes and triplexes in Manhattan Beach are 65% of its MUD households.

For the Inland Cities, MUD size is more evenly distributed. Gardena and Inglewood have a majority of medium-sized MUDs (4 to 19-units), while Carson and Hawthorne have higher occurrences of large MUDs (20+ units). Lawndale is similar to the Beach Cities; the majority of its MUDs are duplexes and triplexes.

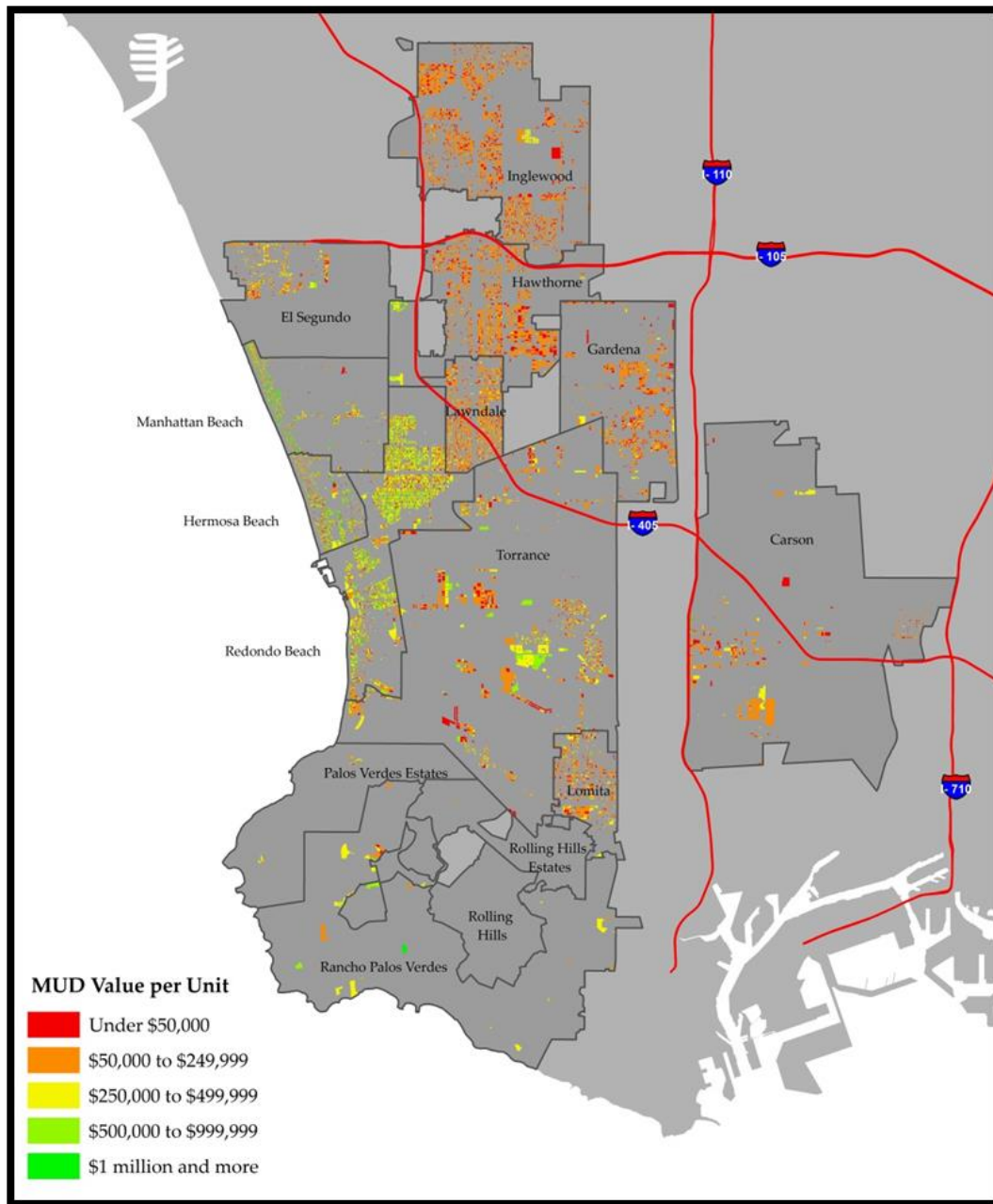
Torrance is home to a significant share of the subregion's 50+ unit MUDs.

2.2 Per Unit Value

Early PEV sales indicate that higher-income households are purchasing PEVs at higher rates than middle- and low-income households.⁴ High-income households tend to purchase new vehicles at faster rates in general and also have more disposable income to spend on new technologies such as PEVs. High-income earners can also afford to live in higher value homes, making the MUD value per unit an indicator of latent PEV demand. This provides the basis for the propensity to purchase measure discussed in Chapter 3. Figure 3 and Table 3 present the spatial distribution and total number of MUD households by value per unit for each South Bay city.

⁴ DeShazo, J.R., Samuel Krumholz, Tamara L. Sheldon et al. UCLA Luskin Center for Innovation. 2015. *Learning from California's Early Plug-in Electric Vehicle Market Growth and Policy Experiments: 2010-2015*.

Figure 3. MUD per Unit Value across the South Bay Cities



Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 3. MUD per Unit Value for the South Bay Cities

City	Under \$50,000	\$50,000 to \$249,999	\$250,000 to \$499,999	\$500,000 to \$999,999	\$1 million and more
Hermosa Beach	763	2,267	1,964	1,040	442
Manhattan Beach	445	1,865	1,066	983	713
Redondo Beach	1,724	7,493	6,997	4,355	209
Carson	1,523	3,996	613	2	2
Gardena	2,435	7,983	573	26	0
Hawthorne	6,223	15,837	649	324	0
Inglewood	6,156	19,047	415	0	0
Lawndale	1,075	5,701	726	14	0
Lomita	805	2,883	734	7	0
Palos Verdes Estates	8	145	183	13	3
Rancho Palos Verdes	116	1,051	1,580	76	8
Rolling Hills Estates	0	2	42	62	0
El Segundo	670	2,587	1,017	244	0
Torrance	6,646	13,278	4,836	1,489	1
Total	28,589	84,135	21,395	8,635	1,378

Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

The value of property, including MUDs, in the South Bay is generally higher closer to the Pacific Coast. Indeed, 90% of MUDs valued at \$500,000 per unit or greater are located within the Beach Cities. Alternatively, for the Inland Cities (except Lomita), 90% or more of MUD households are valued at less than \$249,999 per unit.

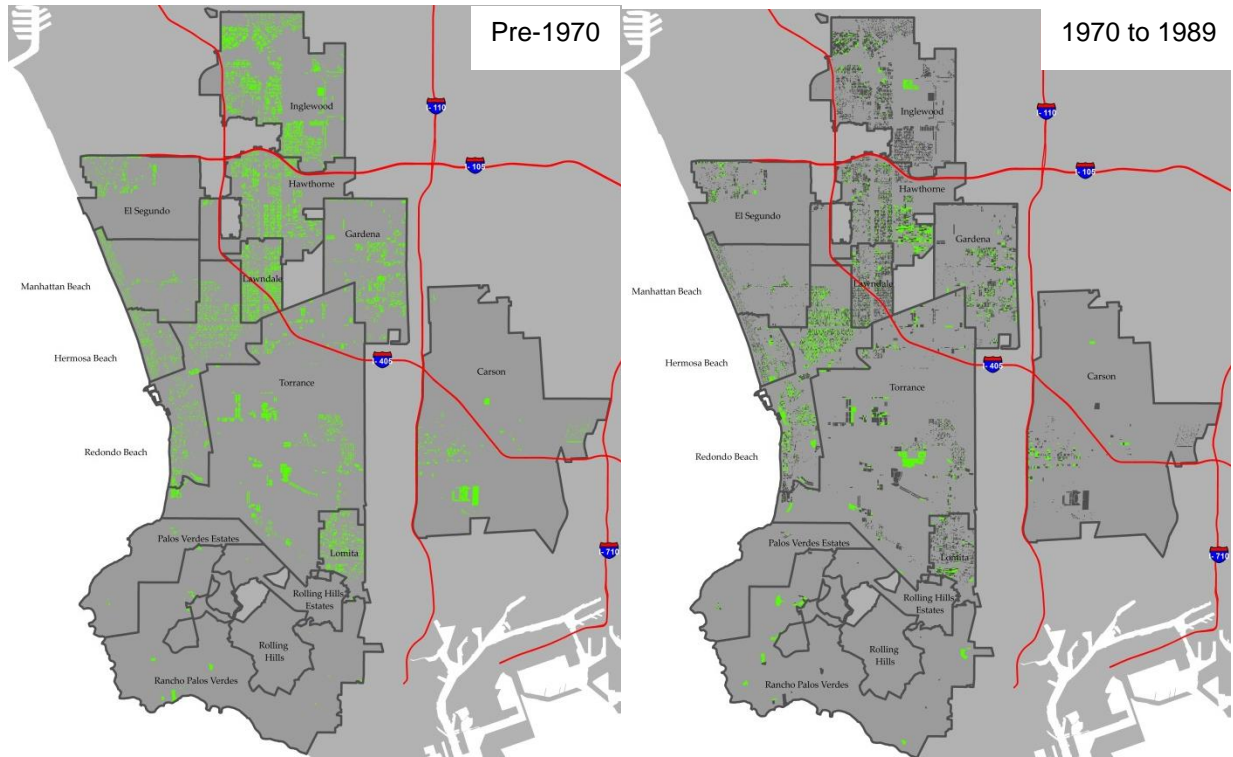
2.3 Vintage

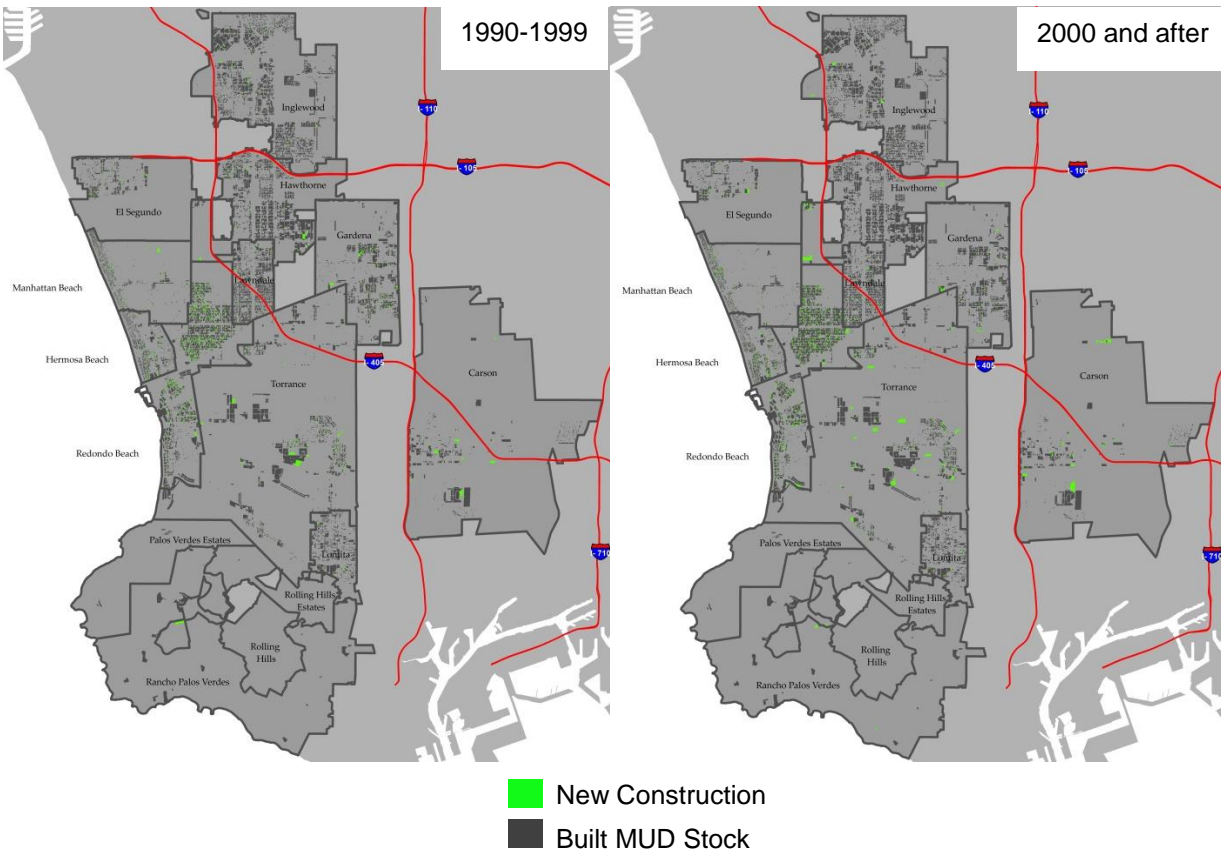
More recently constructed MUDs may provide advantages when installing EVSE on site for two reasons. First, the electrical service being provided by the utility to the MUD is more likely to have sufficient capacity for supporting PEV charging, avoiding the need for potentially costly service upgrades like installing a new service wire or transformer. Second, if panel upgrades such as new circuit breakers are required to provide sufficient capacity for PEV charging, replacement materials may be easier to find and less expensive.

The MUD stock in the South Bay subregion can be described as older with over 61% of MUD households (88,108) built before 1970. Only 10% or 12,465 MUD households were built in or

after the year 2000. Figure 4 and Table 4 present the MUD construction trends in the South Bay over time as well as the MUD vintage of each South Bay city's building stock.

Figure 4. MUD Construction over Time across the South Bay Cities





Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 4. MUD Vintage for the South Bay Cities

City	Pre-1970	1970 to 1989	1990 to 1999	2000 and later
Hermosa Beach	3,633	2,209	274	360
Manhattan Beach	3,245	815	601	411
Redondo Beach	8,647	8,966	1,310	1,855
Carson	3,285	1,491	754	606
Gardena	6,923	3,210	608	276
Hawthorne	11,271	10,757	528	477
Inglewood	21,051	3,553	470	544
Lawndale	5,149	1,946	263	158
Lomita	3,311	1,006	47	65
Palos Verdes Estates	226	118	0	8
Rancho Palos Verdes	941	1,852	0	38
Rolling Hills Estates	2	0	44	60
El Segundo	2,760	1,416	172	170
Torrance	17,664	6,220	837	1,529
Total	88,108	43,559	5,908	6,557

Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

Inglewood has the majority of MUDs (21,051 or 82%) built before 1970; Rolling Hills Estates has the least (2). Redondo Beach is home to the most number of MUDs (1,855 or 28%) built in the South Bay in or after the year 2000, however the majority of its MUDs (17,613) were also built before 1989. The cities with the second, third, and fourth highest number of newer MUDs are Torrance (1,529), Carson (606) and Inglewood (544), respectively.

2.4 Ownership Types

MUD ownership influences a resident's motivation to invest in home charging. MUDs include both apartment buildings and condominiums. Apartment buildings are generally owned by an individual or company that rents out the units to individual tenants. The building owner is responsible for all common spaces such as lighting for the building's lobby. Any structural changes to the building will be paid for by the owner who will make investment decisions based on increasing the value of the units and charging higher rents. Condominiums are owned by the resident with non-unit decisions, such managing common areas, often made by a Home Owner Association (HOA) governing board.

For renters, the investment motivation is weak or non-existent because they are unlikely to invest a significant sum of money in an immobile piece of equipment that they may move from in the future. Moreover, apartment owners and management groups may not view EVSE as an amenity by which to attract tenants. Alternatively, condominium owners are likely to view the EVSE as a property improvement positively affecting the potential resale value of their unit, although a significant installation may require approval by the HOA governing board.

MUD ownership will also determine who is responsible for common area management including overseeing the 110/120-volt outlets that may be accessible in the parking area. In an apartment building setting, these outlets, which can provide Level 1 charging if there is sufficient electrical capacity, are often connected to the house panel. The house panel controls the electrical supply for all shared appliances and common areas such as laundry machines and pool pumps. Renters should seek approval from the property owner to consume electricity when the parking area electrical outlets are connected to the house panel (see Chapter 4 for more information about the electrical configuration of MUDs).

Table 5. MUD Apartment Building Ownership Share by Size of Building for the South Bay Cities

City	Duplex/Triplex	4 to 9-unit	10 to 19-unit	20 to 49-unit	50+ unit	Total
Hermosa Beach	77%	80%	86%	32%	68%	75%
Manhattan Beach	79%	76%	76%	82%	100%	79%
Redondo Beach	36%	77%	63%	63%	45%	55%
Carson	100%	76%	22%	44%	48%	55%
Gardena	97%	91%	70%	70%	62%	82%
Hawthorne	98%	95%	84%	90%	97%	93%
Inglewood	99%	96%	88%	66%	79%	89%
Lawndale	98%	87%	77%	87%	34%	89%
Lomita	98%	86%	93%	58%	63%	81%
Palos Verdes Estates	58%	71%	50%	53%	-	59%
Rancho Palos Verdes	72%	89%	50%	35%	53%	51%
Rolling Hills Estates	100%	-	0%	0%	-	2%
El Segundo	98%	90%	71%	73%	0%	83%
Torrance	84%	89%	75%	73%	69%	75%
Total	81%	89%	76%	72%	67%	78%

Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

The MUD stock of the South Bay consists of 78% apartment buildings with the highest concentration in the Inland Cities. The Beach Cities and Peninsula Cities have a far greater incidence of condominiums. Redondo Beach's significant duplex and triplex supply (7,081) is 64% condominium. Table 5 provides the percent of apartment building ownership across the MUD size categories for each South Bay city.

2.5 Parking Layouts

In Southern California and the South Bay, the private vehicle has played a significant role in shaping land use patterns and the built environment, as well as MUD architectural designs. The latter tends to change over time and location depending on construction trends and sociodemographic changes. These changes can influence unit size, the availability of on-site amenities such as laundry services, and the parking layout of the property.

For both owners of apartment buildings and owners of PEVs, the parking layout is of particular importance to the challenge of EVSE installation and use. Indeed, one of the most significant drivers of EVSE installation costs is the distance from the electrical panel to the PEV charging spot and a MUD's parking layout will greatly influence this length of distance. The parking layout may also determine whether a PEV driver will have access to an electrical outlet for Level 1 charging. And finally, some parking layouts such as shared garages may provide opportunities for sharing the installation costs for multiple EVSE or the deployment of new technologies such as energy management systems (EMS) which allow for the strategic charging of multiple PEVs by optimally balancing each vehicle's state of charge with available electrical capacity. The impact of parking layout on MUD EVSE installation costs is discussed at length in Chapter 4.

The nine most common MUD parking layouts of the South Bay are the 1) dingbat with door, 2) dingbat without door, 3) detached parking with door, 4) detached parking without door, 5) podium garage, 6) subterranean garage 7) parking lot, and 8) driveway only. As described in Table 6, the "dingbat" design was the most frequently observed MUD parking layout by far; it accounts for the parking design for over half of the South Bay MUD households.

1) Dingbat with door



Photo Credit: UCLA Luskin Center

- Enclosed individual garage partitioned by walls
- Equipped with private garage door
- Often located directly below driver's housing unit
- At or below grade
- High probability of electrical outlet access

2) Dingbat without door



Photo Credit: UCLA Luskin Center

- Open or partitioned parking spots
- Not equipped with private garage door
- Located below housing units
- At or below grade
- Medium probability of electrical outlet access

3) Detached parking with door



Photo Credit: UCLA Luskin Center

- Enclosed individual garage partitioned by walls
- Equipped with private garage door
- Detached from main MUD structure
- At grade
- Medium to high probability of electrical outlet access

4) Detached parking without door



Photo Credit: UCLA Luskin Center

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5) Podium garage



Photo Credit: UCLA Luskin Center

- Enclosed shared garage
- Not equipped with private garage door
- Located below housing units
- Below grade
- Medium to high probability of electrical outlet access

6) Subterranean garage



Photo Credit: UCLA Luskin Center

- Enclosed shared garage
- Not equipped with private garage door
- Located below housing units
- At grade
- Medium to high probability of electrical outlet access

7) Parking lot

- Open parking lot not partitioned by walls
- Not equipped with private garage door
- Located adjacent to main MUD structure
- At grade
- Zero to low probability of electrical outlet access

8) Driveway only

- Open parking spot or spots not partitioned by walls
- Not equipped with private garage door
- Located adjacent to main MUD structure
- At grade
- Zero to low probability of electrical outlet access

Table 6. MUD Apartment Building Share for the South Bay Cities

City	Dingbat with door	Dingbat without door	Detached parking with door	Detached parking without door	Podium garage	Sub-teranean garage	Parking lot	Driveway only
Hermosa Beach	4,105	254	415	0	554	492	64	592
Manhattan Beach	3,462	209	231	80	166	250	14	661
Redondo Beach	12,769	813	1,461	488	1,843	1,791	198	1,416
Carson	2,277	574	263	459	1,123	933	275	231
Gardena	4,143	2,503	665	1,118	852	670	468	597
Hawthorne	7,654	4,071	1,359	2,665	2,979	2,289	787	1,230
Inglewood	9,049	3,501	2,200	4,804	1,662	1,282	1,113	2,007
Lawndale	3,393	928	1,065	422	393	305	86	923
Lomita	1,479	658	381	621	397	303	250	338
Palos Verdes Estates	151	0	0	0	104	97	0	0
Rancho Palos Verdes	1,176	22	0	0	904	729	0	0
Rolling Hills Estates	46	0	0	0	31	28	0	0
El Segundo	2,996	393	222	0	358	286	68	195
Torrance	13,579	939	647	0	5,198	4,456	819	612
Total	66,280	14,865	8,909	10,658	16,564	13,912	4,141	8,803

Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

To identify the most common parking layout at MUDs in the South Bay, we conducted a random sampling exercise that considered 900 South Bay MUD parcels. The most common parking layout in subregion is the dingbat with door, accounting for nearly 46% of MUD households. For the Beach Cities, the dingbat with door share increased to 63% and for the Inland Cities, the share reduced to 36%.

Inland cities are estimated to provide significantly more detached parking layouts than the other city groupings, comprising 20% of households' parking access compared to 8% for the

Beach Cities, 3% for Torrance and El Segundo, and 0% for the Peninsula Cities. In Chapter 4, we discuss how detached parking layouts are likely to result in high EVSE installation costs.

Shared garages make up a large share of MUDs in Torrance, El Segundo and the Peninsula Cities when compared to the Beach and Inland Cities. These parking layouts may lend themselves to group investments of EVSE equipment or the deployment of new technologies such as energy management systems.

2.6 Presence in Disadvantaged Communities

The South Bay includes 49 census tracts that are classified as disadvantaged communities by the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 2.0 screening tool. Disadvantaged communities are defined using a series of environmental, health and socioeconomic criteria with the purpose of identifying areas disproportionately burdened by and vulnerable to multiple sources of pollution.⁵ The distinction is an important one with Senate Bill 535 allocating 25% of Greenhouse Gas Reduction Funds to projects that provide a benefit to disadvantaged communities, and a minimum of 10% of the funds for projects located directly within these predefined communities.⁶ In fiscal year 2014-15, the Greenhouse Gas Reduction Fund (GGRF) received \$1.49 billion from Cap-and-Trade revenue, an amount that is expected to increase in subsequent years.⁷ Table 7 and Figure 5 provide an overview of the MUD households in the South Bay's disadvantaged communities.

Table 7. MUD Counts in Disadvantaged Communities per South Bay City

City	Duplex/Triplex	4 to 9-unit	10 to 19-unit	20 to 49-unit	50+ unit	Total
Carson	550	424	94	434	1,125	2,627
Gardena	1,095	2,680	845	860	402	5,882
Hawthorne	1,888	3,180	978	1,668	1,266	8,980
Inglewood	2,343	3,117	2,422	1,320	941	10,143
Lawndale	3,473	881	424	529	166	5,473
Torrance	153	231	25	129	142	680
Total	9,502	10,513	4,788	4,940	4,042	33,785

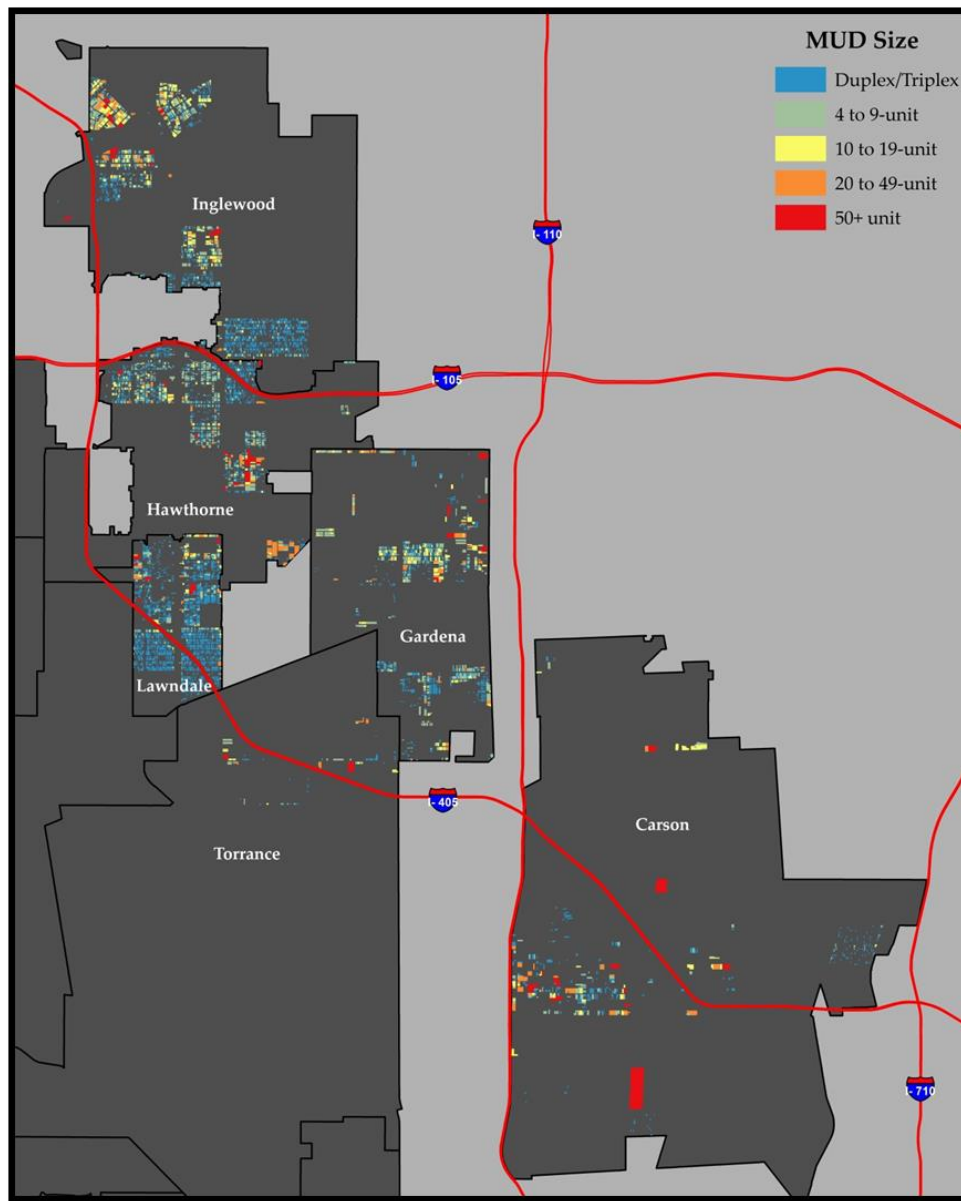
Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

⁵ California Office of Environmental Health Hazard Assessment. <http://oehha.ca.gov/ej/ces2.html>

⁶ Text of Chapter 830, Statutes of 2012 (SB 535, de Leon), Section 39713.
http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0501-0550/sb_535_bill_20120930_chaptered.

⁷ Rabin, Jeffrey, Colleen Callahan, and J.R. DeShazo. UCLA Luskin Center for Innovation. 2015. *Guide to Greenhouse Gas Reduction Fund Program Designs, Expenditures and Benefits*.

Figure 5. MUD Sizes in the South Bay's Disadvantaged Communities



Source: Los Angeles County Office of the Assessor Secured Basic Abstract File

Inglewood and Hawthorne account for 56% of MUD households in disadvantaged communities in the South Bay with 10,143 and 8,980 households, respectively. Most of the MUDs within disadvantaged communities are smaller, with duplexes and triplexes making up 28% of households and 4 to 9-unit MUDs making up 31%.

These households may be the target of future investment including from one of the largest recipients of GGRF - the Low Carbon Transportation program - with the purpose of accelerating

the transition to zero-emission or near-zero emission passenger cars, transit vehicles and freight transportation. GGRT investments are already being channeled to programs looking to expand PEV adoption to low- and moderate-income households. An example is the California Air Resources Board's Enhanced Fleet Modernization (EFMP) Plus-Up Pilot Program, which provides significant financial assistance to low income households in the Greater Los Angeles area and the San Joaquin Valley who scrap their old gross-polluting car and replace it with a more fuel-efficient vehicle. When purchasing a PEV, low-income participants can receive \$9,500 to buy or lease a new plug-in hybrid electric vehicle plus a \$1,500 Clean Vehicle Rebate Program (CVRP) rebate for a total of \$11,000 of assistance. For a new battery electric vehicle, the rebate is \$9,500 plus the \$2,500 CVRP rebate for a total of \$12,000. To qualify, the resident must live in a zip code that includes a disadvantaged community census tract.⁸

Additionally, Southern California Edison's Charge Ready program - which aims to install up to 1,500 charging stations at parking sites where dwell times exceed four hours or longer-term parking sites including MUDs - will target at least 10% of its deployment within disadvantaged communities.

⁸ California Air Resources Board. Making the Cleanest Cars Affordable.
http://www.arb.ca.gov/newsrel/efmp_plus_up.pdf.

CHAPTER 3:

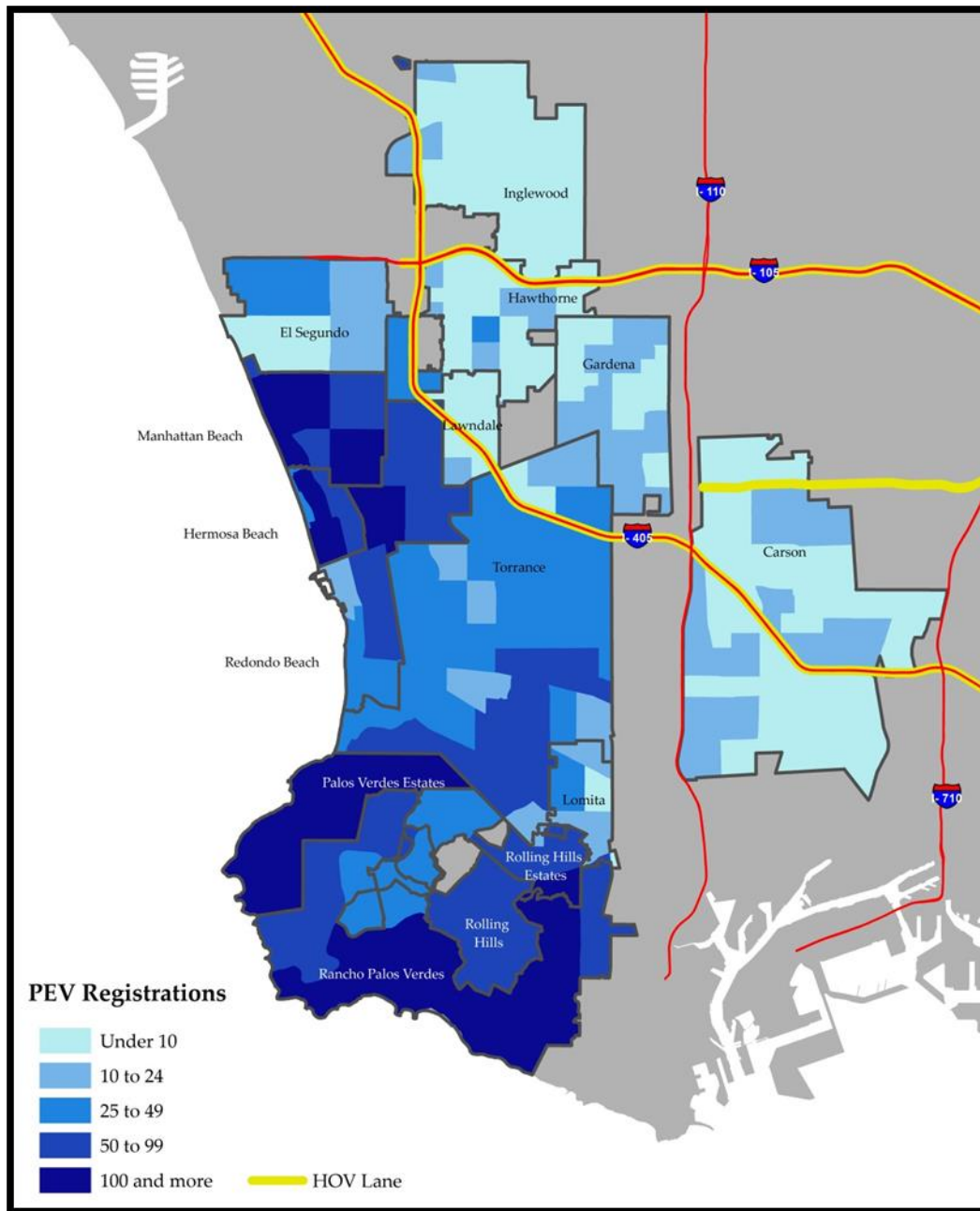
Plug-in Electric Vehicle Demand in the South Bay

The South Bay is a leader in the adoption of plug-in electric vehicles (PEVs) in Southern California. By the end of 2015, the subregion was home to 22 census tracts in the top fifth percentile for PEV registrations across Los Angeles County, with three census tracts in the top 10 for PEV adoption. In total, the subregion is home to 5,657 PEV drivers.

This chapter provides an overview of where PEV demand in the South Bay subregion is the greatest and where this demand is greatest among multi-unit dwellings (MUD) residents. The latter is calculated using a propensity to purchase score which estimates PEV demand as a function of historical PEV adoption trends as well as income level and MUD per unit value. Subregional and municipal governments and other interested stakeholders should use this chapter to prioritize neighborhood outreach or organize other planning efforts (see Chapter 5 for more detail on outreach strategies).

Consistent with statewide trends, early PEV drivers tend to be higher income households. As such, the Beach Cities, the Peninsula Cities and the City of Torrance are responsible for 78% of PEV registrations. Figure 6 and Table 8 provide a PEV registration overview for each South Bay city.

Figure 6. PEV Registrations across the South Bay Cities



Source: IHS Automotive, California Department of Transportation

Table 8. PEV Adoption for the South Bay Cities

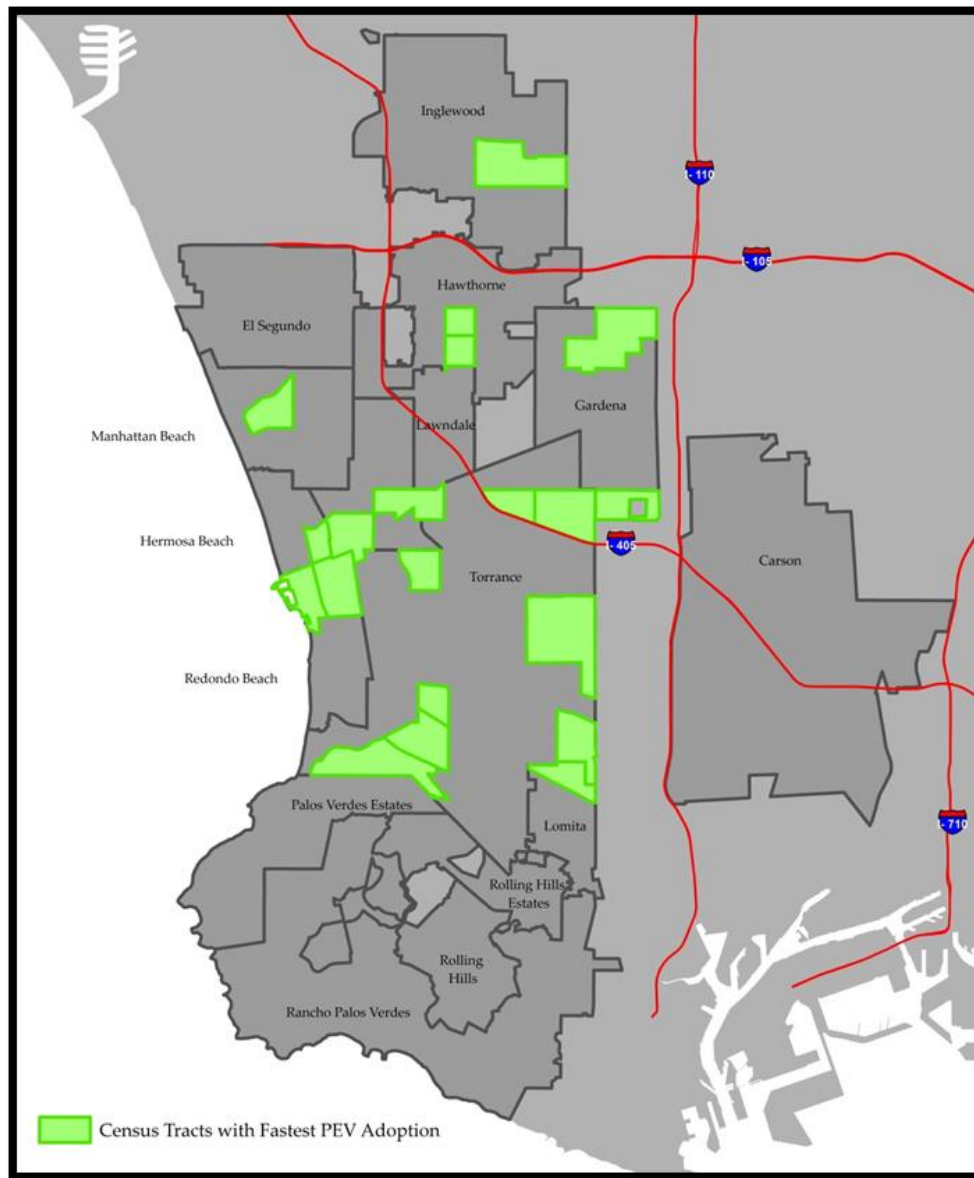
City	PEV Registrations	PEVs per 100 Residents	2015 Growth Rate	% Battery Electric Vehicle	Number of Publically Available Chargers
Hermosa Beach	420	21.5	42%	45%	7
Manhattan Beach	1,081	30.8	45%	47%	9
Redondo Beach	69	1.7	38%	39%	13
Carson	193	2.1	36%	36%	14
Gardena	128	2.2	44%	49%	2
Hawthorne	186	2.2	62%	41%	20
Inglewood	110	1.0	64%	42%	1
Lawndale	53	1.6	39%	38%	1
Lomita	74	3.7	40%	32%	0
Palos Verdes Estates	388	28.9	40%	42%	0
Rancho Palos Verdes	877	13.1	45%	42%	6
Rolling Hills	168	90.3	31%	50%	0
Rolling Hills Estates	678	84.0	38%	47%	2
El Segundo	152	9.1	52%	49%	31
Torrance	1,080	7.4	40%	38%	24
Total	5,657	7.6	43%	42%	130

Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File, U.S. Department of Energy Alternative Fuels Data Center

As more moderate-income households begin to view the PEV as a viable transportation option,⁹ adoption will spread beyond the higher-income census tracts. Figure 7 presents evidence that this is occurring in the South Bay, with some of the largest percentage PEV registration growth of 2015 taking place in census tracts within the Inland Cities of Gardena, Hawthorne, Inglewood and Lomita.

⁹ In 2012, PEV drivers with income levels below \$100,000 made up 18% of PEV purchases. In 2015, this same group has made up over 25% of new PEV purchases (California Center for Sustainable Energy. 2014. *California Plug-in Electric Vehicle Driver Survey Results*.).

Figure 7. Census Tracts with Fastest PEV Registration Rates

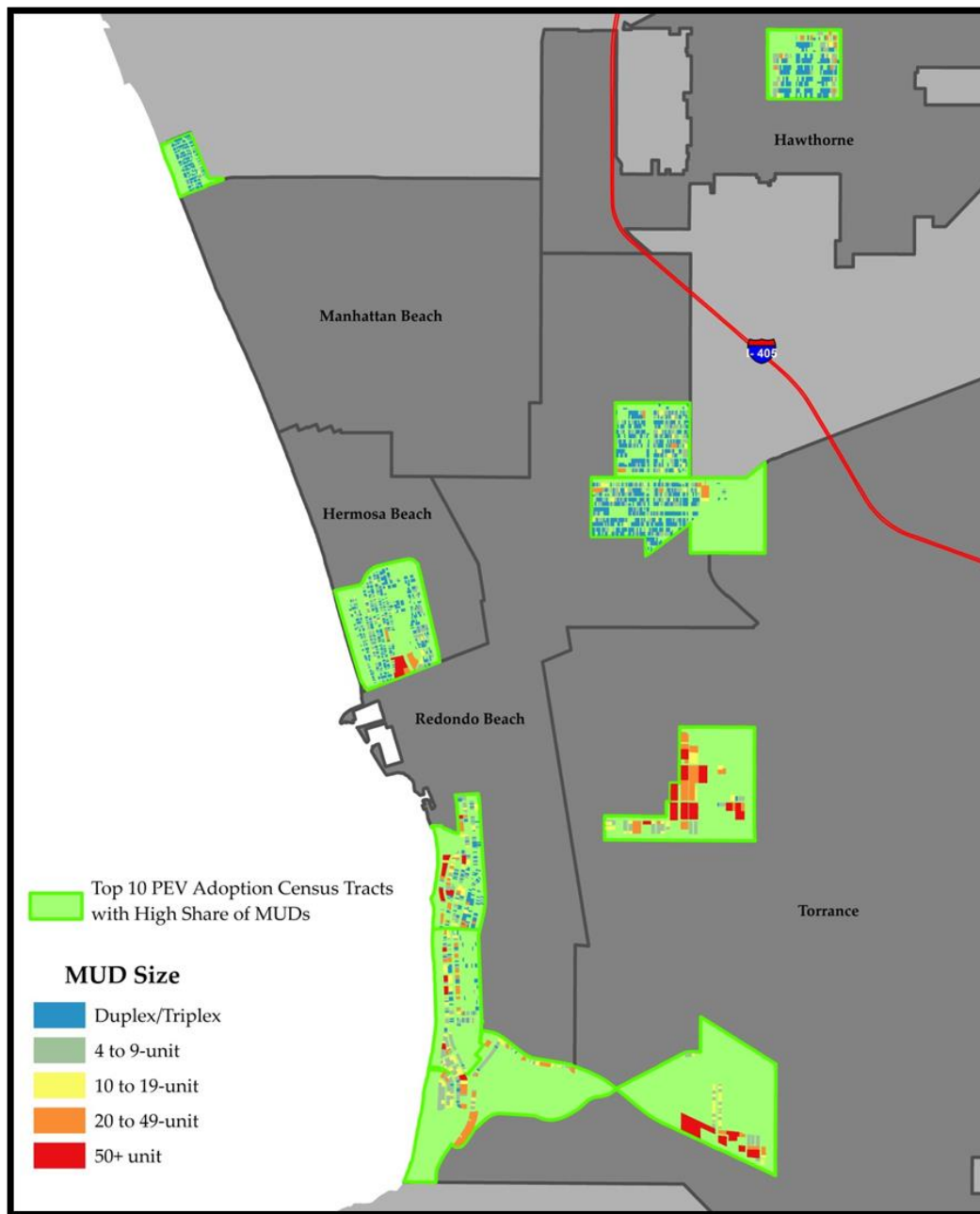


Source: IHS Automotive

3.1 High PEV Demand in High MUD Census Tracts

Census tracts with high PEV adoption and a high share of MUDs may be areas with high latent PEV demand. If MUD residents here do not have access to home charging, it is likely that the MUD is serving as a constraint to these census tracts' full PEV adoption potential. Figure 8 and Table 9 provide the 10 highest PEV registration census tracts with at least a 50% MUD residential land use mix. Neighborhood level outreach to increase PEV adoption may be most effective within these 10 census tracts.

Figure 8. Census Tracts with High PEV Adoption and High MUD Share



Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 9. Census Tracts with High PEV Adoption and High MUD Share

Census Tract	City	PEV Registrations	Percent MUD	Total MUD Households
6037621104	Hermosa Beach	133	64%	2,439
6037620601	Redondo Beach	66	59%	1,460
6037620201	Manhattan Beach	53	74%	794
6037651304	Torrance	58	55%	1,459
6037620521	Redondo Beach	54	50%	858
6037602403	Hawthorne	54	77%	1,387
6037621324	Redondo Beach	53	77%	1,774
6037650602	Torrance	39	77%	2,392
6037621326	Redondo Beach	39	80%	1,607
6037651222	Torrance	39	60%	1,493

Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

The Manhattan Beach and Hermosa Beach census tracts (6037620201 and 6037621104, respectively) show a high percentage of duplexes and triplexes, and outreach here should incorporate this MUD size. The Torrance census tracts (6037650602 and 6037651222) consist mostly of large and very large MUDs (20 to 49-unit and 50+ unit, respectively). There may be opportunities for multiple tenants to invest in the installation of EVSE and reduce per resident costs (see Chapter 4 for more detail about this cost reduction strategy).

3.2 Demand within Multi-Unit Dwelling Parcels

To identify and prioritize high latent PEV demand within MUD households, we calculated a propensity to purchase score for each MUD parcel in the South Bay. The score accounts for the historical adoption rate of PEVs in each census tract, as well as the PEV adoption rate of individuals living in households of a certain value.

Considering that a large share of PEVs are purchased by high-income individuals who are likely to live in high-value homes, the propensity to purchase score model allocates a greater score to high-value homes.

When totaling propensity to purchase scores across cities or census tracts, the results provide an estimate of aggregate PEV demand for MUD residents. As seen in Table 10, duplexes and triplexes are generally higher-value properties and are thus estimated to show the greatest demand for PEVs. The Beach Cities account for over 70% of the PEV demand for MUD residents, a result of the high PEV adoption rates and the large number of high-value MUDs including duplexes and triplexes. Redondo Beach has the highest cumulative propensity to purchase score for each MUD size category, particularly for medium and large MUDs (4+ units). After the Beach Cities, Hawthorne and Torrance have the fourth and fifth highest cumulative

propensity to purchase scores respectively. The Peninsula Cities account for the lowest scores, due to the low number of MUD households.

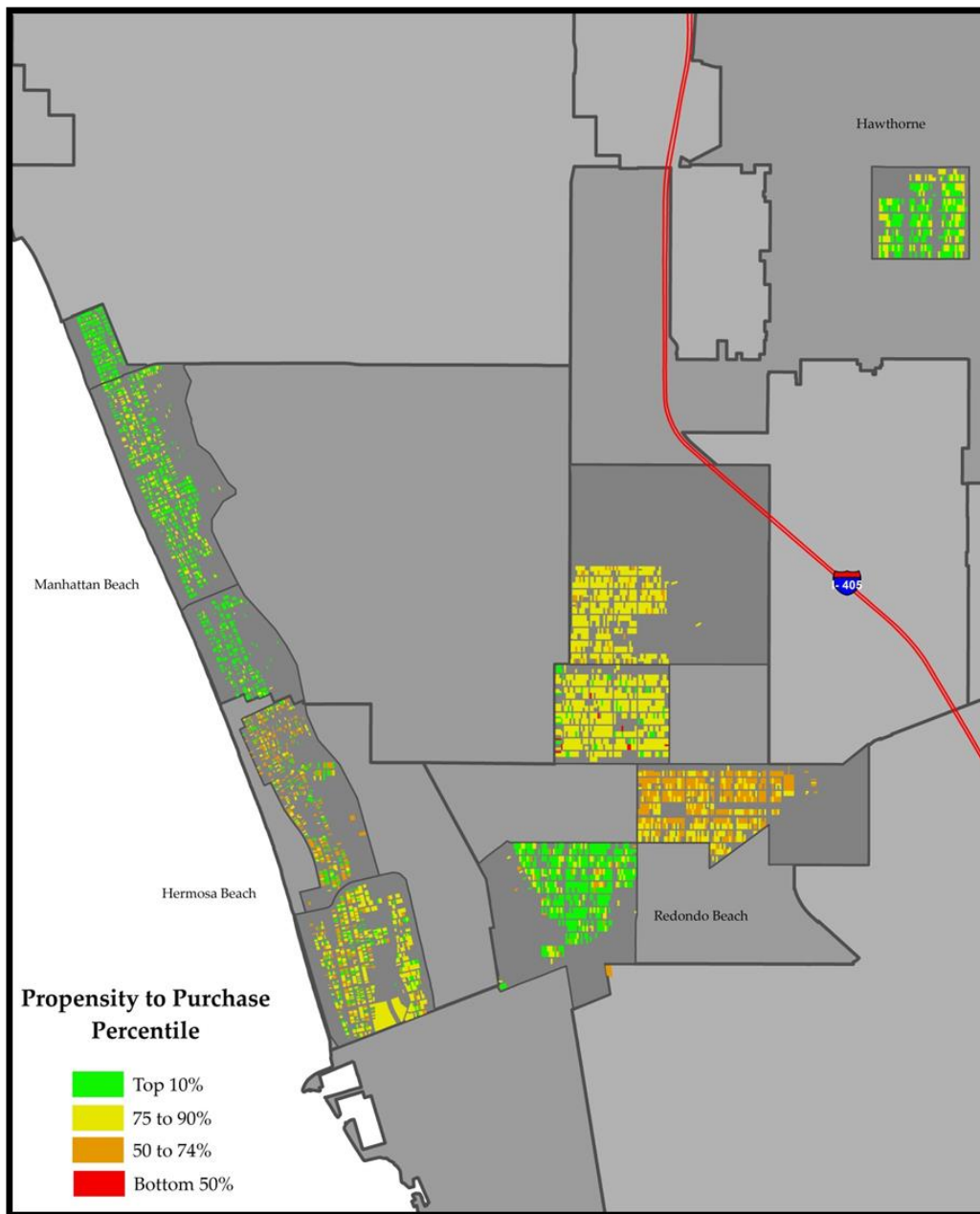
Table 10. Census Tracts with High PEV Adoption and High MUD Share

City	Cumulative Propensity to Purchase Scores			
	Duplex/Triplex	4 to 9-unit	10 units or more	Total
Hermosa Beach	17.34	3.82	0.66	21.82
Manhattan Beach	29.36	3.31	0.52	33.18
Redondo Beach	35.53	9.71	2.04	47.28
Carson	0.74	0.21	0.26	1.21
Gardena	1.29	1.03	0.39	2.7
Hawthorne	6.66	2.69	1.17	10.51
Inglewood	2.86	2.02	0.48	5.35
Lawndale	3.89	0.53	0.13	4.55
Lomita	1.47	0.39	0.21	2.08
Palos Verdes Estates	0.09	0.31	0.19	0.58
Rancho Palos Verdes	0.07	0.12	0.33	0.52
Rolling Hills Estates	0.02	0	0.03	0.05
El Segundo	2.18	2.09	0.43	4.69
Torrance	5.48	2.62	1.96	10.07
Total	106.96	28.84	8.81	144.60

Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

Figure 9 and Table 11 present the top 10 cumulative propensity to purchase score census tracts. Parcels with scores in the top 10 percentile across all MUDs in the subregion are highlighted in bright green. As expected, census tracts from the Beach Cities top the list with a single Hawthorne census tract as the only non-Beach. Again, these census tracts likely represent quality starting points for neighborhood level outreach.

Figure 9. Census Tracts with Highest Cumulative Propensity to Purchase Score



Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 11. Census Tracts with Highest Cumulative Propensity to Purchase Score

Census Tract	City	Cumulative Propensity to Purchase Score	PEV Registrations	Total MUD Households
6037620305	Manhattan Beach	13.03	203	1,249
6037621104	Hermosa Beach	8.78	133	2,439
6037620702	Redondo Beach	8.73	128	411
6037620904	Manhattan Beach	7.83	109	224
6037620201	Manhattan Beach	7.74	53	794
6037620522	Redondo Beach	7.4	69	842
6037621004	Hermosa Beach	5.8	115	951
6037602403	Hawthorne	5.42	54	1,387
6037620601	Redondo Beach	5.04	66	1,460
6037620501	Redondo Beach	5.04	83	515

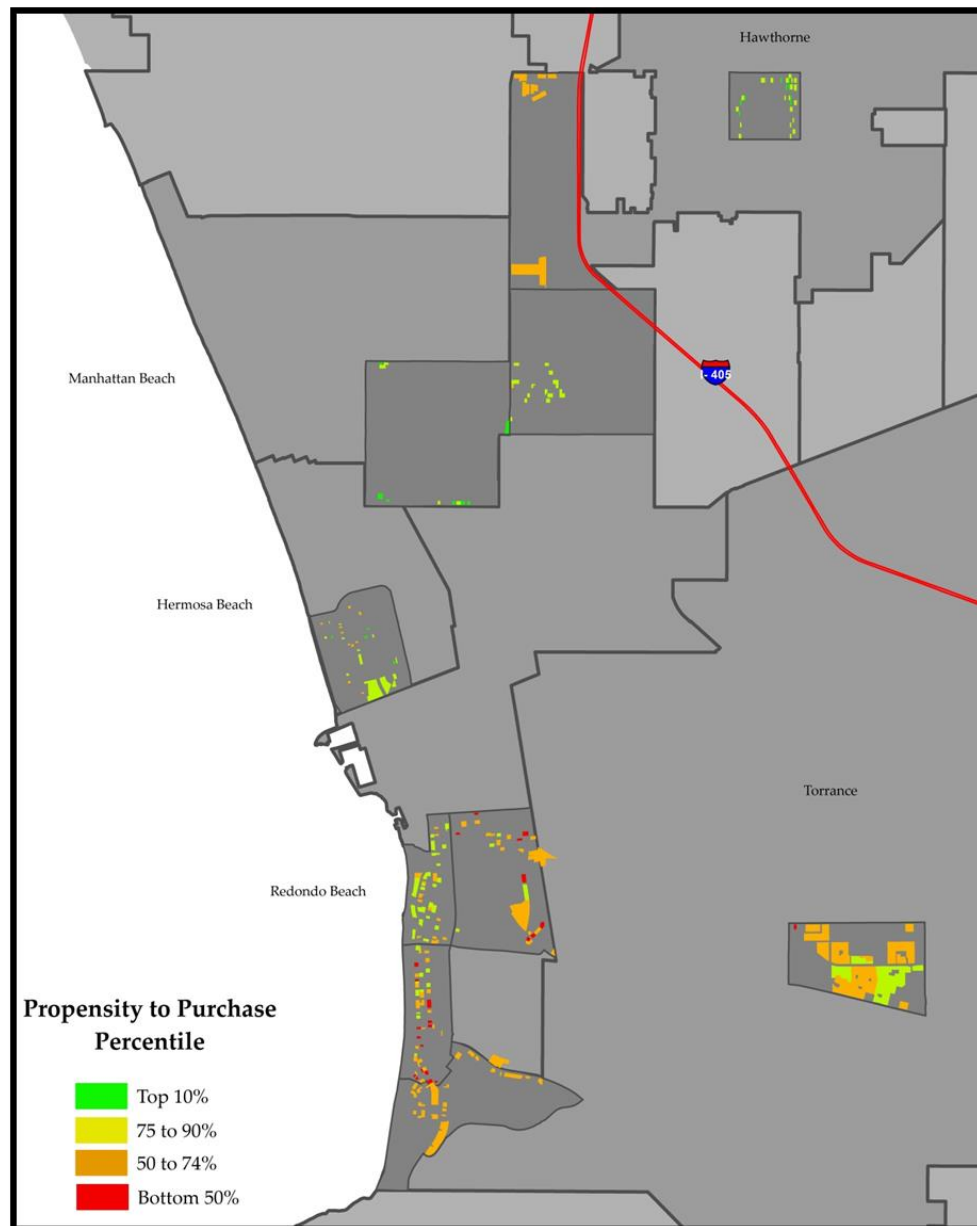
Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

3.2.1 Demand at Large Multi-unit Dwellings

There may be significant advantages to installing multiple EVSE and sharing installation costs among PEV drivers. Additionally, Southern California Edison's (SCE) Charge Ready program requires a minimum of 10 EVSEs per site.¹⁰ As such, Figure 10 and Table 12 present the census tracts with the highest cumulative propensity to purchase scores for MUDs of 10 units or more. These census tracts may serve as quality candidates for neighborhood level outreach programs to increase PEV adoption among residents of larger MUDs, as well as promote the potential cost savings to group investing in EVSE installation.

¹⁰ A minimum of 5 EVSE in disadvantaged communities.

Figure 10. Census Tracts with Highest Cumulative Propensity to Purchase Score for MUDs with 10 or more Units



Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

Table 12. Census Tracts with Highest Cumulative Propensity to Purchase Score for MUDs with 10 or more Units

Census Tract	City	Cumulative Propensity to Purchase Score for MUDs with 10+ units	PEV Registrations	Total MUD Parcels with 10 or more units	Total MUD Households with 10 or more units
6037602403	Hawthorne	0.49	49	35	654
6037621324	Redondo Beach	0.43	46	45	1,420
6037650800	Torrance	0.32	67	38	2,247
6037621326	Redondo Beach	0.28	36	51	1,198
6037621104	Hermosa Beach	0.28	121	30	886
6037620800	Manhattan Beach	0.2	182	11	190
6037621301	Redondo Beach	0.2	79	33	1,098
6037602302	Hawthorne	0.2	33	30	598
6037620501	Redondo Beach	0.18	76	14	270
6037651304	Torrance	0.17	51	35	792

Source: IHS Automotive, Los Angeles County Office of the Assessor Secured Basic Abstract File

CHAPTER 4:

The Cost of Charging Infrastructure Installation in Multi-Unit Dwellings, a Barrier to Plug-in Electric Vehicle Adoption

As owners of a new transportation technology, plug-in electric vehicle (PEV) drivers are changing the way they refuel their vehicles. In place of a 15-minute detour to a gas station, most PEV owners refuel when they are at home and plugged-in throughout the night. To charge PEVs at home overnight, drivers generally choose a Level 1 or 2 charger. The decision is based on charging preference, recharging needs and cost of installation. Level 2 chargers refuel PEVs at a much faster rate than Level 1 but are likely to require greater installation costs. In many instances, Level 1 charging does not involve any installation costs.

Level 1 charging requires a 110/120-volt outlet, the standard 3-prong plug that is available in many parking layouts. It requires 15 amps of continuous load to charge between four and six miles per hour. Seventy-eight percent of PEV drivers average 15 to 45 miles of driving per day, which can be satisfied with 3 to 8 hours of Level 1 charging.¹¹

Level 2 charging requires a 208/240-volt outlet and charges PEVs at a much faster rate: 3.3 kW (30 amps) to 19.2 kW (100 amps). Most vehicles currently on the market are only capable of using 30 amps for 3.3 or 6.6 kW charging with a charge rate between 8 and 24 miles per hour. Level 2 charging is the more popular choice for early adopters of PEVs.¹²

The important tradeoff to consider when selecting charge levels in an MUD environment is the electric load each requires. The Level 1 load is minimal, similar to a microwave. Level 2 charging is likely to produce a significant new load for the property. In both instances, a homeowner or renter should seek the expertise of an electrician to estimate the electrical capacity of the property and to determine if the additional load can be supported.

For single-family homeowners, home charging is generally an easily available amenity. They tend to have sufficient electrical capacity to support overnight charging and the installation of the charging equipment (electric vehicle supply equipment or EVSE) is a predictable cost and a straightforward process.

¹¹ California Center for Sustainable Energy. 2014. *California Plug-in Electric Vehicle Driver Survey Results*.

¹² 64% of respondents have installed a Level 2 charger at home (California Center for Sustainable Energy. 2014. *California Plug-in Electric Vehicle Driver Survey Results*.)

The same cannot be said for PEV home-charging at MUDs. Foremost, the cost of installing EVSE in a MUD parking environment varies greatly from site to site and can quickly become cost prohibitive. Costs can arise at two stages of installation:

- 1. Investing in sufficient electrical capacity to support the additional load of PEV charging.**

Electrical upgrades, at either the panel or utility service level, can quickly increase installation costs depending on the electrical configuration of the property and the utility that serves it. For example, a new panel with sufficient electrical capacity can cost over \$1,000 for materials and labor and a new transformer at the utility service level can cost upwards of \$7,000.

- 2. Connecting the EVSE to the building's electrical system.**

To provide electricity to the EVSE, wiring is run through conduit from an electrical panel to the PEV parking spot. Costs can become significant as the distance between the two increases and varies depending on the property's structural configuration and parking layout. For example, all MUD sites where the PEV parking spot was 100 feet or greater from the relevant electrical panel required construction and/or engineer activities to safely run the wiring and conduit. Such activities alone can cost \$4,000 or more and significantly increase total EVSE installation costs.

This chapter presents the findings made when visiting MUD sites with a qualified electrician throughout the South Bay and reviewing the resulting installation cost estimates including the electrical configuration of MUDs, the panel and service upgrades that may need to be performed to provide home charging, the costs associated with EVSE installation at MUDs and how these might vary across different parking layouts, and potential opportunities and solutions for low-cost Level 1 and Level 2 installation.

The cost barrier to home charging for MUD residents was repeatedly validated during this exercise; cost estimates ranged from \$1,800 to \$17,800 and averaged \$5,400. Even more, our electrician partner estimated that all 27 sites visited required at least some panel upgrades for Level 2 charging, with only one site electrically ready for EVSE installation (Case Study 1, Appendix).

Although the MUD barrier to PEV adoption was decisively confirmed, some potential cost-reduction strategies emerged including Level 1 charging as a viable option for home charging particularly in dingbat parking layouts and the opportunity to share EVSE installation costs across multiple PEV drivers. Additionally, some parking layouts and electrical configurations may offer potentially lower-cost Level 2 charging infrastructure installations. These findings are shared in the Appendix and will inform the policy recommendations outlined in Chapter 5.

4.1 Overview of Electrical Service at Multi-Unit Dwellings

MUDs have a distinct electrical configuration that makes the prospect of home charging challenging. MUDs receive power from utilities' distribution networks at a single service point that leads to the property's electric meter which is on the side of the structure or within an electrical box (or electrical room). Electrical service is supplied through either an overhead service drop or an underground service connection. An overhead drop often comes from a utility pole to the roof of the property and down to the



Two examples of overhead service drops providing electricity to the MUD's electric box

meter section or to the electric box. Underground service connections come from a pull section or pull box – an underground compartment that serves as the main termination point for the utility feed. The connection is then run up to the MUD's electric box. Alternatively, an underground service connection can run down a utility pole, be tunneled underground, and then resurfaced at the property's electric box.

Inside the electric box is the property's meter section which includes the house and unit meters as well as the main breakers (pictured). Each residential unit has its own meter and main breaker. Power is distributed from the meter section to a panel located in each unit, or the **unit panel**, where circuit breakers safely manage each unit's electric load. The house meter(s) and main breaker(s) distribute power to a **house panel(s)** which then provides electricity to common areas and general electrical loads such as parking outlets, laundry machines, pool pumps, electric



A grouping of house and unit meters (i.e. the meter section) and their main breakers inside an electric box.

water heaters and more. The house panel can be located in the electric box or in another common space.

4.2 Electrical Upgrade Options and Estimated Costs

When installing Level 2 chargers, an electrical upgrade will likely be required. Level 1 EVSE may also necessitate additional capacity through an electrical upgrade. The upgrade can occur in two ways within an MUD's electrical configuration: 1) adding capacity to the unit or house panel, and/or 2) upgrading electric service capacity to the MUD from the utility.

The cost of upgrading a MUD's electrical system varies based on a host of factors, including the age of the building and its electrical equipment and the utility servicing the MUD. For the South Bay, the MUD housing stock can be described as older and oftentimes has insufficient panel capacity for significant new loads. The subregion is almost exclusively served by Southern California Edison (SCE), a utility whose codes and standards influence the costs of service upgrades.

The following section reviews observations made when visiting 27 MUD sites across the South Bay with a qualified electrician and the 19 cost estimates that resulted. Additional utility-specific information was attained by reviewing the SCE Electric Service Requirements and other SCE Guidelines.

4.2.1 Adding Electrical Capacity at the Panel Level

For **Level 1 charging**, a dedicated 20-amp breaker rated for continuous use is required. In many instances, 110/120-volt outlets are available in the parking area and receive electricity from a 15- or 20-amp breaker on the house panel. The amount of available capacity often depends on the other loads tied to that panel, such as electricity needed for common areas. A confluence of loads on the same house panel may trip the main breaker – a safety response that shuts down service to all loads sharing the panel.

To assess the feasibility of Level 1 charging, the resident, property manager or owner and an electrician should review the annual peak load of the house panel to determine if there is available capacity. This information is often available from your electric utility at the request of the person named on the bill.

To support **Level 2 charging**, a dedicated 40-amp circuit is required. If there is sufficient capacity and breaker space on the panel, then additional breakers can simply be added to the panel to create the necessary dedicated circuits. When there is insufficient capacity or space on the electrical panel for a dedicated circuit, an electrician must create additional capacity in one of the following ways: upgrade to a new panel, reconfigure the current panel to provide more breaker space, add a sub-panel for the EVSE unit, or add a separate panel from the existing service.

1) Upgrade to a new panel

A panel upgrade replaces the existing panel (e.g. 50-amp) with one that has additional breaker space or with a new panel of greater capacity (e.g. 100-amp).

2) Reconfigure the current panel to provide more breaker space

Electricians may be able to creatively reconfigure the breakers on the existing panel to free up space for additional breakers. For example, a tandem circuit breaker allows for two circuits to be installed in one circuit breaker space.

3) Add a sub-panel for the EVSE unit

Electricians may also install a sub-panel. This is often done by replacing multiple breakers with a tandem circuit breaker and running a wire from it to the new sub-panel. The result is a sub-panel with space for multiple breakers including a dedicated one for Level 2 charging.

4) Add a separate panel from the existing service

An electrician may add a separate panel with a dedicated service for PEV charging. This requires a newly installed panel to connect to the current service drop or connection (sometimes called “tapping into” or “tapping off”). The resident and property manager or owner and an electrician should work with their local utility to ensure they follow all electrical service guidelines.

4.2.2 Cost of Adding Electrical Capacity at the Panel Level

In total, 78% of sites visited had access to 110/120-volt outlets in the parking environment. Depending on the parking layout, outlets were either scattered randomly throughout the parking environment or were available at each individual parking spot. Of these sites, 96% of the 110/120-volt outlets were connected to a 15- or 20-amp circuit on the house panel. Without permission to review the annual peak load, it is uncertain whether there is sufficient capacity on the house panel to facilitate Level 1 charging.¹³

For Level 2 charging, 93% of the sites visited were estimated to have insufficient panel capacity or breaker space. At these sites, additional capacity would need to be added through a panel upgrade, a reconfiguration of panel breakers, the installation of a sub-panel, or the installation of a new dedicated panel that is connected to the existing service. Adding capacity at the panel level may cost:

- 1) \$1,000 or more for a panel upgrade with new breakers,
- 2) \$60 to \$500 to reconfigure a panel’s breakers depending on its type, size and age,
- 3) \$500 to \$2,000 to install a sub-panel depending on distance between panel and sub-panel and the number and type of breakers, or

¹³ a request to the property managers and utility was not successful

- 4) \$1,000 or more to install a new dedicated panel and to connect to existing service depending on the space available for the panel and the distance between the new panel and the service connection.

Before a new panel (whether upgraded, sub-, or dedicated) is installed, a SCE representative will visit the site to review the installation and provide electrical code instructions. If the current panel is not up to the utility's current Electrical Service Requirement standards or there is no space for an additional panel, the installer may be required to move the entire meter section, resulting in an additional cost. For example, SCE requires flat ground below meters and three feet of clear working space in front of it so that staff can easily and safely access and read meters. If these standards are not followed, any electrical upgrade that requires SCE approval will require bringing the property up to code. This may include installing a concrete foundation beneath the meter box or moving the meter box in its entirety. Bringing the electric service up to current standards can represent an additional cost and a qualified electrician with experience within the utility territory should review the EVSE installation plan.

4.2.3 Upgrading Electric Utility Service to Multi-Unit Dwellings

When considering adding capacity at the panel level, the customer must contact the utility to determine whether there is enough power being provided to the property to support the added load of EVSE charging. If there is insufficient power, tenants or owners must apply for a utility service upgrade. A service upgrade can include service line upgrades such as replacing the service wire that is feeding the MUD, as well as distribution line upgrades such as replacing or upgrading the transformer.

4.2.4 Cost of Upgrading Electric Utility Service to Multi-Unit Dwellings

Adding capacity at the panel level may require upgrading the MUD's utility service. Service upgrades may be more likely when the MUD is located at the end of the utility's electrical lines served by a substation or in urban areas where building density has already maximized the electric service capacity.¹⁴ To accommodate additional capacity, the utility may need to perform service line and/or distribution line upgrades.

For these types of upgrades, SCE is "responsible for the cost of the service connector, connectors, support poles, and metering."¹⁵ These costs are covered by a residential allowance and any amount in excess of the allowance is billed to the customer. The customer is

¹⁴ California Department of Housing and Community Development. 2013. *Electric Vehicle Ready Homes*.

¹⁵ San Diego Gas and Electric. 2014. *Joint IOU Electric Vehicle Load Research Report*.

“responsible for any trenching, conduit, substructures, or protective structures required for the upgrade. These costs are not covered by the allowance.”¹⁶

Within SCE territory, if the service capacity from an overhead drop increases to over 200 amps, the customer is responsible for burying the overhead feed underground.¹⁷ This will likely require significant construction activities including trenching and the demolition of concrete and may lead to a cost-prohibitive project. Medium-sized MUDs (10-19 units) receiving electricity from an overhead drop may be at or above the 200-amp threshold and thus be subject to this rule and associated costs.

Out of 9,300 on-site residential service assessments for PEV charger installations completed before November 2014, SCE required service upgrades only 26 times (0.3%).¹⁸ The service upgrade costs ranged from \$274 to \$33,499, with service line upgrades averaging \$2,055 and distribution line upgrades averaging \$7,165.¹⁹ It is important to note that these include a significant share of single-family households that are more likely to have sufficient capacity available. SCE also needed 9 service upgrades for commercial installations which may be more reflective of medium- and large-sized MUDs. In the event that a service upgrade is required, the applicant shall be granted an allowance of \$3,402 per residential dwelling unit.²⁰

4.3 Connecting Charging Infrastructure to the Building’s Electrical System

Once there is sufficient power for PEV charging, the next set of installation costs is from providing electricity to the EVSE itself. This requires an electrician to run wires and conduit from the panel to the PEV charge point. If the panel is proximate to the EVSE location, the installation process can be straightforward. As the length between the panel and the EVSE site is extended, additional costs can arise from materials, labor and construction activities such as trenching through concrete or asphalt. In MUDs where parking areas represent a significant structural feature (e.g. subterranean garages), EVSE installation may require engineering tests such as x-raying concrete to ensure structural integrity.

Soft costs include permitting and inspection fees, tool rentals for construction or engineering activities, taxes on the materials purchased and contractor profit. Labor is often the most significant cost component of project installation and can vary depending on the contractor’s experience, complexity of job and whether the contractor is member of a trade union. The cost

¹⁶ San Diego Gas and Electric. 2014. *Joint IOU Electric Vehicle Load Research Report*.

¹⁷ Phone Interview with Southern California Edison (November 28, 2015).

¹⁸ San Diego Gas and Electric. 2014. *Joint IOU Electric Vehicle Load Research Report*.

¹⁹ San Diego Gas and Electric. 2014. *Joint IOU Electric Vehicle Load Research Report*.

²⁰ Southern California Edison Tariff Books. Rule 15.

of tool rentals will be related to the materials and type of labor required and will vary greatly from project to project. Taxes on materials vary by county and profit varies by the company contracted for labor.

Permitting, inspection requirements and associated fees vary by city and by county. The installation of EVSE and any corresponding electrical upgrade will likely require engineering drawings which must be reviewed by the responsible agency such as a Department of Building and Safety. Requirements for engineering drawings can vary and may require electrical load studies of the property.

4.3.1 Cost of Connecting Charging Infrastructure to the Building's Electrical System

Once there is sufficient electrical capacity to perform PEV charging, a contractor needs to run conduit and wire from the relevant panel to the PEV parking spot, overcoming any physical barriers that might arise. The cost of connecting charging infrastructure to the building's electrical system varies from site to site. The strongest predictor of costs is the distance between the panel with the EVSE-dedicated circuit and the PEV parking spot.

For the 27 MUDs visited, we found that the cost of installing Level 2 EVSE at MUD sites is variable and often high, ranging from \$1,800 to \$17,800, and averaging \$5,400. To contrast, Level 2 installation costs for single-family residences average \$1,500.²¹

The most significant component of installation costs is labor, at times accounting for over half of the total project cost. Table 13 provides share of costs per category for the 19 installation estimates.

Table 13. Average Category Costs across EVSE Installation Estimates

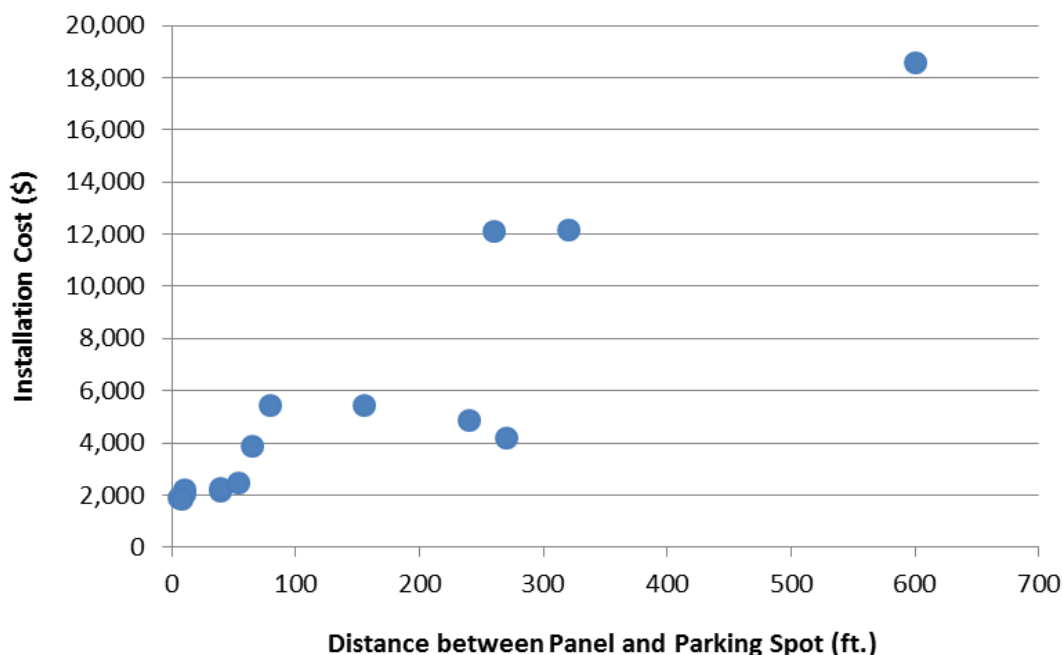
Cost Category	Average Share of Total Installation Costs	Range
Material	33%	28% - 40%
Labor	46%	41% - 56%
Tools, Permits and Fees	7%	3% - 10%
Other	13%	12% - 20%

Source: On Target Electric, for study purposes only

²¹ Electric Power Research Institute. 2013. *Electric Vehicle Supply Equipment Installed Cost Analysis*.

The further the distance between the EVSE and the PEV dedicated circuit, the greater the installation costs. Figure 11 confirms this correlation.

Figure 11. Estimated Total Installation Costs and Distance between Panel and EVSE



Source: On Target Electric, for study purposes only

EVSE installations that traverse long distances not only require greater lengths of conduit and wiring, but also increase the likelihood of requiring significant construction and engineering activities. For each of the six MUD sites visited that required a wiring and conduit run of 100 feet or greater, additional construction and engineering work would be needed. Table 14 presents the construction and engineering requirements for the six MUD sites with 100 feet or more between the relevant panel and the PEV parking spot.

Table 14. Construction and Engineering Activities Impact on Overall Estimated Costs

MUD Site	Construction/Engineering Type	Material and Labor Construction/Engineering Costs²²	Share of Total Material and Labor Costs
1	Drilling foundation	\$180	5%
	Demolition, rework and patching		
2	Drilling foundation	\$238	8%
	Demolition, rework and patching		
3	Rework of gutter	\$920	22%
	Demolition, rework and patching		
4	Coring	\$2,655	40%
	X-ray		
	Engineering plans		
5	Rental equipment lift	\$3,071	22%
	Demolition, rework and patching		
	Engineering plans		
6	Coring	\$4,600	48%
	X-ray		
	Demolition, rework and patching		

Source: On Target Electric, for study purposes only

4.4 Opportunities to Reduce Charging Infrastructure Installation Costs

Strategies can be deployed to help reduce the cost of EVSE installations at MUD sites. As multi-unit dwellers reside on the same property and often share parking environments, dividing the installation costs among multiple PEV drivers can be practical and greatly reduce the per driver cost. If group purchasing is unavailable, a PEV driver may rely on Level 1 charging to avoid installation costs altogether. This section reviews these two cost saving strategies.

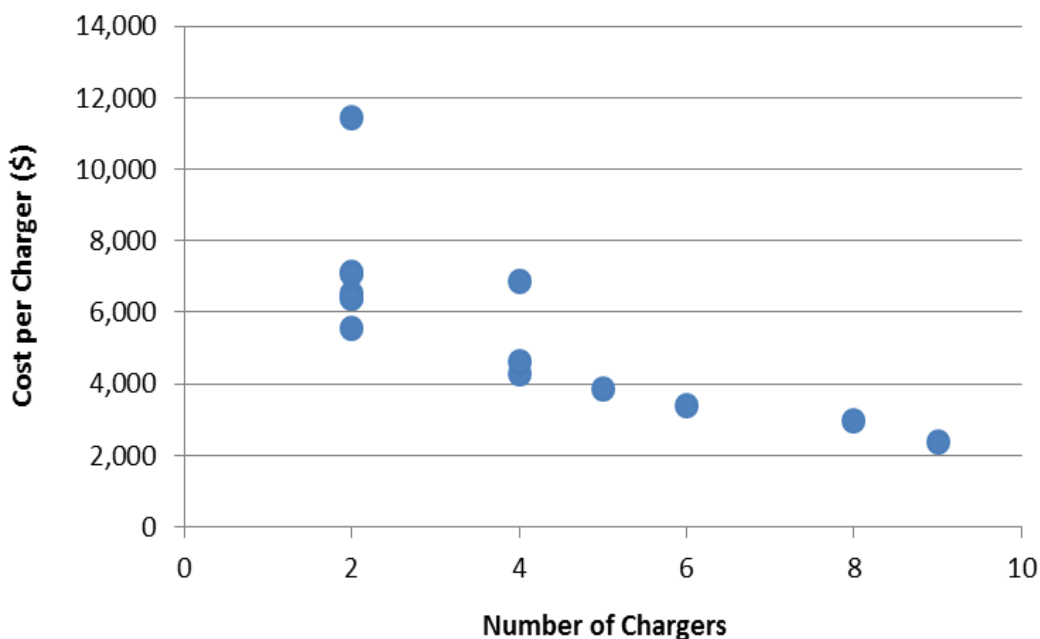
4.4.1 Cost Advantages to Group Investing in Level 2 Charging Infrastructure

Economies of scale can be realized when EVSE installation costs are shared between multiple MUD residences. Figure 12 shows the decreasing cost per EVSE as additional EVSE are installed. When considering EVSE installation, an owner or renter should survey neighbor units

²² Does not include material tax or profit; assumes \$60 per hour prevailing wage for labor

to gauge interest in PEV ownership and to potentially share the costs associated with EVSE installation.

Figure 12. Cost Reductions Achieved due to Multiple EVSE Installations



Source: On Target Electric, for study purposes only

Technological solutions (often referred to as “Smart Chargers”) can support group investments in EVSE installation. For example, energy saving technologies such as energy management systems (EMS) can be installed to optimize the number and use of multiple PEV charges. The management of energy in response to vehicles’ state of charge and a building’s available electrical capacity can delay the need for costly electrical upgrades.²³

4.4.2 Accessing Level 1 Charging to Avoid Electrical Upgrades

MUD parking environments with access to 110/120-volt outlets may represent quality candidates for Level 1 EVSE charging. This will ultimately be determined by the PEV driver’s available charge time and daily commute, as well as the electrical configuration tied to the

²³ Standalone smart charging equipment can range from several hundred dollars to upwards of \$1,000; Service providers such as Chargepoint provide smart charging equipment as part of their standard EVSE installation costs (which are variable by site installation).

parking area outlet. The availability of Level 1 charging can avoid the high installation costs often required for Level 2 charging.

Seventy-eight percent of MUD sites visited had access to a 110/120-volt outlet in their parking areas and 96% of these were tied to the house panel. The resident, property manager or owner and an electrician should review the annual peak load of the house panel to determine if there is available capacity considering other loads tied to the panel, such as laundry machines, pool pumps, etc. This information is often available from your utility at the request of the person named on the electric bill.

If the house panel does not have sufficient capacity to supply the additional PEV load, strategic energy efficiency measures may be deployed to reduce the overall load of the house panel. This can include efficient lighting, or energy efficient replacements for a property's electric water heater, washer/dryer, or pool pump. Electric utilities offer several rebates and incentives to improve efficiency.

CHAPTER 5:

Policy Tools to Overcome the Multi-Unit Dwelling Barrier to PEV Adoption

To achieve the ambitious zero-emission vehicle (ZEV) adoption goals of the State of California, and to ensure equitable distribution of the benefits of ZEV, residents of multi-unit dwellings (MUDs) must have the option to charge their plug-in electric vehicles (PEVs) at home. This is particularly true for a South Bay subregion that has 144,132 MUD households. As reviewed in Chapter 4, the cost of EVSE installation at MUD sites is variable and often high. Moreover, property owners show a low- to non-existent motivation to invest in charging infrastructure. This dis-interest is related to the absence of tenant requests to provide it. This is an example of the chicken-egg syndrome.

In order to break into the circular causality of vehicle purchases and MUD charging, regional, subregional and municipal governments, as well as state agencies, air quality management districts and utilities (hereafter “other administrative entities”) will likely need to deploy policy tools to overcome the MUD barrier to PEV adoption. Increasing PEV ownership among tenants may provide the demand to which the owners will respond. However, that may come too late for meeting the adoption goals since currently it is not rational to purchase a vehicle that must be fueled at home if home fueling is not available.

Policy solutions aimed at expanding access to PEV home charging for MUD residents can be approached in three distinct ways - The first two are traditional, and the third is based on the Sustainability South Bay Strategy:

1) reduce the cost of installing PEV charging at MUDs and/or develop business plans so that charging can become a profit center for owners.

Governments and other administrative entities may opt for a top-down policy intervention to help ease the cost barrier to MUD home charging. This can include:

- Rebates designed to reduce the cost of EVSE installation at MUD sites;
- New building requirements and codes to ensure PEV readiness;
- Public charging programs to be provided and potentially administered by local government entities;
- Complementary programs such as Southern California Edison’s Charge Ready program and the California Air Resources Board’s Plus-up Program finding synergies in outreach to maximize participation.

2) motivate property owners or homeowner associations to invest in PEV home charging.

This second strategy requires generating enough PEV demand from apartment renters or condominium owners that property owners or homeowner associations (HOA) view home charging as an amenity by which to increase their property value and attract renters or owners – similar to on-site laundry services. This effectively shifts the investment motivation from the renter to the property owner or from the condo-owner to the HOA. Outreach and education that promotes the financial and environmental benefits of the PEV—while educating the audience on PEVs and the installation of EVSE at MUDs—can help overcome the uncertainty of transitioning to a new technology. The following chapter reviews these potential policy solutions to overcome the MUD barrier to PEV adoption.

3. Adopt policies that encourage small battery, short range vehicles that are meant to charge on Level 1 service.

The strategy is to downsize the vehicle to match the documented driving needs of the majority of trips as well as the 78% of the MUDs that currently offer Level 1 charging in the parking area, rather than upgrade the infrastructure to satisfy large battery vehicles (see 5.6 below).

5.1 Designing Rebates to Reduce the Cost of EVSE Installation

Policymakers design public incentives with the aim of inducing consumers to adopt innovative technologies. Such incentives may include price subsidies, rebates, tax credits, sales tax exemptions, and subsidized financing. Rebates are currently provided to Californians to increase the adoption of PEVs. The Clean Vehicle Rebate Program (CVRP) offers PEV buyers \$1,500 for a plug-in electric hybrid (PHEV) or a \$2,500 rebate for a battery electric vehicle (BEV) after purchase. Sixty-five percent of PEV drivers found the CVRP to be extremely or very important to their purchase decision.²⁴ The State, local municipalities and other administrative entities can also provide free or subsidized Level 2 chargers. Sixty percent of early adopters of the PEV found a rebate to be extremely or very important to their decision to install a Level 2 charger.²⁵ Due to the variable and often high cost for installing EVSE at MUD sites, an EVSE installation MUD rebate may prove to be an effective policy tool to ease the cost barrier and expand PEV access.

Using the cost estimates and the MUD parking type estimates for the South Bay, the weighted average of Level 2 EVSE installation for South Bay MUDs is estimated to be \$4,468.²⁶ To retrofit

²⁴ California Center for Sustainable Energy. 2014. *California Plug-in Electric Vehicle Driver Survey Results*.

²⁵ California Center for Sustainable Energy. 2014. *California Plug-in Electric Vehicle Driver Survey Results*.

²⁶ This removes two high outliers (>\$10,000) and should be viewed as lower-cost installations or low-hanging fruit properties.

10% of current MUD parcels,²⁷ a rebate that fully covers the estimated weighted average cost of installation would cost a total of \$4,305,000.

To increase the cost-effectiveness of this substantial rebate, and to maximize the adoption of PEVs at MUDs, the efficacy and ancillary costs of allowing and managing equipment and/or systems for multiple PEV drivers to share EVSE equipment and utilize energy management applications should be studied for consideration as a rebate options. As reviewed in Section 4.4.1, the high variable costs for Level 2 EVSE installations provides an opportunity to share costs across multiple residences. Likewise, the opportunity exists to share the rebate cost across multiple residences and provide a greater number of PEV drivers home charging access per rebate dollar spent.

The range of incomes found in the South Bay may lend itself to tiered rebates based on consumer income levels. These types of progressive rebates have been found to be more cost effective, have lower total policy costs, and result in greater equity.²⁸

Alternative rebates may also prove to be effective but at lower total policy costs. For example, a rebate can be designed around evaluating the Level 1 PEV readiness of MUDs in the South Bay – a charging strategy we view as feasible for many drivers and one that is likely already available at a significant number of sites. In 27 site visits across the South Bay, 78% of MUDs provided a 110/120-volt outlet in the parking area. With access to an outlet, besides working out how to pay the cost of the electricity used, the driver would only need to ensure the panel that the outlet is connected to has sufficient electrical capacity to Level 1 charge. For a lower cost and potentially highly effective rebate design, consideration should be given to a program that partners with utilities²⁹ and covers the cost for local electricians to review the electrical capacity of the panel providing electricity to the parking area outlets and to conduct an overall assessment of charging readiness. This cost could be included in an enhanced rebate if the project is implemented.

5.2 Implementing PEV Ready New Construction Codes

Local jurisdictions may set guidelines for remodels and new MUD construction that require developers to provide Level 1 or Level 2 charging readiness. Many new building code examples exist throughout California that can serve as models for the cities of South Bay. Local jurisdictions should implement the 2013 California Green Building Standards, which in relation

²⁷ excludes duplexes and triplexes (963 total parcels of 4+ units)

²⁸ DeShazo, J.R., Samuel Krumholz, Tamara L. Sheldon et al. UCLA Luskin Center for Innovation. 2015. *Learning from California's Early Plug-in Electric Vehicle Market Growth and Policy Experiments: 2010-2015*.

²⁹ a utility's primary role can be to be responsive to annual peak load requests per site

to PEVs in MUDs state that “at least 3 percent of the total parking spaces, but not less than one, shall be capable of supporting future electric vehicle service equipment (EVSE).”³⁰

Even more, jurisdictions can follow the lead of cities such as Los Angeles whose Green Building Code (Chapter IX, Article 9, of the Los Angeles Municipal Code) mandates newly constructed “high-rise” residential (i.e. multi-level MUDs) to be Level 2 charging-station ready and requires “220/ 240 Volt 40 Amp outlets equal to 5 percent of the total number of parking spaces, with the outlets located in the parking area.” Jurisdictions may also propose PEV readiness mandates for remodels in addition to new construction.

Unfortunately, much of the South Bay’s residential land use is built out. If new construction codes were adopted by the South Bay cities, it would take 43 years at current construction rates³¹ for 10% of MUDs to be capable of providing PEV charging access. The City of Torrance has built the greatest number of MUD parcels since 2000 followed by Redondo Beach. These cities should create and implement PEV ready new construction codes as quickly as possible.

5.3 Siting Public Charge Programs to Provide Charging for MUD Residents

Local governments can also provide alternative public charging sites in locations such as city-owned parking lots. Strategic siting of Level 2 or DC Fast Chargers near MUD clusters may provide an option for multi-unit dwellers who cannot charge at home.

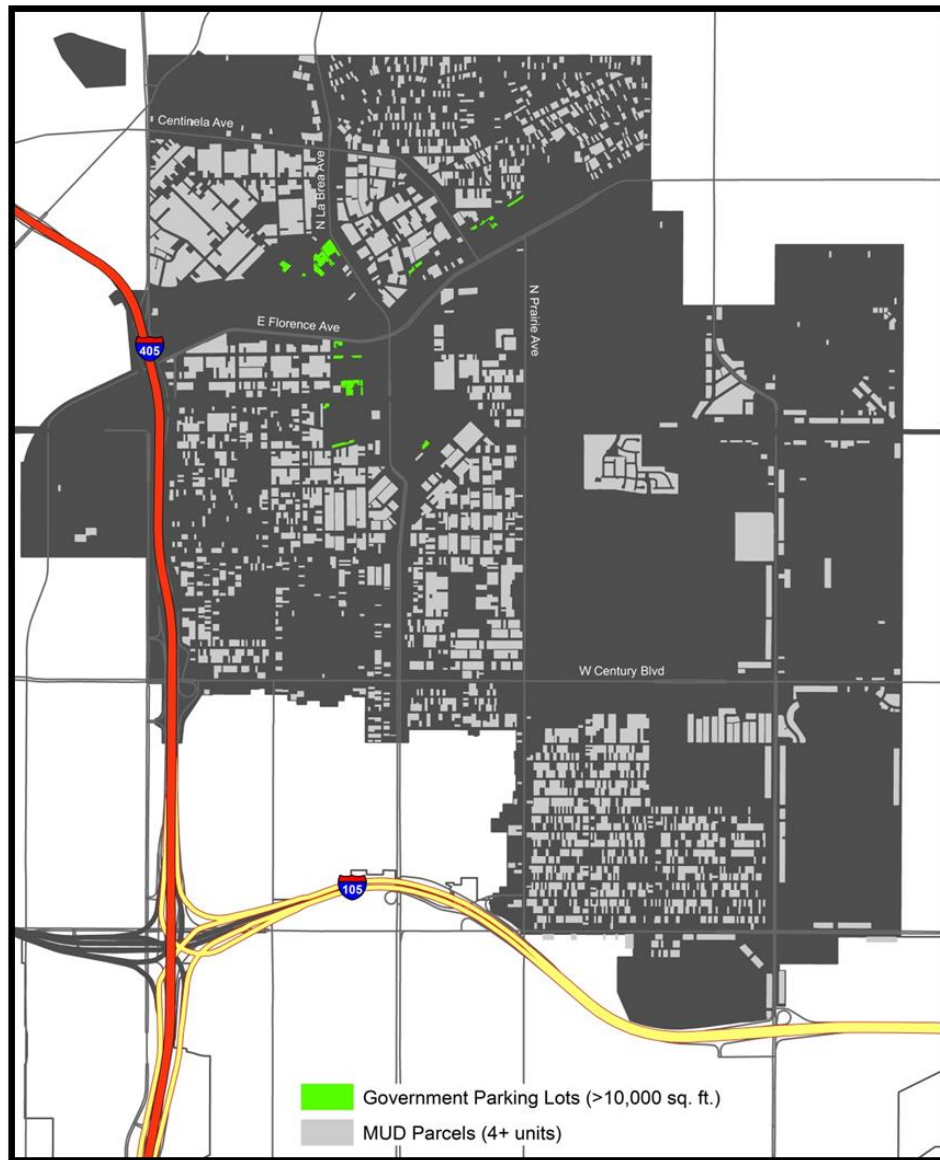
There are a number of potential dual-use parking possibilities throughout the South Bay. They include where large MUDs are adjacent to parking for public facilities such as schools, colleges, parks, recreation and civic centers. A charging program for dual use lots may need to be administered by a local government to organize and coordinate charge times etc.

Figure 16 provides an example of city-owned parking lots in Inglewood that may be candidates to host a charging program for MUD residents.

³⁰ California Department of Housing and Community Development. 2013. *Electric Vehicle Ready Homes*.

³¹ 220 MUD parcels (includes only 4+ unit MUDs) constructed between 1998 and 2008, the final full year of data.

Figure 16. City of Inglewood Owned Parking Lots adjacent to MUD Clusters



Source: Los Angeles County GIS Data Portal, Los Angeles County Office of the Assessor Secured Basic Abstract File

5.4 Outreach and Education to Drive PEV Ownership and Shift EVSE Investment Motivation to MUD Owners

The PEV remains a relatively new technology. Substantial sales of the battery electric vehicle (BEV) started only in 2010, and most believe we are still in the very early stages of PEV

adoption.³² As with many new technologies, consumers have been hesitant to switch out their internal combustion engine (ICE) for a PEV. Some of this hesitation can be rooted in the comfort level drivers have with the ICE - the dominant form of private transportation for over a century whose refuel infrastructure is robust and easily accessible; and some can be the result of the uncertainty and concerns that come with a new technology, as evident with range anxiety – the fear of running out of battery mid-trip.

Outreach and education can respond to this hesitation and help introduce potential PEV drivers to the new technology by promoting its environmental and financial benefits as well as answering common questions and concerns. From an EVSE in MUD perspective, the goal with outreach and education is to drive demand for home charging among MUD residents, and shift the investment motivation from the renter to the property owner, who may be motivated to attract tenants by providing new amenities. With strong PEV adoption rates in the South Bay, as well as large number of high-value MUDs (10,013 MUD households over \$500,000 per unit), the subregion may help lead this shift in investment motivation.

Outreach and education can include direct mailing initiatives, advertising, hosting workshops, and emailing newsletters. For a neighborhood level outreach to be conducted by local government or by Southern California Edison (SCE) and the Charge Ready Program, the census tracts proposed in Chapter 3 provide high-quality candidates based on the prevalence of the MUD and an estimated high latent PEV demand. The outreach and education materials should focus on a series of topics including:

- **New technology education** including available makes and models and associated lifespan, range, and maintenance requirements; purchase or lease costs and associated rebates; charging technologies such as Level 1 and Level 2 charging including a time of recharge tool (with Level 1 highlighted as a feasible charging choice); and location of public chargers and convenient apps that provide easy access to this information.
- **Environmental and financial benefits** including emissions avoided and fuel savings
- **Charging in MUD education** including instruction on how to evaluate panel electrical capacity for Level 1 (20-amp circuit with available panel capacity) and Level 2 charging (40-amp circuit with available panel capacity) and how to identify cost drivers for EVSE installation (as reviewed in Chapter 4).
 - For level 1 charging, instruction on how to verify available electrical capacity on the house or unit panel by reviewing shared loads such as laundry machines, pool pump, etc., as well as the annual peak load from the utility bill.
 - For Level 2 charging, instruction on how to evaluate installation cost drivers including the distance from the electrical box or relevant electrical panel to the

³² DeShazo, J.R., Samuel Krumholz, Tamara L. Sheldon et al. UCLA Luskin Center for Innovation. 2015. *Learning from California's Early Plug-in Electric Vehicle Market Growth and Policy Experiments: 2010-2015*.

PEV parking spot.

- Insight into the cost advantages of group purchases for Level 2 charging installation including recommendations to survey other tenants' interest for PEV ownership.
- **Renters' rights' education** including CA SB 880 which makes it illegal to impose any condition that "effectively prohibits or unreasonably restricts" installation of charging in an owner's designated parking space and CA AB 2565 which requires a lessor of a dwelling to approve a request to install EVSE at a designated parking spot if the installation "complies with the lessor's procedural approval process for modification of the property."
- **South Bay specific benefits** including the cost and time savings that come from access to high-occupancy vehicle (HOV) lanes, a benefit that has had a significant impact on PEV sales.³³
- **Specialized and culturally sensitive outreach and education** including Spanish language materials and income-adjusted rebate information such as with the Enhanced Fleet Modernization Program (EFMP) Plus-up Program (see below) to be provided to the disadvantaged communities of the South Bay.

Increasing adoption among low- and moderate-income households within disadvantaged communities will be a particular challenge to achieve the environmental equity goals of California. Low- and moderate-income households are less likely to purchase a new vehicle and many reside in MUDs that will not have access to home charging.³⁴

California is expected to commit \$20 million from the Greenhouse Gas Reduction Fund (GGRF) to be administered by the California Air Resources Board (ARB) through the Enhanced Fleet Modernization Program (EFMP) Plus-up Project in the fiscal year 2015-16.³⁵ The program provides low-income households up to \$12,000 for the purchase or lease of a battery electric vehicle (BEV).³⁶ To qualify, the household must live in a zip code that includes a disadvantaged community census tract. With the EFMP Plus-up Program and the Charge Ready program, ARB and SCE are providing complementary incentives – one for the PEV itself and the other for

³³ DeShazo, J.R., Samuel Krumholz, Tamara L. Sheldon et al. UCLA Luskin Center for Innovation. 2015. *Learning from California's Early Plug-in Electric Vehicle Market Growth and Policy Experiments: 2010-2015*.

³⁴ The used EV market is, at present, undefined in terms of adoption across all communities.

³⁵ Rabin, Jeffrey, Colleen Callahan, and J.R. DeShazo. UCLA Luskin Center for Innovation. 2015. *Guide to Greenhouse Gas Reduction Fund Program Designs, Expenditures and Benefits*.

³⁶ Includes the \$2,500 Clean Vehicle Rebate Program (CVRP) rebate.

access to home charging - to a population far less likely to invest in new vehicle technologies and its charging equipment.

We recommend ARB, the South Coast Air Quality Management District as well as the South Bay's utilities (SCE and LADWP) optimize outreach effectiveness by conducting joint efforts within disadvantaged communities. Events such as "ride and drives" can be held with representatives from both programs to showcase the PEV, as well as the significant amount of savings that can be leveraged when participating in both programs. Additional mailing campaigns and workshops are also encouraged where both programs and the potential savings are promoted. Section 2.6 in Chapter 2 shares the disadvantaged census tracts in the South Bay with MUDs. Event staff and outreach materials should be conscious of language barriers and culture and adjust accordingly.

5.5 Advocating "Right-Ranging" Vehicle Choices

A new approach to MUD charging is to advocate short range, small battery, slow speed vehicles that charge only on Level 1. This class of vehicles includes Neighborhood Electric Vehicles (NEVs), electric bikes, and Segways as well as spate of recent personal mobility devices. We refer to them as Local Use Vehicles (LUVs).

This captures the idea of "charging demand management." Rather than install expensive Level 2 charging infrastructure to satisfy expensive full speed BEVs which are not needed for most trips, simply extend from the 78% of MUDs with functioning Level 1 charging available in the parking area to 100% of MUDs.

The SBCCOG has been studying travel patterns in the South Bay for 14 years, including NEV and BEV demonstration projects where GPS tracked the ICE vehicle and the trial electric vehicle usage in each participating household. These projects uncovered a a surprising reality – most drivers were unaware of their actual mobility needs and tend to substantially over estimate their miles driven.

The GPS records revealed that 70% of a household's trips were 3 miles or less. There is no reason why a full speed, long distance ICE vehicle should be used for 1, 2 and 3 mile trips. Some form of LUV would be an adequate substitute and at a fraction of the cost for the vehicles as well as the charging infrastructure.

MUD owners and tenants could save millions with this strategy with no sacrifice in mobility and PEV deployment could advance much more rapidly than by waiting for MUDs to get retrofitted with Level 2 charging infrastructure. The key is helping households understand their actual mobility needs.

One barrier to this strategy involves CARB's CVRP which provides the largest subsidy to full speed, big battery vehicles while offering virtually nothing to small battery LUVs . CARB has for years been focusing its investments on vehicles that replicate the performance characteristics of ICE vehicles – high speed with long range on a single charge based on large batteries. We

recommend that CARB conduct a trial project whereby maximum subsidies are offered to LUVs (cost range from under \$1,000 to around \$12,000). This may be the best way to meet the 2025 ZEV mandate.

Similarly, CARB did not include NEVs in its car sharing pilot project in disadvantaged communities. The logic was that NEVs would be perceived as offering disadvantaged communities less than what more affluent communities get. The issue is what does any household actually need and what is the most cost-effective manner of providing for those needs? It's quite possible that every community would prefer a short range option for more households over more car for fewer households.

Local governments can play a significant role in promoting LUVs. In addition to the education function mentioned above, cities have policies that govern parking and street right-of-way management. Preferential parking for LUVs would provide a very practical incentive to LUV use. Similarly, creating a slow-speed network on city streets (only slightly wider than a bike lane) would incentivize LUV usage.

The SBCCOG has been interested in developing and demonstrating a "decision tool" that would assist household members identify vehicle options based on their actual driving needs. Users would be asked to enter data regarding the distance to a large set of destination types. Knowing that 70% of trips are 3 miles or less, most users will find a LUV is one of their purchase options.

Appendix A:

EVSE Installation Case Studies from the South Bay Region

When reviewing the EVSE installation cost estimates for the sites visited, multiple factors influenced the cost of installation. The following presents three Level 2 charger installation case studies to highlight these cost factors and provide insight into how they resulted in a high or low cost of installation.

Case Study 1: Low-cost Re-working of Panel for a 4-unit Dingbat with Door

Case Study 1 presents the estimated costs of installing Level 2 EVSE at a 4-unit MUD with a dingbat with door parking layout. The site's electrical box is located on the northern side of the building and shares a wall with the parking garages. The house panel has a 30-amp circuit breaker (as shown by red box in Figure 13) that leads to an existing sub-panel in the garage that shares the wall with the electric box.

Figure 13. House Panel and Garage Sub-panel for Case Study 1

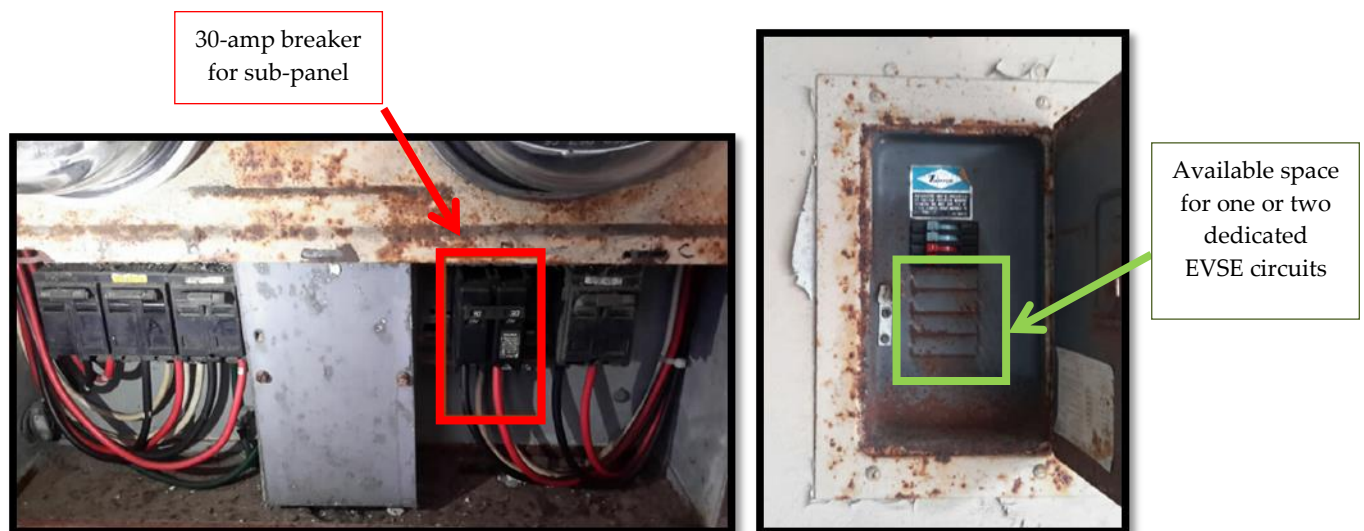


Photo Credit: On Target Electric

The electrician anticipated an easy re-working of the panel by upsizing the existing 30-amp breaker to 50 amps, and then pulling the cover from the sub-panel to add one or two dedicated 40-amp breakers (at the site of the green box in Figure 13) for one or two Level 2 EVSEs. The preexisting equipment and necessary electrical configuration resulted in an estimated installation cost of less than \$2,000 for two EVSEs.

Case Study 2: High-cost Coring of Parking Deck for a 42-unit MUD with Subterranean Garage

Case Study 2 presents the estimated costs of installing Level 2 EVSE at a 42-unit MUD with a subterranean garage. The site's electrical room (seen in Figure 14) is located on a different level than the parking garage and receives power from the utility through an underground service connection. To run wire and conduit from a newly installed dedicated panel to the EVSE installation site, a contractor will need to x-ray the subterranean parking deck that needs to be cored through to ensure foundational integrity.

Figure 14. Electrical Room and Conduit for Case Study 2



Photo Credit: On Target Electric

In total, the construction and engineering requirements for this job represented 48% of the material and labor costs with a total cost estimate of well over \$10,000.

Case Study 3: High-cost Trenching for a 4-unit MUD with a Detached Parking Garage with Door

The final case study presents a cost estimate for a Level 2 EVSE installation at a 4-unit MUD with a detached parking garage with door. The garage is set on the back of the property line and does not share any walls with the main MUD structure. The MUD receives electricity through an overhead drop at the front of the building (indicated by green circle in Figure 15), where a separate dedicated panel would need to connect.

Figure 15. Electrical Service Drop and Detached Parking Layout for Case Study 3



Photo Credit: Google Earth, On Target Electric

The distance from the service drop to the detached garage is about 120 feet. The wire and conduit needs to be surface-mounted along the length of the MUD structure and trenched below the concrete driveway at the back of the main MUD structure. A subcontractor would need to trench beneath the concrete driveway which requires the demolition and hauling away of concrete, the trenching itself, and the pouring of new concrete over the buried wire and conduit. This exercise alone is estimated to cost thousands of dollars and the project, in total, over \$20,000.

Appendix B:

Evaluating Charging Potential in Various Parking Configurations in the South Bay

Although the ability for a PEV driver and MUD resident to charge at home varies from site to site, some parking layouts in the South Bay can provide greater access to 110/120-volt outlets and Level 1 charging, as well as lower cost installation solutions for Level 2 charging. For example, parking layouts such as the dingbat with door and higher-value detached parking garages with door are likely to have access to a private 110/120-volt outlet. And while the detached parking garage may be a quality candidate for Level 1 charging, it may not be for Level 2 charging due to the strong probability of trenching below asphalt or concrete during installation. The Level 1 and Level 2 charging potential for different MUD parking layouts based on our observations from visiting MUD sites throughout the South Bay.

Level 1 Charging Opportunities

For Level 1 charging, PEV drivers need access to a 110/120-volt outlet and sufficient electrical capacity on the house or unit panel. Many driver's travel needs can be satisfied by an overnight Level 1 charge, making this a possible strategy to recharge PEVs under the MUD's current electrical configuration and avoiding the need to install Level 2 charging. The resident, property manager or owner and an electrician should review the annual peak load of the house or unit panel to determine if there is available capacity. This section outlines the opportunities for Level 1 charging at the nine most common MUD parking layouts of the South Bay: dingbat with and without door, detached parking with and without door, podium garage, subterranean garage, parking lot and driveway only.

Dingbat with door

It is likely that a significant share of MUDs in the South Bay that have a dingbat with door parking layout will have access to a 110/120-volt outlet in their parking garage. The likelihood is particularly high if the door is automatic, as it shows some electricity is already being fed to the garage. At each dingbat with door parking site visit, a PEV driver would have private access to Level 1 charging.

It is extremely likely that the outlet is connected to the house panel. This represents an opportunity but also a potential issue. If there are no significant loads such as a laundry machine or pool pump on a medium- or large-amp rated panel (50-100 amps), it may have the capacity to support Level 1 charging. In these cases, PEV drivers and the property owner or management group should keep track of an increasing number of PEVs and other loads that

may use the house panel.³⁷ If more than one PEV charges simultaneously throughout the night, electrical issues such as tripping the main breaker can occur.

For condominiums, garage outlets may be connected to individual unit panels. This represents an even greater opportunity for Level 1 charging as the condo owner will have greater access to information on their electricity use and be able to control circuit loads that share their unit panel. For example, they can choose not to wash clothes while charging their PEV.

Dingbat without door

MUDs that have a dingbat without door parking layout will also likely have 110/120-volt outlets, although these may be scattered across the parking environment. One lower-value dingbat without door (under \$50,000 per unit) did not have access to any outlet.

These outlets are almost always connected to the house panel so again, consideration to capacity and shared loads should be made. In scenarios where tenants have assigned parking, swapping spots may allow PEV owners to access the outlet.

Detached parking garage with door

For MUDs that have detached garages with doors, it may be less likely to find an outlet in each individual garage, although MUDs of a higher value and/or newer vintage are more likely. If the door can be opened automatically, there is also a higher likelihood of access to an outlet. One lower-value detached garage with door (under \$50,000 per unit) did not have access to 110/120-volt outlets, and was used only for storage.

Detached parking without door

MUDs that have detached parking without doors may be the least likely to have access to a 110/120-volt outlet. Four out of six detached garages visited did not have an outlet in the parking area. If outlets are available, they may be scattered. When parking is assigned, residents may need to swap parking spots to gain access to Level 1 charging.

Subterranean garage and podium garage

MUDs that have subterranean or podium garages and are likely to have similar access to 110/120-volt outlets. Every subterranean garage and podium garage visited did have at least one outlet available. They may be scattered throughout the shared parking environments so in assigned parking scenarios, parking spots may need to be swapped.

Driveway only

MUDs that have driveways only are unlikely to have access to a 110/120-volt outlet. There may be an opportunity for Level 1 charging if there is an outlet on the outside wall of the MUD that faces the driveway.

³⁷ At one site, researchers heard anecdotal evidence of PEV charging tripping the house panel's main breaker. The 9-unit MUD's house panel was rated at 50 amps which fed the garage outlets, shared space lighting, and a sub-panel for a washer and dryer machine and an electric water heater.

Parking lot

MUDs that have parking lots are unlikely to have access to an electrical outlet.

Level 2 Charging Opportunities

Level 2 charging requires a dedicated 40-amp circuit breaker and wiring and conduit from the dedicated breaker to the EVSE unit. The distance between the breaker and EVSE unit may be influenced by the parking layout of the MUD; the further this distance, the more likely installation costs will rise. The nine common parking and electrical layouts found in the South Bay MUDs including those that may offer less expensive Level 2 EVSE installation opportunities.

Dingbat with door

Some MUDs with the dingbat with door parking layout have access to the unit panel if the garage is below or in front of the unit (which is often the case), reducing the length of distance between the panel and parking spot. Although the distance between the two may be minimal, the wiring and conduit may need to be cored through unit walls and/or the floor.

We observed one dingbat with door condominium where the unit panel was inside the garage. This left very little distance between the panel and potential EVSE location, and is likely to result in a low cost EVSE installation.

Without access to the unit panel, the EVSE will need to be connected to the house panel or a separate dedicated panel. The distance from the EVSE to the panel will vary greatly from site to site, and parking spot to parking spot. Although there may be some distance between the dingbat garage and the panel, the two are usually at the same grade and may not require any subterranean coring through foundation or trenching through asphalt or concrete. The most frequent construction activity will be coring through the garage wall.

Dingbat without door

MUDs that have the dingbat without door parking layout offer a similar Level 2 EVSE installation assessment to dingbat with door, although coring through a wall may not be needed. The conduit and wiring can often be surface-mounted along the length of the parking site

Detached parking garage with door and without door

MUDs with detached parking garages with and without doors both present a host of problems for installing Level 2 charging. Case Study 3 provided a common installation story for these parking layouts. Because parking is usually separated from the MUD structure and the house and unit panels by concrete or asphalt, running wiring and conduit from the panel to the EVSE is likely to require a construction activity such as trenching.

Subterranean garage

MUDs with subterranean parking garages may present Level 2 EVSE installation issues when the building's electrical box is on the ground floor. This is because the wiring and conduit may need to traverse through building material and/or Earth. Large subterranean garages may also have multiple levels of parking and thus may require coring through concrete decks. These difficult conduit pathways may require foundational tests such as the x-raying of concrete as well as using heavy machinery and hiring skilled labor.

When the electrical box is located within the parking garage and there is space available, connecting to the existing service may be present a lower-cost installation opportunity.

Podium garage

MUDs with podium parking garages are likely to have its electrical box on the same level as the parking area. Therefore, the risk of coring through structure or ground may not be as prevalent when compared to subterranean garages. For small and medium-sized podium garage MUDs (4- to 20-units) that are served through an overhead feed, the electrical box may be mounted on the outside of a wall that is shared with the parking garage. With the distance between panel and parking spot reduced, this structural configuration may lend itself to a lower-cost installation.

Podium and subterranean garages may also provide an opportunity to deploy cost reduction strategies discussed in Section 4.4.1. Group investments of EVSE may be more practical in shared garage environments as the EVSE units can be chained along the wall. Likewise, technologies such as energy management systems can more easily be installed and accessed by multiple PEVs.

Appendix C:

MUD Owner's Toolkit



Owners' Tool Kit for Electric Vehicle Charging Stations in Multi-Unit Dwellings

Prepared for: California Energy Commission

Prepared by: South Bay Cities Council of Governments and
UCLA Luskin Center for Innovation

NOVEMBER 2016

CEC-ARV-14-305



Electric Vehicle Charging Stations and MUDs in The South Bay

The purpose of this toolkit is to inform apartment owners and homeowners associations (HOAs), also known as Multi Unit Dwellings (MUDs), about the opportunity to install Electric Vehicle (EV) charging in the South Bay. To understand this opportunity, we are providing you with the following:

- State and local policy goals for electric vehicle adoption
- Laws that pertain to electric vehicle charging at MUDs
- Types of electric vehicle charging equipment
- Installation steps for electric vehicle charging equipment
- The benefits and incentives to MUD owners and managers which include:
 - Attracting Future Tenants
 - Revenues from amenity fees
 - Available SCE and LADWP rebates
 - Electric Vehicle Charging Fee Models
 - Tax credit

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

Overview of Electric Vehicles Types

Plug-in electric vehicle or PEV is a general term for any car that runs at least partially on battery power and is recharged from the electricity grid. PEVs sold in California include: Battery Electric Vehicle (BEV), and Plug-in Hybrid Vehicle (PHEV)

Battery-electric vehicles or **BEVs** run completely on electricity stored in batteries and have an electric motor rather than a gasoline engine. Most BEVs have a limited range of approximately 100 miles. This means that a resident with a BEV who uses it for the majority of their trips must have access to charging on a daily basis in order to operate their vehicle. An example is the Nissan Leaf.



2016 Nissan Leaf



Nissan Leaf Charge Port

Plug-in Hybrid Electric Vehicles or **PHEVs** combine two propulsion modes in one vehicle – an electric motor that is battery powered and can be plugged in and recharged, and a gasoline engine that can be refueled with gasoline. Ideally residents with a PHEV will be able to recharge at their residence but if they cannot, they may operate their vehicle in gasoline mode. An example is the Chevrolet Volt.



2016 Chevrolet Volt



Chevrolet Volt Charge Port

Another term for EVs is **Zero Emissions Vehicles** or **ZEVs**. These are vehicles such as BEVs that emit no tailpipe pollutants from the onboard source of power. Plug-in Hybrid Electric Vehicles or PHEV are known as transitional ZEVs since they operate on electricity but may also operate on gasoline.

Benefits of Plug-in Vehicles to our community

Adoption of plug-in electric vehicles by South Bay residents will provide several benefits to the community.

1) Lower Emissions leading to improved health

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

California has relatively large environmental damages from gasoline vehicles that burn fossil fuels. Electricity generation in California, on the other hand, uses a mix of fossil fuels and renewable energy, producing less air pollution than the burning of gasoline for the same amount of energy supplied. This implies a large positive environmental benefit of an electric vehicle.

2) Increased Fuel Economy leading to lower costs

PHEVs and BEVs can reduce fuel costs dramatically because of the low cost of electricity relative to conventional fuel. Because they rely in whole or part on electric power, their fuel economy is measured differently than conventional vehicles. Today's BEVs (or PHEVs in electric mode) can exceed 100 mpge (miles per gallon equivalent) and can drive 100 miles consuming only 25-40 kWh (kilowatt hours).

3) Energy Security leading to less reliance on foreign countries

Using PEVs instead of conventional gas-powered vehicles can help reduce U.S. reliance on imported petroleum and increase energy security. Plug-in hybrid electric vehicles (PHEVs) and Battery Electric Vehicles (BEVs) are both capable of using off-board sources of electricity, and almost all U.S. electricity is produced domestically.

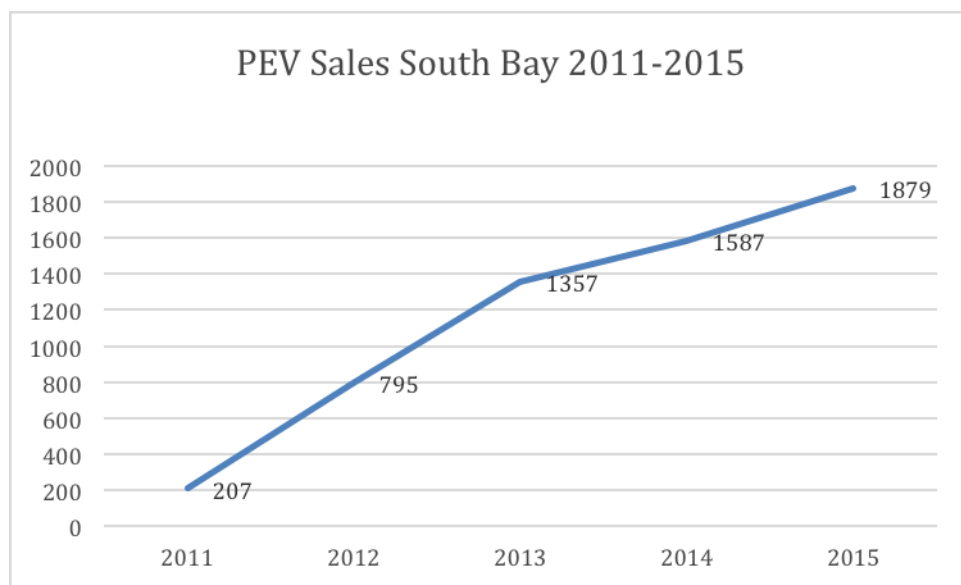
The Role of MUDs in Attaining the Governor's Zero Emission Vehicles (ZEV) Goal

Governor Jerry Brown established an executive order calling for 1.5 million Zero Emission Vehicles (ZEV) on California's roads by 2025. That requires over 15% of all total sales of new cars purchased in the South Bay to be some type of electric vehicle. To achieve this ambitious goal, significant barriers in our state must be overcome to expand and accelerate plug-in electric vehicle (PEV) adoption including the need to build out the necessary refueling infrastructure.

MUDs in the South Bay play a crucial role. Almost half of all households in the South Bay (46%) are located in MUDs (over 144,000 households).³⁸ Considering the South Bay's current market share of electric vehicle purchases, South Bay residents will need to purchase 70,000 ZEVs *vehicles* by 2025. Given that about half of South Bay residents live in MUDs, the pressure will be on to find ways for ZEV drivers to charge at home – in their designated parking areas.

The Electric Vehicle Market Is Growing in The South Bay

South Bay residents are increasingly purchasing Plug-in Electric Vehicles (PEVs). From 2011 to 2015, sales of PEVs in the South Bay increased over 900% (see graph below). Year to year sales increased at the following rate: from 2011 to 2012, 384%, from 2012 to 2013, 171%, from 2013 to 2014, 117%, and from 2014 to 2015, 118%. Leading the way are the Chevrolet Volt and Tesla Model S. The U.S. PEV market itself is growing. The Chevrolet Bolt, a 4-door hatchback that goes over 200 miles in electric battery range. Tesla will later release its Model 3 which also breaks the 200-mile range mark at 215 miles. Tesla has received over 400,000 reservations for the vehicle so far.



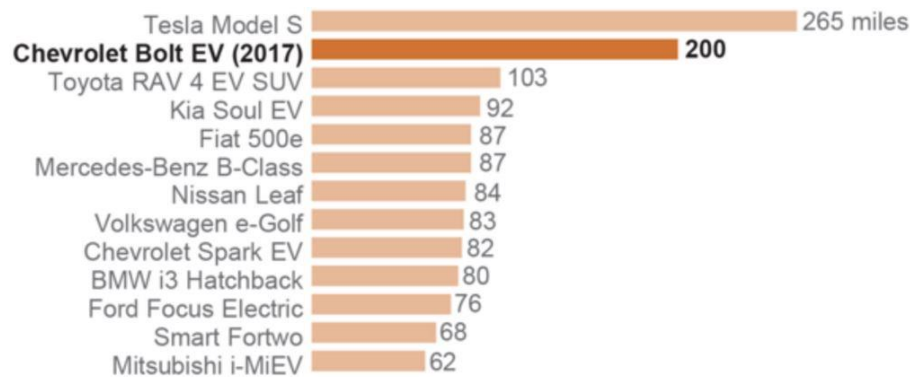
Source: IHS Automotive

How will MUDs meet the increasing demand for PEVs and match the Governor's goal? One answer is an increase in electric vehicle charging stations so tenants can charge their PEVs.

³⁸ DeShazo, J., et al. "Assessing the Multi-unit Dwelling Barrier to Plug-in Electric Vehicle Adoption in the South Bay." Luskin Center for Innovation, Los Angeles, Calif (2012).

Electric Vehicles and Their Driving Ranges

Below are electric vehicles that tenants may purchase or already own, as well as each vehicle's total electric driving range.



Source: Los Angeles Times c/o Edmunds.com

Upcoming Long-Range BEVs:

As new Battery Electric Vehicles get released to the market, we can see that their ranges are increasing. Both the 2017 Chevrolet Bolt and Tesla Model 3 surpass the 200-mile range mark. By 2018, EV-range could surpass 300 miles. Tenants, who purchase future EVs, will have a greater demand to charge their vehicles.



2017 Chevrolet Bolt (238 miles)



Tesla Model 3 (215 miles)

The Laws of EV Charging at Multi-Unit Dwellings (MUDs)

The state has passed laws that prioritize Electric Vehicle charging at MUDs. The statutes listed below are the first of many in the coming years. The current statutes that are relevant are:

Senate Bill 880 protects the rights of residents of multi-unit dwellings, affirming that "it is the policy of the state to promote, encourage, and remove obstacles to the use of electric vehicle charging stations." The legislation makes it illegal to impose any condition that "effectively prohibits or unreasonably restricts" installation of charging in an owner's designated parking space. If the charging unit is installed in a common area, the law states that certain conditions can be imposed, e.g. a \$1 million home owner liability policy that names the Home Owner Association as an additional insured.

SB 880 Explained: This law focuses on HOAs. The basic purpose of the law is to ensure that PEV drivers are not unreasonably prohibited from installing a charging station, either in their deeded or designated parking spaces or in common areas. HOAs must allow charging in common areas only if installation in the PEV owner's deeded or designated space is impossible or unreasonably expensive. If a driver has exclusive use of a charging station in a common area, HOAs must then enter a license agreement with the PEV driver.

The HOA can also compel current and future owners of the charging station to pay for maintenance, repair or removal of the charging station and for any resulting damage to the station, common area, or exclusive use common area. Importantly, the law allows, without a full HOA member vote, a portion of the common area to be used for utility lines or meters to support charging in a deeded or designated parking space.

Enforcement of this and other vague provisions in the law may be decided in court. However, there is no need for enforcement if the parties can make their own arrangements. Utilities could make a professional mediator available to assist with negotiations between residents and HOAs, or even between landlords and tenants looking for a way to charge in an MUD.

Assembly Bill 2565 provides that for a residential lease executed, extended, or renewed after July 1, 2015, "a lessor of a dwelling shall approve a written request of a lessee to install an electric vehicle charging station at a parking space allotted for the lessee that meets the requirements of this section and complies with the lessor's procedural approval process for modification to the property." The law does not apply to residential properties with less than five parking spaces, properties that are subject to rent control, residential leases where no parking is provided as part of the lease, or residential properties where EV charging stations already account for at least 10% of available parking spaces.

AB 2565 Explained: This law focuses on owners and tenants. It requires apartment owners to allow tenants to install charging stations, at their own expense. The law applies to residential rental properties where off-street parking is provided in the lease, with more than five parking spaces, and where electric vehicle charging stations number less than 10% of the parking spaces. It requires the use of regular charging stations, so simple power outlets would not be sufficient.

The process starts with a written request from the tenant to the landlord, and the tenant must meet a fairly high level of documentation. This includes a complete plan, provided by the tenant, for the installation, use, maintenance and removal of the charging station, as well as a complete financial model, and complete documentation of modifications required to the landlord's property. Additionally, the tenant must put up a \$1 million insurance policy naming the landlord, in case there is some kind of problem.

Owners will want to consider the impacts of AB 2565 early in the lease negotiation process. Owners providing an allocation of reserved parking to a tenant may want to provide in their lease that future EV parking will come out of that allocation. Owners may also want to designate specific areas in the parking lot for EV charging station installation, so that stations are not located far from supporting infrastructure. Owners may also want to reserve the right to create lease rules and regulations regarding the maintenance, operation, and surrender of tenant-installed EV charging stations. Tenants, in the lease negotiation process could potentially mention their desire to use AB 2565 to allow installation of a charging station. Tenants may also attempt to gain certainty regarding rental rates for charging station space and the location of the space.

Choosing the right Charging Equipment for the building and PEV drivers

There are different types of charging. Here are some of the options that are available for use in apartments and condominiums.

Level 1

Existing standard electrical outlets in parking areas can be used for tenants to charge their Plug-in Electric Vehicles. Standard electrical outlets are typically 120 volts and are considered "Level 1" charging. No special installation of charging equipment is needed. However, Level 1 charging is slow to fully charge a PEV. Depending on the battery and vehicle type, Level 1 charging adds about 2 to 5 miles of range per hour of charging time. That said, many PEV owners use Level 1 Charging at night while they sleep. If Level 1 charging does not work for tenants, there is also Level 2.



"Level 1" Outlet

Level 2

240 volt outlets are considered Level 2. Level 2 charging takes place at a much quicker rate: 10-20 miles of range per hour of charging time is possible depending on the vehicle and battery type. Full battery charge can take as little as 3 hours. Level 2 Charging requires installation of a dedicated circuit of 20-80A, in addition to the charging equipment. That said, Level 2 Chargers are eligible for rebates by Southern California Edison (SCE) and Los Angeles Department of Water and Power (LADWP).



Level 2 Charger



Level 2 dual arm charger: has the capacity to charge two cars at once

DCFC (Direct Current Fast Charger)

These chargers are capable of rapid charging and are generally located in areas of high traffic and at *public* fueling stations. It has been called DC Level 2 or DC fast charging. Some DC fast charging units are designed to use 480V input, while others use 208V input. PEVs equipped to handle DC fast charging can add 50 to 70 miles of range in about 20 minutes. Often these can be found at auto dealerships.



DCFC (Direct Current Fast Charger)

Charging Equipment Compared

Charging Level	Vehicle Range Added per Charging Time	Supply Power (Volts)
Level 1	2-5 miles/hour	120
Level 2	10-20 miles/hour	240
DCFC (Direct Current Fast Charger)	50-70 miles/20 minutes	208/480

Each type has its advantages and disadvantages. Although level 1 charging is the easiest to set up, at only 2-5 miles of range per hour, charging time could be an issue for tenants. On the other hand, DC fast chargers may take less than 20 minutes to give a vehicle 70 miles of range, but hardware and installation costs make this option less practical for MUDs (hardware price ranges \$10,000-\$40,000, plus construction material and labor costs).³⁹ This charger type is more suited for use in commercial buildings or public streets. Level 2 charging, which takes an hour to give a vehicle up to 20 miles of range, is therefore the most plausible alternative that balances the needs of tenants without incurring exorbitant installation costs to property owners. With a level 2 charger, a tenant who drives 40 miles a day only needs to plug his vehicle in for 2 hours to regain a full charge.

The PEV Charging Installation Steps in MUDs

The process of setting up PEV charging in MUDs generally falls into two categories:

- 1) a resident-driven process in which an individual tenant or condo owner initiates the process and pays for equipment and installation for his or her charger;
- 2) an owner-driven process in which the landlord or homeowner association (HOA) provides this as an amenity for present and future residents.

In either scenario, a complicating factor in MUD charging is the number of stakeholders involved. Unlike in a single-family home, PEV drivers must obtain permission for installation from homeowner associations (HOAs), landlords, and/or fellow tenants. Furthermore, installation itself involves several steps, including a site visit by the electric service provider to assess your electric service for possible system upgrades as well as the need for an electrician to inspect service wiring for adequate capacity, for example, to supply a Level 2 charging station.

Installation Steps

The two electric service providers in the South Bay are Southern California Edison (SCE) and Los Angeles Department of Water and Power (LADWP). Focus on the electric service provider that services your building(s). After each utility's installation steps are discussed, a chart will also show the steps. Please note: installation steps primarily deal with Level 2 charging, as Level 1 charging can be accomplished through existing 120 Volt Outlets.

Southern California Edison (SCE) Installation Steps:

Note: In order to support California's zero-emission policies, SCE has launched their Charge Ready Electric Vehicle (EV) charging station with rebate program. MUDs are encouraged to participate in the program. The cost of the electric infrastructure is covered by the Charge Ready program. As part of Charge Ready, SCE also offers a rebate against the cost of the

³⁹ http://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf

charging stations and installation. There are minimum requirements to participate in Charge Ready.

Minimum requirements for Charge Ready:

- 10 charging stations per site or
- 5 charging stations per site in disadvantaged communities

To remain eligible in the program

- Must own and operate qualified charging stations for at least 10 years
- Allow collection of usage data on any Level 2 charging stations
- Agree to participate in future demand-response programs designed for Charge Ready

SCE Charge Ready Step 1: Submit the Required Forms:

Interest is expressed in the program including your preference for the charging station's location via the Charge Ready enrollment portal located at chargeready.sce.com. There, you'll be able to populate the required forms, upload documents, and track the status of your application. Your account manager will provide support.

Step 2: SCE Evaluates Your Site:

SCE visits your site to confirm that it meets minimum requirements for the program and they determine number and location of charging stations. Then SCE will review your application and determine the feasibility of deploying charging stations on your site.

Step 3: You Confirm Participation:

SCE prepares reservation request and contract agreement showing proposed number of charging stations and deployment location within your site. After you review and approve the proposal, SCE reserves funding. When the funding is reserved you select a charging station vendor and procure the charging stations. You can find approved vendors and charging stations in the Approved Package list at on.sce.com/chargeready

Step 4: Design site plan with SCE:

SCE completes and presents deployment design to you. You approve design. SCE then applies for construction permits.

Step 5: Construction Begins:

After SCE acquires construction permits, SCE begins construction on your site. This includes:

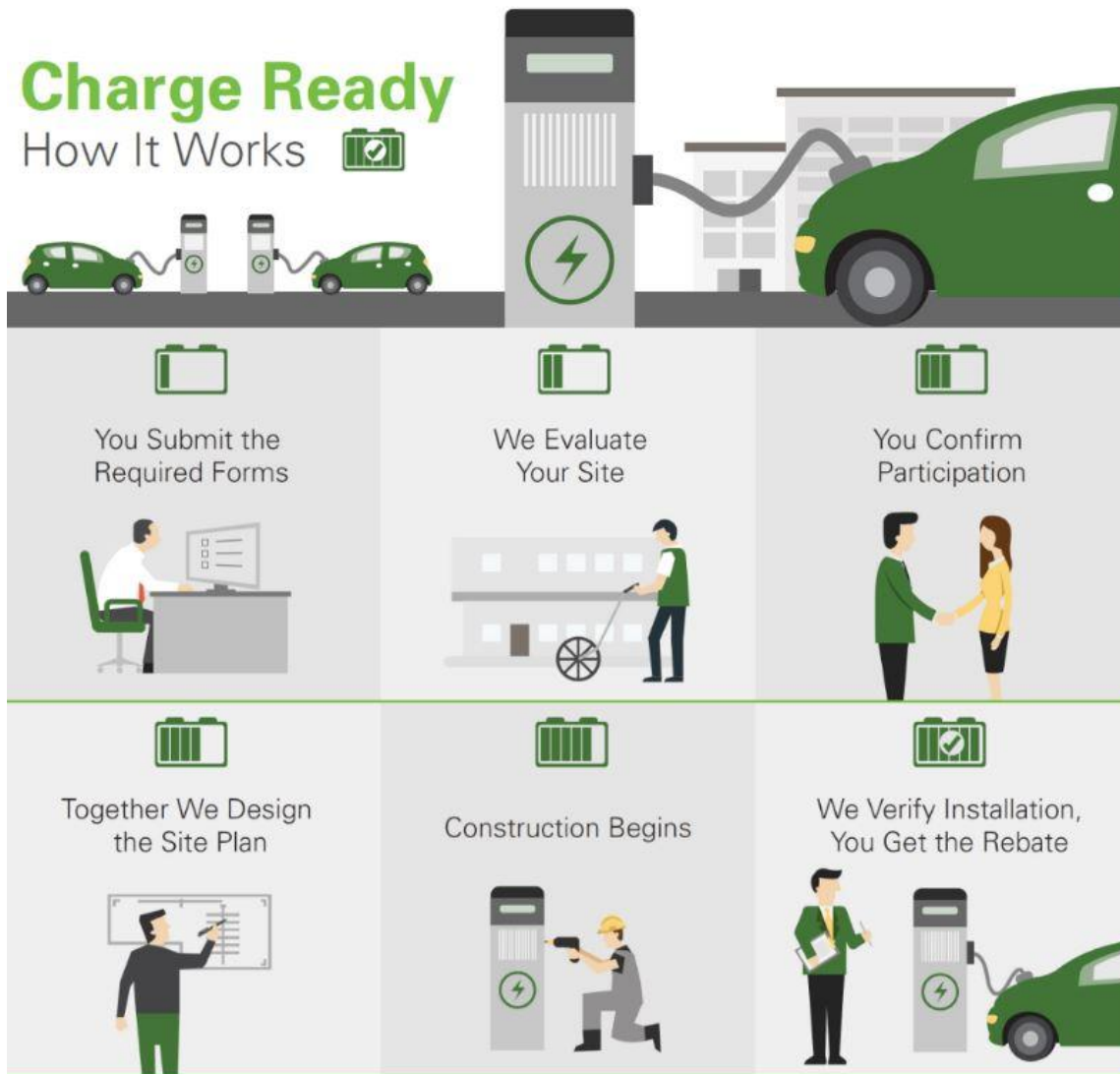
- a) Installation of the transformer

b) All trenching, conduit and conductor

Step 6: SCE verifies installation and you get a rebate:

After your vendor has installed the charging stations, SCE conducts a walkthrough of the site to verify deployment is consistent with approved plans. You then receive notification that the project is complete. SCE then processes the rebate payment. More on SCE rebates below.

SCE Installation Steps Chart:



Los Angeles Department of Water and Power (LADWP) Installation Steps:

Step 1: Contact LADWP

Contact LADWP for consultation on rate and meter options. Speak to LADWP about your specific property in considering Level 1 or Level 2 charging. LADWP will focus on three key areas:

- A) Determine if the local electrical distribution service is adequate to support the planned PEV charging
- B) Provide information on utility rates
- C) Advise customers about the electrical service and metering equipment options necessary to support their installations

Step 2: Contact an Electrician

The Electrician will advise about feasibility of the preferred meter option. The electrician will also inspect service wiring for adequate capacity, for example, to supply a Level 2 charging station. A list of certified electricians can be found here:

https://www.dir.ca.gov/dlse/ecu/CA_Electricians_Certified.pdf

Step 3: Make a Charging Station Request

If you decide that a Level 2 charger fits your needs, you would inform LADWP and complete their online EV Charging Station Request form, which can be found at

<http://www.ladwp.com/ev>. A LADWP Electric Service Representative (ESR) is automatically dispatched within 5 business days.

Step 4: Electricity Service Provider Site Visit

The Electric Service Representative (ESR) will visit your property and assess service for possible system upgrades. The ESR will also advise you about LADWP meter options and provide a written report.

Step 5: Electrician Obtains Electrical Permit

The electrician will confirm meter and rate options with you and then will obtain an electrical permit. After completing installation, the electrician will call for an inspection of the installation.

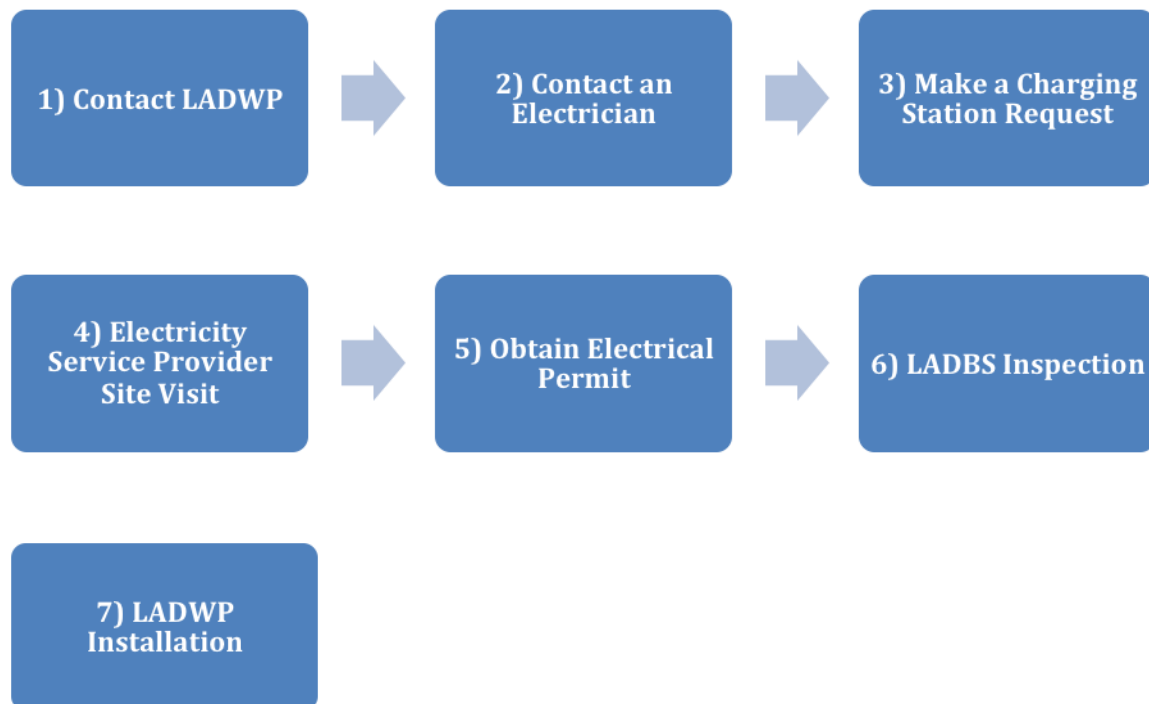
Step 6: Los Angeles Department of Building and Safety (LADBS) Inspection

LADBS will then inspect the installation. LADBS' job is to ensure that electrical safety and building codes are observed and that the EV Charging installation is safe. Approval of work is transmitted to LADWP when the installation passes inspection.

Step 7: Final Step: LADWP Installation

LADWP receives approval from LADBS. LADWP crew is dispatched to install meter and perform system work as needed.

LADWP Installation Steps Chart:



Range of Costs for EVCS

In order to discuss cost recovery for owners and managers it is important to see the costs associated with installing electric vehicle chargers:

Charger Type	Unit Cost	Estimated Annual Electricity Cost
Level 1	\$2,300*	\$394
Level 2	Up to \$5,000	\$782
DCFC (Direct Current Fast Charger)	Up to \$80,000	\$564

* If outlet does not exist

Cost Recovery

Amenity Fees: An amenity fee can be charged to tenants charging their EVs on your property. Tenants with dedicated parking or regular access to community parking with vehicle charging capability, could be assessed an additional parking fee on a monthly, quarterly or annual basis.

Commercial Cost Recovery Options: Two electric vehicle charging companies, ChargePoint and EverCharge, install electric vehicle chargers and offer different fee models for owners and managers to recoup costs or which could become a revenue opportunity for owners

The ChargePoint Fee Model:

ChargePoint, the world's largest electric vehicle (EV) charging network, brings EV charging to apartments and condos. The ChargePoint model works with both assigned and shared parking. ChargePoint helps select the right charging products and install electrical infrastructure and stations. There are two model options:

ChargePoint Personal Model: Tenants Charge at Their Assigned Parking Spot:

- * 1 Tenant to 1 station
- * Tenant pays monthly service fee plus cost of electricity
- * Property owners or managers can recover costs by setting a rate for electricity usage
- * Electricity rates can include premium “Time Pricing” to account for peak-period utility rates and/or to encourage tenants to move their vehicles through increasing costs for electricity usage after a certain period of time or if their EV is left plugged after it has been fully charged.
- * ChargePoint handles billing and remits 100% of the electricity fees back to the property or HOA

ChargePoint Community Charging Model:

- * 2 or more tenants share a charging station
- * Tenants take turns charging in a shared parking area
- * Annual network plan paid by property owner/manager
- * Charging fees paid by tenants at rates set by the property
- * Billing and reimbursement: payment processing for station usage and reimbursements to the property or HOA

For more information on Charge Point:

Web: chargepoint.com/businesses/apartments-and-condos

Phone: 408-705-1992

Email: multifamily@chargepoint.com

The EverCharge Fee Model:

- * EverCharge offers an EV charging solution designed specifically for MUDs
- * EverCharge chargers are installed directly in the tenant’s parking space for their exclusive use

- * Billing, electricity usage, and reimbursement: Each charger has a built-in monitor to keep track of the electricity consumed, which tenants are billed and owners/managers are subsequently reimbursed

For more information on EverCharge:

Web: <http://evercharge.net/>

Phone: 888-342-7383

Email: sales@evercharge.net

NRG EVgo

NRG EVgo is an electric vehicle charging company. For a limited time, under special agreement with the state of California, NRG EVgo is wiring qualifying apartment buildings for electric vehicle charging – for free. NRG EVgo will also manage the charging stations and cover the electricity costs through each driver's usage fee. Tenants must subscribe to an NRG EVgo charging plan. For example, their Level 2 plan costs \$5.95 monthly for tenants, in addition to a \$1.00 / per hour charge fee.

For more information on NRG EVgo:

Web: <http://takechargeca.com/learn-more/>

Phone: 844-247-4648

Email: TakechargeCA@nrg.com

Incentives:

Installation Rebates:

Both SCE and LADWP offer rebates depending on the number of EV charging installations.

SCE Charge Ready Rebate amount for Multi-Unit Dwellings:

From \$806.50 to \$1958.00 per charging station package. Rebate amounts are determined via the Charge Ready Rebate Calculator:

[https://chargeready.sce.com/\(S\(04k1pzkwfc15pws0l0qn55ng\)\)/calculator/Default.aspx](https://chargeready.sce.com/(S(04k1pzkwfc15pws0l0qn55ng))/calculator/Default.aspx)

LADWP “Charge Up L.A.!” rebate program:

Rebates are available to compensate commercial LADWP customers for costs incurred on the purchase of EV charger(s). LADWP revamped and expanded their “Charge Up L.A.!” rebate program for 2016 to customers who install qualified Level 2 chargers (240-volt) within LADWP’s service area. MUDs are encouraged to apply. Eligible customers will receive up to \$4,000 for each hardwired EV charger. One (1) Level 2 (240-volt) EV charger rebate will be available to customers who have a minimum of three (3) parking spaces available to tenants.

One (1) additional Level 2 charger rebate will be available for every 10 additional parking spaces at the same location, business, or property.

For example:

3 parking spaces = 1 EV charger rebate

13 parking spaces = 2 EV charger rebates

To apply you would download the appropriate rebate application from LADWP's website: www.ladwp.com/ev or to have a form mailed to you call 1-866-484-0433

Federal Alternative Fuel Infrastructure Tax Credit

Fueling equipment for electricity, installed between January 1, 2015, and December 31, 2016, was eligible for a tax credit of 30% of the cost, not to exceed \$30,000. Permitting and inspection fees are not included in covered expenses. Consumers who purchased qualified residential fueling equipment prior to December 31, 2016, may receive a tax credit of up to \$1,000. Unused credits that qualify as general business tax credits, as defined by the Internal Revenue Service (IRS), may be carried backward one year and carried forward 20 years. For more information about future opportunities for contact the IRS: <https://www.irs.gov/uac/form-8911-alternative-fuel-vehicle-refueling-property-credit>

IRS Phone: (800) 829-1040

The Future of Rebates and Incentives:

In July 2016, the White House formed a strategic partnership with the Department of Energy (DOE), The Department of Transportation (DOT), and the Environmental Protection Agency (EPA) to formulate a set of Guiding Principles to Promote Electric Vehicles and Charging. Both the State of California and Southern California Edison (SCE) have signed on. Specifically, (SCE) will encourage incentives, and improve customers' electric vehicle charging experience.

Lastly, it is important to mention the General Benefits of Installing Electric Vehicle Charging Stations to a building(s) future success:

General Benefits:

- * Attracting and retaining residents
- * Increasing property values
- * Providing a sought-after amenity that EV driving residents need
- * Differentiating your property

* Modeling sustainable business practices, which projects a powerful image to the community and helps to meet the governor's ZEV targets

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https://driveclean.arb.ca.gov/pev/Charging/Home_Charging/Multi-unit_Dwellings.php

Ever Charge: Why Ever Charge <http://evercharge.net/why-evercharge>

Ever Charge: FAQs <http://evercharge.net/faqs>

EV Safe Charge: EV Charging in Multifamily Developments provides many benefits
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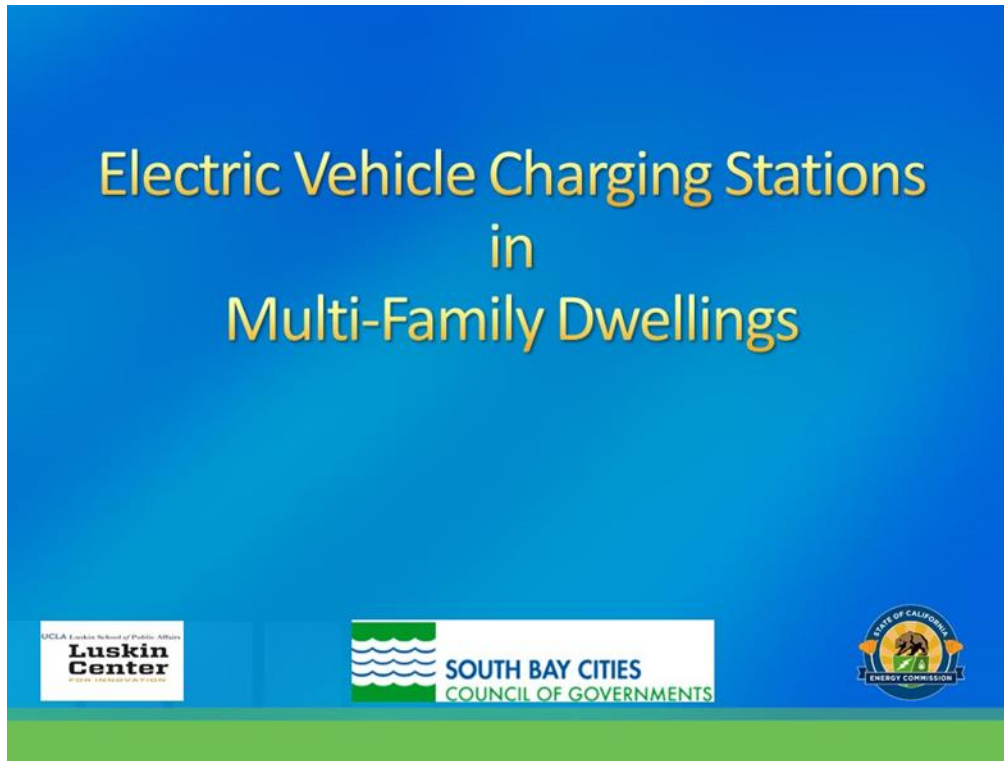
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Appendix D:
MUD Owner's Workshop Presentation

“Hot Topic” Presentation for Lunch & Learn Forums

- **November 30, 2016 at South Bay Cities Council of Governments, Torrance, California**
- **December 7, 2016 at Apartment Association of Southern California, Long Beach, California**

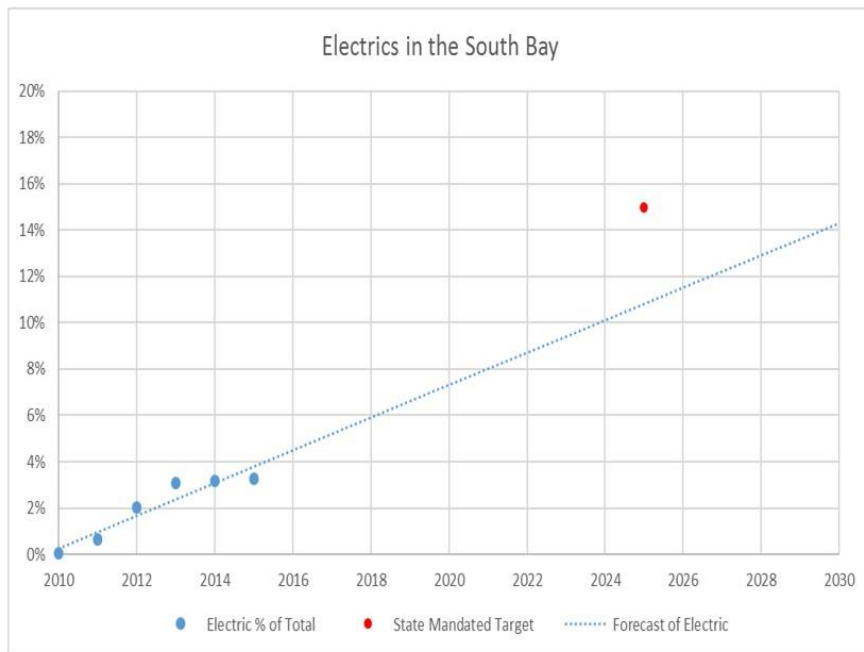


Project Background

- California Energy Commission Grant
 - South Bay Cities Council of Government
 - Research Partner: Luskin Center for Innovation at UCLA

Governor Executive Order re Zero Emission Vehicles

- Governor's Goal: 1.5 Million ZEVs by 2025
 - Market for ZEVs is growing too slowly to meet the target
 - Need 70,000 ZEVs in the South Bay by 2025
 - Building Out the Infrastructure to Support ZEVs is Essential to Meet these Goals
 - Charging Locations: Workplace, Public and Residential



Significance to the South Bay

- Residents spend over \$500 million annually on gasoline which can be spent on other goods and services
- Congestion is choking the economy but electric vehicles tend to be smaller, some much smaller, requiring less roadway space and parking spaces
- Burning gasoline causes drought and heat waves which increases likelihood of fires and diminishes air quality

Charging Conundrum

- ZEV Owners Require a “Long Dwell Time” to Charge
- 2 Primary Places for Charging: Home and Work
- 46% of All Households Live in Apartments or HOAs
- Multi unit buildings must be retrofit to accommodate EV charging
 - In order to help the EV market expand
 - Because some EV owners are bootlegging electricity due to the lack of appropriate infrastructure

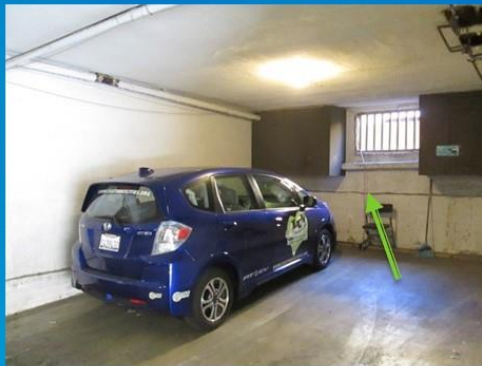
Do The Math... Some ZEV Owners Are Living In Apartments and Condos



And...They're Already Figuring Out



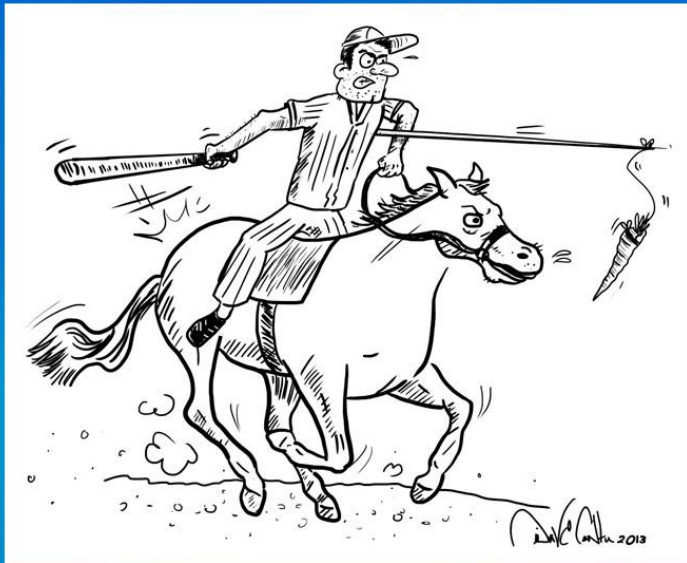
...Creative Ways to Charge!



...Live in an Apartment...Will Charge



Carrots...and Sticks!!!



Laws:

“Policy of the State to promote, encourage and remove obstacles to the use of electric vehicle charging stations”

- Senate Bill 880 – Home Owners’ Associations
- Assembly Bill 2565 – Apartment Buildings

Laws:

- Senate Bill 880 – Home Owners’ Associations
 - Makes it illegal to impose any condition that “effectively prohibits or unreasonably restricts” installation of charging in an owner’s designated parking space.
 - The law allows, without a full HOA member vote, for a portion of the common area to be used for utility lines or meters to support charging in deeded or designated parking areas
 - HOAs must allow charging in common areas only if installation in the PEV owner’s deeded or designated space is impossible or unreasonably expensive.
 - If the EV charging station, in a common area, is used exclusively by one driver than the HOA must enter into a license agreement with that individual.
 - The HOA can compel current and future owners of charging stations to pay for maintenance, repair or removal of the charging station – as well as damages to common area that may occur.

Incentives: Rebates/Tax Credits

- Utility Companies – Installation Rebates
 - SCE
 - LADWP
- Federal Tax Credit (Sunsets December, 2016)

Resources

- SBCCOG “Tool Kit”
- SCE – Charge Ready Program
- LADWP – Charge Up L.A.!
- Air Resources Board (ARB) – Drive Clean CA Program

Questions + Your Thoughts

Appendix E:

MUD Owner's Workshop Outreach and Notes

Owner's Outreach Events

Marketing Summary - "Hot Topic Events" & Regional Workshop:

Southern California Apartment Association

- E-Blasts (weekly) beginning October 18th to about 2,500 of our members.
- Monthly Magazine- November and December Magazines – circulated to 2,500 + members
- Flyers are set out monthly in our statements to about 700 +members
- Through postings on Apt-Association web site – Calendar Page
- Public Reminders at Monthly Meetings (October and November)


South Bay Cities Council of Governments

- E-Blasts (monthly) October and November, 2016 18th to 15,000 + SBCCOG list serve members.
- Email invitations to South Bay property management groups (2000+ units)
- Email invitations to HOA Boards of 2 large Condominium Associations (700 units)
- Email invitations to known apartment owners and/or condominium owners (15 individuals)
- Email invitations to South Bay elected officials and City Managers

Southern California Association of Governments (Regional Workshop)

- Email invitations to:
 - o State Officials
 - o CEC Commissioners
 - o AQMD
 - o Regional Association of Governments
 - o Local Elected Officials

Marketing Material: “Hot Topic” Forums + Regional Workshop



Apartment Association,
California Southern Cities presents

HOT TOPICS

Brown Bag Lunch Series

Electric Vehicle Charging Stations and Rental Properties

- ♦ Wednesday, November 30, 2016 (SBCCG Location)
- ♦ Wednesday, December 7th, 2016 (AACSC Location)

11:30a.m. to 1:15p.m.

- The pros and cons of installing EVCS, including **REBATES**
- Properties exempt from installing EVCS
- Tenant responsibilities: (i.e. Insurance, Maintenance)




Presented by: Aaron Baum, Environmental Services Analyst for South Bay Cities Council of Governments (SBCCG)

Cost: FREE to Members - Lunch is Provided!!!

Nov. 30: SBCCG Office
20285 S. Western Ave. #100
Torrance, CA 90501

Dec. 8: AACSC Education Center
333 W. Broadway, #101
Long Beach, CA 90802

► **Reservations Required** ◀
Seating is Limited to 30



info@apt-assoc.com www.apt-assoc.com

EV Charging Stations and Multi-family Housing: Overcoming the Obstacles

Tuesday, December 13th (10:00 am – 3:00 pm)
SCAG Downtown Los Angeles Office
818 W. 7th Street, 12th Floor, Policy Room B
Los Angeles, CA 90017

Teleconference & Webinar Information:

Call-in: (877) 336-1831 | Participant Code: 180113 | <http://scag.adobeconnect.com/scag2016/>

Videoconferencing available at regional offices:

Time	Program
10:00am	Welcome & Introductions Marco Anderson, <i>Southern California Association of Governments</i>
10:15am	Panel 1: State of the Practice Moderator: Aaron Baum, <i>Environmental Services Analyst, SBCCOG</i> J.R. DeShazo, <i>Director of the Luskin Center at UCLA</i> Danny Santana, <i>City Planner, City of Torrance</i>
11:15am	BREAK
11:30am	Panel 2: Building Managers Viewpoint Moderator: Marco Anderson, <i>SCAG</i> Johanna Cunningham, <i>Executive Director, Apartment Association, California Southern Cities</i> Joe Shinn, <i>VP of Sales, EvStructure Co.</i> David O. Levine, <i>President, Marina del Rey Lessees Association;</i> <i>Associated with Shores & Marina Harbor Apartments and Anchorage</i>
12:30am	LUNCH
1:30pm	Panel 3: State and Regional Policy Perspective Moderator: Jacki Bacharach, <i>South Bay Cities Council of Governments</i> Rhetta deMesa, <i>Advisor to Commissioner Janea Scott, California Energy Commission</i> Cassie Cuaresma, <i>Charge Ready Program Manager, Southern California Edison</i> Scott Briasco, <i>Manager of Fleet Environmental Compliance and Electric Transportation, Los Angeles Department of Water and Power</i> Henry Hogo, <i>Assistant Deputy Executive Officer for the Mobile Source Division, Science and Technology Advancement, South Coast Air Quality Management District</i>
3:00pm	Adjourn

“Hot Topic” Notes

ZEV MUD Owner’s Workshop #1

Date: November 30, 2016

Time: 11:30 AM – 1 PM (Lunch Provided)

Place: SBCCOG Office – Torrance, CA 90501

Marketing: Apartment Association of Southern California Communication Channels

- Email Blast “Hot Topic” Luncheon Invitation (2500+ members)
- Newsletter “Hot Topic Announcement (2500+ members)
- SBCCOG Invitations to known SB Owners/Property Managers

Attendees:

- 1 Apartment Owner (City of Long Beach)
- 3 SBCCOG
- 1 Luskin Center – UCLA

Overview

- Review of Study
- Presentation of “Owner’s EVCS Toolkit”
- Discussion of EVCS and MUDs
- Feedback about presentation and Toolkit

Notes:

- Attendee’s owned 2 buildings (circa 1960’s) with 4 units per building
- 1 parking spot per tenant
- There is (1) 110 household outlet that is located in a closed and locked area of one building; there are no other common outlets available at or near the parking area of her buildings.
- The electrical panel for each building is located a “long way” away from the tenant parking areas.
- No tenant “has ever inquired” about wanting to charge an electric car on her property
- Ironically, the attendee lives in an HOA community (in South OC) where full-sized electric cars are expressly forbidden to charge unless fees are paid – even then, it is

unclear if she would be allowed to “plug in”; golf carts that pay a nominal price can charge – as they are part of the mobility/transportation system of the community.

- The attendee was not aware of the laws affecting owners/tenants and EVCS
- The question of insurance – and the necessity for the tenant who seeks EVCS to carry - was one that the attendee found interesting and wanted more information.
- If approached by a tenant, the attendee would consider the EVCS; however, she “would need to know the exact costs”.
- The value proposition of installing EVCS – to make money on charging; raise rent; and/or increase the value of the property – did not seem to be a motivating factor for why the owner would allow charging. Rather it would be a way to “work with the tenant” which would help them be happy.
- Of primary concern to the owner (a potential barrier) is the “unknown costs” of working with an electrician: “they’re very expensive”
- The attendee, understood/learned that the demand for EVCS in MUDs was on the horizon.
- The attendee felt as though she “had learned” something that she otherwise didn’t know.
- That the “presentation was “valuable”
- That she had “the resources to learn more”, should she ever want to install EVCS

ZEV MUD Owner’s Workshop #2

Date: December 7, 2016

Time: 11:30 AM – 1 PM (Lunch Provided)

Place: Apartment Association of Southern California Office – Long Beach, CA 90802

Marketing: Apartment Association of Southern California Communication Channels

- Email Blast “Hot Topic” Luncheon Invitation (2500+ members)
- Newsletter “Hot Topic Announcement (2500+ members)
- SBCCOG Invitations to known SB Owners/Property Managers

Attendees:

- 1 Apartment Owner (City of Long Beach)
- 2 SBCCOG
- 1 SCAG
- 2 Apartment Association

Overview

- Review of Study
- Presentation of “Owner’s EVCS Toolkit”
- Discussion of EVCS and MUDs
- Feedback about presentation and Toolkit

Notes:

- Bonnie is an owner of a 4-unit apartment building that has 4 individual garages with doors. Currently, none of her tenants have EVs, but she sees it as a matter of “when” not “if”. She decided to attend so she can be more prepared for the time it does happen. After an engaging discussion, Bonnie stated that she was more than willing to work with tenants should they approach her with a need for EV charging. She even stated that she was interested in getting her own EV at some point in the future. After the conclusion of the meeting, Bonnie was very happy with the knowledge she left with and provided us with insight of a small-building apartment owner.
- Apartment Association staff were very receptive of the topic. Oliver mentioned that he speaks with a couple of owners a week in regards to this issue, most wondering how to get “around” having to provide charging stations. Despite that, they agree that this issue is going to hit a point where apartment owners will need to consider the needs of EV owners. The Apartment Association thought that more education about incentives available for charging station installation would be beneficial for apartment owners, as well as more advertising about opportunities to learn about EVs and EV Charging.
- At the end of the meeting, Bonnie asked if it would be possible for SBCCOG/SCAG to attend one of the upcoming monthly Apartment Association meetings and give a similar talk since those meetings naturally draw a larger audience. Apartment Association staff seemed open to planning something along those lines.

SCAG/SBCCOG Regional Workshop Notes

EV Charging Stations and Multi-Family Housing: Overcoming the Obstacles December 13, 2016

List of Known Attendees (26):

Johanna Cunningham, Apartment Association, CA Southern Cities
Joe Shinn, EVStructure
David O. Levine, Marina del Rey Lessees Association, Shores & Marina Harbor Apartments
J.R. DeShazo, UCLA Luskin Center
Danny Santana, City of Torrance
Rhetta deMesa, CEC
Cassie Cuaresma, SCE
Scott Briasco, LADWP
Henry Hogo, SCAQMD
Julie Bior, City of Ontario
Robert Scott, Mulholland Institute
Gabby Collins, SCE
Gennie Naughton, City of Rolling Hills Estates
Paul Haggis, City of El Segundo
Rick Lerner, Landlord in Hermosa Beach
Nina Rey, City of Torrance
Matthew Petski, City of Montebello
Rajit Gadh, UCLA
Michael Huntsman, South Bay Cities Council of Governments
Bud Duwell, South Bay Cities Council of Governments
Jacki Bacharach, South Bay Cities Council of Governments
Wally Siembab, South Bay Cities Council of Governments
Aaron, Baum, South Bay Cities Council of Governments
Marco Anderson, SCAG
Alex Mena, SCAG
Darrell Paterson, SCAG

Panel 1: *State of the Practice*

- SCAG was awarded a multifamily charging grant, looking at Westside Cities area.
- The Luskin Center was asked to do a follow-up study from the South Bay Cities analysis that was completed in 2013. It takes a landscape view of the MUD “ecosystem”.
- Identifies the key barriers towards multifamily housing and EV infrastructure.
- The analysis looks into the South Bay’s buildings and the challenges facing various building types and parking systems.
- The report also provides solutions and technical assistance on what building managers can do for installing EV.
- The Luskin Center developed models for what types of housing is most likely to have EV infrastructure installed.

- Cities engaging in outreach to MUD building managers was a low-cost solution to encouraging the installation of EV technologies.
- The cost of EV installation reduces when chargers are installed near other multifamily housing in the same vicinity.
- In the Luskin analysis, the total cost of EV chargers increased in multifamily housing when there is an increase in space between the charger and parking space.
- Danny Santana provided an overview of the City of Torrance's state of EV in their jurisdiction.
- Six city facilities that comprise of civic centers and parks include public charging stations. Totalling up to 20 individual chargers. All sub metered, and city owned. City's goal is to have a EV charger accessible within a mile radius.
- Currently have approximately 30 different multifamily housing sites with EV chargers in them.
- The City of Torrance is conditioning private developers to install EV chargers with the new development.
- A problem from installing EV chargers in multifamily housing is that it may not be enough to encourage tenants to purchase BEVs.
- From a local government perspective, it is very easy to have new developments have EV chargers installed according to Mr. Santana, however without a willing public and property owners, the growth of EV charging in multifamily housing will be slow unless the incentives are available for EVs and the availability of charging is ideal.
- 5 new PEVs will be rolled out in the next two years that will focus on residential charging, range anxiety will "disappear from the lexicon" according to Mr. DeShazo, if people are paying attention to the new vehicles that will be placed on the market. Range anxiety will become less significant as a factor for buying EVs as long as the charging amenities are available, according to Mr. Santana.

Panel 2: *Building Managers Viewpoint*

- Joe Shinn provided information about his firms experience in installing EV infrastructure in multifamily housing.
- Because the majority of multifamily housing dwellings in California were built before 1980, many of the buildings can require extensive construction costs due to additional coring and trenching requirements to handle EV.
- With the majority of the buildings being constructed before 1980, many of the tenants—particularly in Long Beach—are also much older and have lived 10, 20, 30 years in the same building. Many of them do not have an interest, or the capacity to use EV chargers.

- The permitting process can also present challenges to the property owners, and it is a concern of SBCCOG that many owners will not consider installing EV chargers due to a perceived notion that the permitting process is too difficult.
- SBCCOG will be going to Sacramento in April to share their concerns about any potential legislation that might hinder the installation of EV in older multifamily housing dwellings, and provide any assistance on advocating for measures that would help drive EV charging in multifamily housing.
- David Levine, manages a 544-unit apartment and another 966-unit apartment. In his experience, he convinced his owners to install EV charging stations in the properties to help spur new tenants to move in.
- After three years, in the 554-unit apartment there are only 8 residents that use the 6 EV chargers (since 2013).
- The most expensive component in installing EV in their apartments is the parking space itself, according to him it could be up to \$35,000 dollars due to the large parking demand.
- There about 50 transactions a month of EV usage in his properties, and it seems to be due to an increase in guests coming to their apartments and using the chargers at the 544-unit apartments.
- The 996-unit apartment has more EV chargers and dedicated parking space, installed during a thorough renovation completed between 2006 and 2008.
- There is a tiered rate for charging at this station, it increases progressively over time as long as it is used.
- Installed EV to attract the “millennial” group, but he has not received any feedback that tenants have moved in because of the availability of EV.
- Can take up to 7 to 8 years to pay off the costs for each EV charging station.
- Members of today’s group asked if it is a marketing issue that many tenants are not utilizing the chargers; David Levine states that it is on their brochures, on the website, and other informational materials but he has not seen any indication that their marketing has helped in way.
- David Levine suggests that even incentives will not assist in helping drive down the costs for EV chargers as the parking spot is high cost burden for the owners.

Panel 3: *State and Regional Policy Perspective*

- Rhett deMesa of the California Energy Commission states that the commission allocates up to \$17-\$18M dollars for EV infrastructure. The agency has an investment plan on where they plan on utilizing their funds, with particular interest in disadvantaged communities.
- Cassie Cuaresma of Southern California Edison states that their organization was recently approved to deploy EV chargers with charging incentives within their region. They are currently helping their customers with an outreach campaign on available

charging. They are targeting multifamily housing, smaller medium sized properties, and property managers and HOAs. Edison also has a primary contact response team to help with outreach for these sectors.

- Scott Briasco of LADWP states that their organization has had a rebate program for EV charging for residential customers for the past 4 years. The LADWP Board approved a new rebate program for commercial customers, which include multi-unit dwelling customers, offering up to \$4,000 for each charger, and up to \$20,000 in rebates for each property.
- Henry Hogo of SCAQMD states that their organization has been looking into EV infrastructure since the mid-90s. Currently have a program offering \$250 per EV charging unit, and up to \$500 if the home owner is in a disadvantaged community. Also have another program where low-income home owners can receive up to \$2,500 in rebates if they replace their conventional fuel vehicle with an approved EV.
- The following topics and concerns were brought up in the discussion period:
 - For LADWP, their customers are only looking for the lowest cost and largest savings for installing EV on multifamily housing and on commercial properties. And the equipment has to be as uncomplicated as possible.
 - Public agencies and utilities are looking to various ways they can incentivize multifamily property owners in installing more chargers, another challenge that Mr. Levine has brought up is calculating the usage of the vehicles and if a chargeback for more EV chargers is even feasible.
 - SCE is focused on incentivizing EV chargers with the ability to further help increase power supply, and considering bidirectional power grids.
 - The state is slated to receive up to \$800M in the next ten years for expanding EV infrastructure from the VW settlement.
 - SBCCOG has a monthly membership meeting for stakeholders, it is suggested that the CEC and SCE can provide demonstrations on their ongoing projects to their group of stakeholders.
 - SCE provides site visit for customers that are interested in their EV program where their field inspectors conduct site visits and evaluate existing headrooms on transformers. They also provide design firm analysis, for permitting accessibility rules. Also provide TE advisory assistance, in terms of site visits and evaluations, the field inspectors also provide insight on what property owners can do to install EV chargers and provide cost-benefit analyses and potential infrastructure costs.
 - EVStructure has installed 16,000 EV installs from Puerto Rico, across the U.S. and Japan. They have found solutions to avoiding the struggles with installing EV chargers on parking lots, such as their project at the Honolulu airport, they have BEVs which travel to parked EVs and charge from the BEV.

- There are various chargeback mechanisms for EV with different pricing models, there is now unified pricing model. One of the challenges property owners and utilities face is how to find the best pricing model. Outreach has been conducted by SCAQMD has conducted outreach to educate the public on gathering input from the public on how to best charge for using EV chargers.
- A problem which arises with property managers is that when they are asked to investigate by their HOAs on how to install EV chargers into their parking lots they typically contact the electricians they already work with on their property. Property managers needs to contact EV charging installers, or electrical engineers. They are familiar with the permitting process and multifamily installations need to examine the entire electrical system. This is beyond the capacity of the average electrician.
- It is suggested that the state should investigate how EV chargers can be installed on sidewalk light posts; rather than being installed inside the parking lot of the property. This would benefit the public as it offers a charging opportunity rather than keeping the charger within the confines of the property of the multifamily dwellings where it is seldom used to their full capacity.

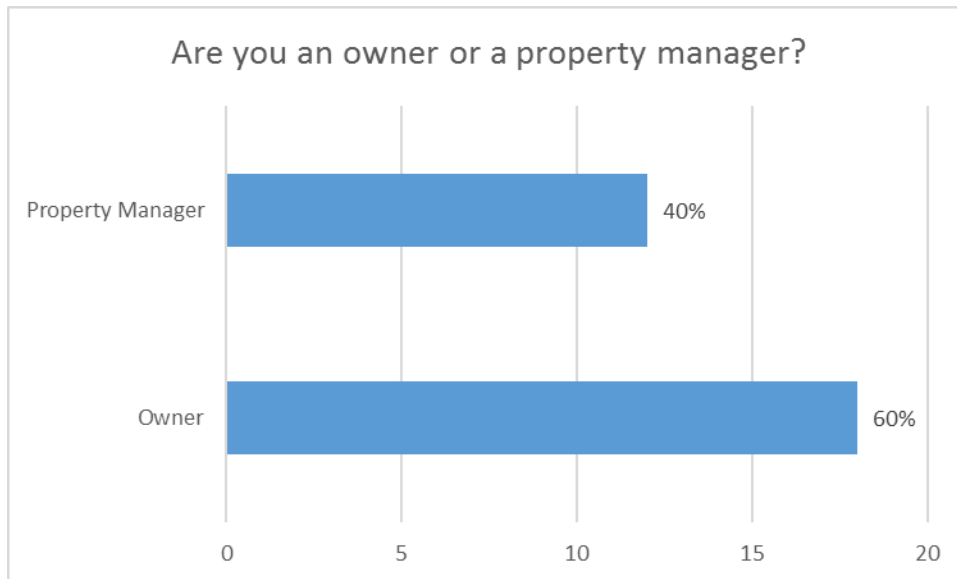
Appendix F:

EV and EVSE Survey of MUD Owners and Property Managers

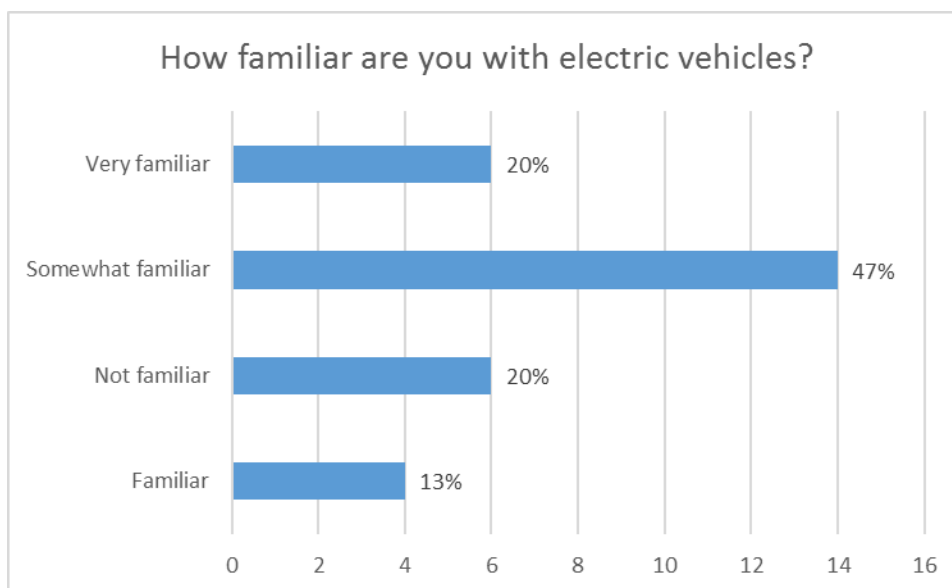
EV and EVSE Survey of MUD Owners and Property Managers

Survey Conducted at Apartment Association of Southern California Annual Trade Show (10/15/16)

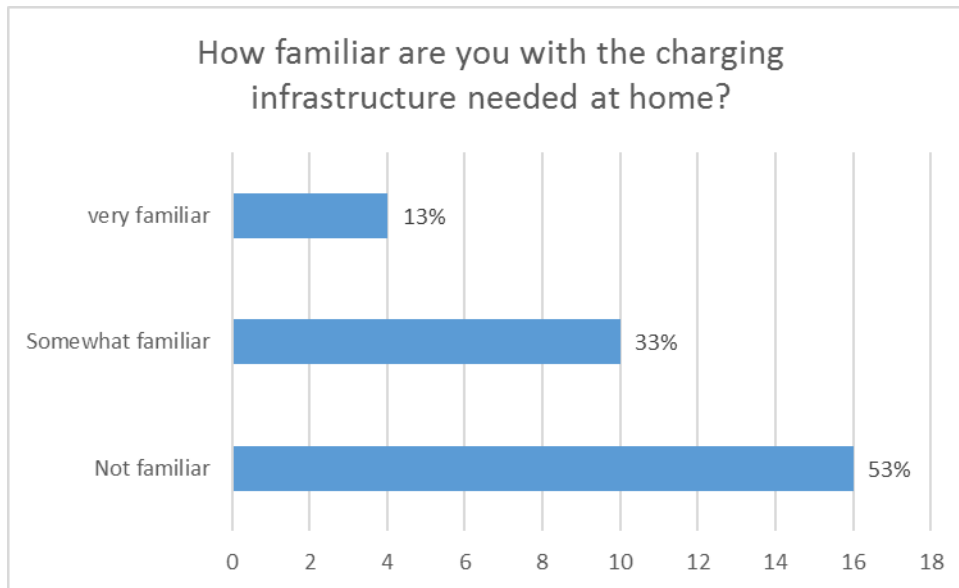
1) Owners outnumber Property Managers 1.5 to 1.



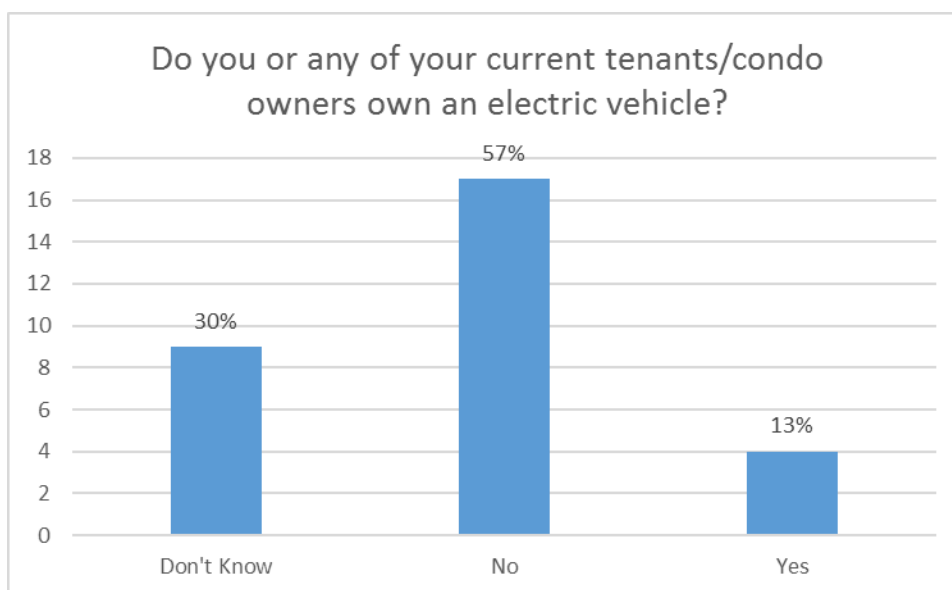
2) 13% of respondents are familiar with EVs. Almost half of respondents (47%) are somewhat familiar. Respondents are more than twice as likely to be somewhat familiar than be very familiar. 1 5th of respondents are not familiar.



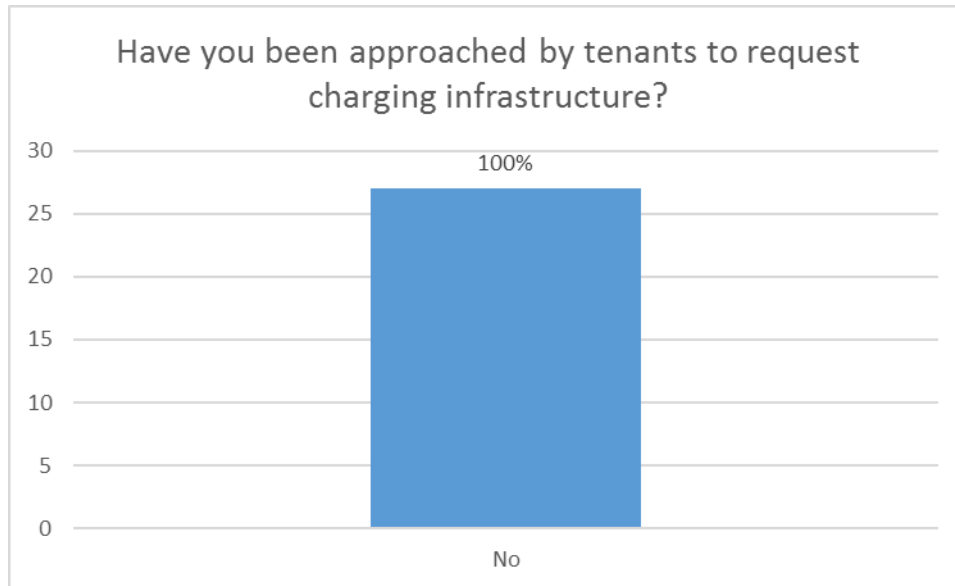
3) A minority of respondents (13%) are very familiar with the charging infrastructure needed at home. Respondents are more than 4 times likely to not be familiar than be very familiar. 1/3 of respondents are somewhat familiar.



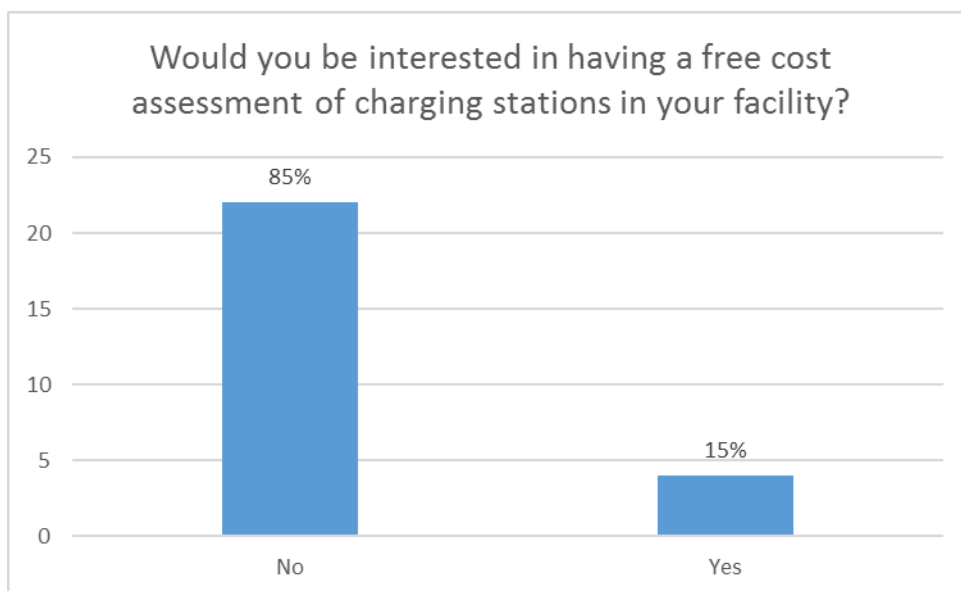
4) About 1 10th of buildings have an EV on site. More than half of buildings do not have an EV and about one third of respondents are not sure.



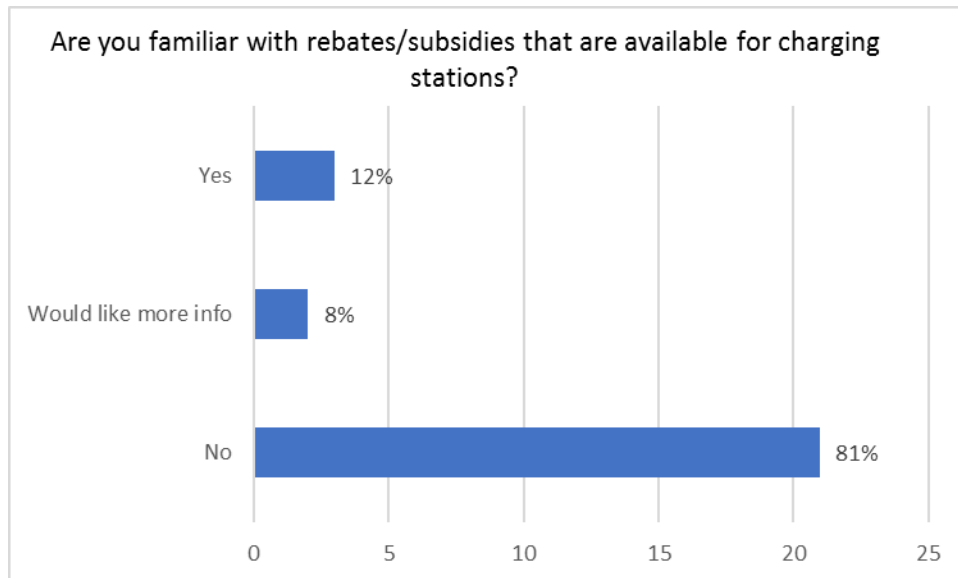
5) No respondents have been approached by tenants to request charging infrastructure.



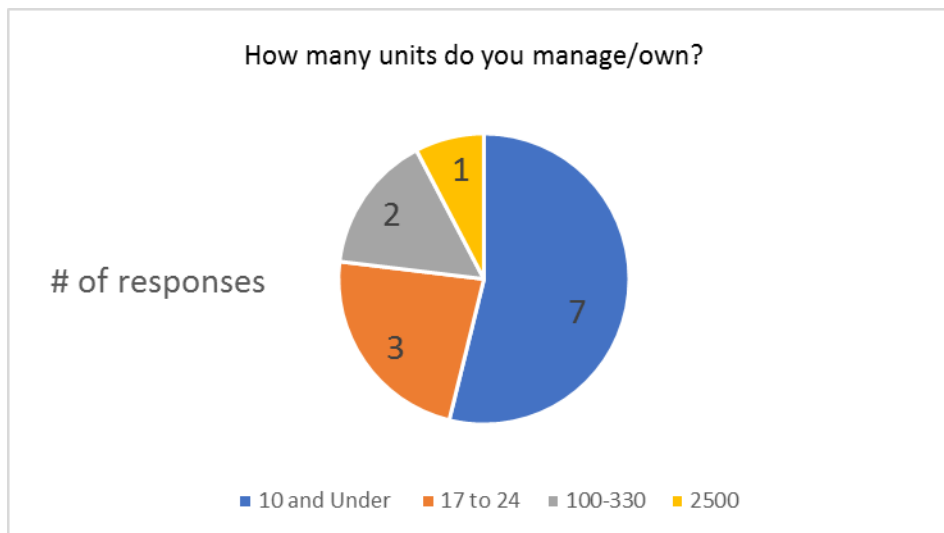
6) More than $\frac{3}{4}$ of respondents are interested in having a free cost assessment of charging stations in their facility while a little less than $\frac{1}{5}$ are not.



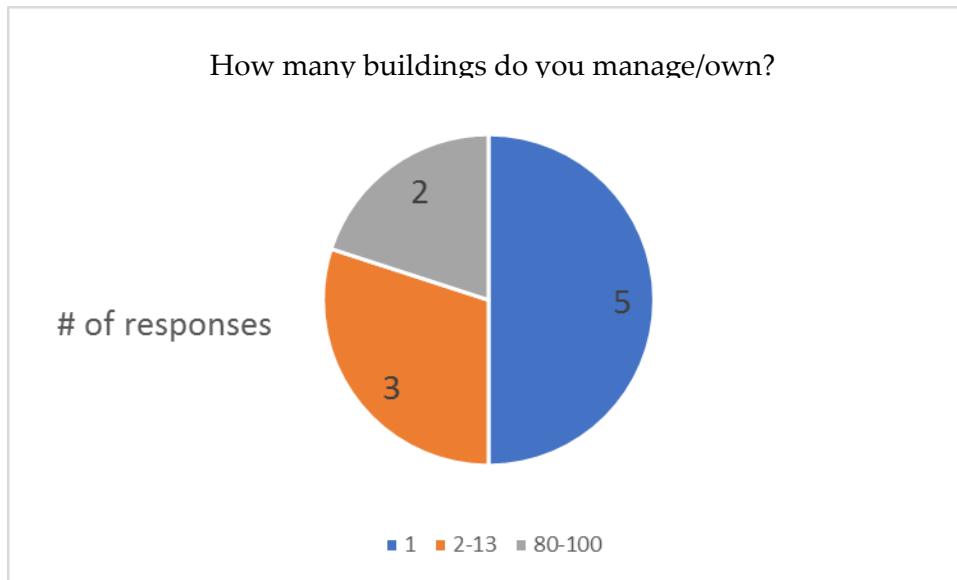
7) Over $\frac{3}{4}$ of respondents are not familiar with rebates/subsidies that are available for charging stations. 12% are familiar and 8% would like more information.



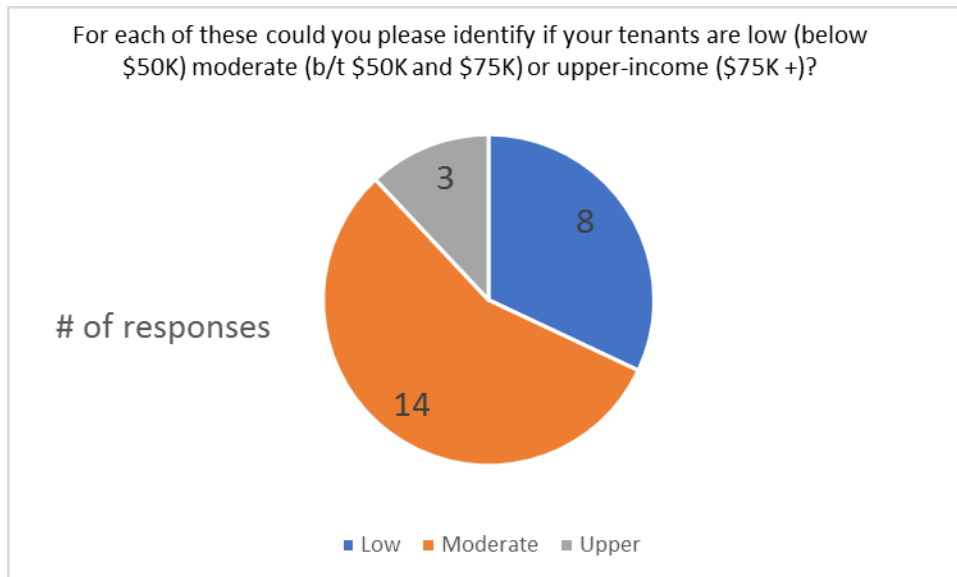
8) Units: the number of units varies greatly. Of the 13 respondents who wrote the # of units they manage/own, over half of respondents are in charge of 10 units and under, almost a quarter have 17-24 units, 2 are in charge of 100-330 units, and 1 respondent has 2500 units.



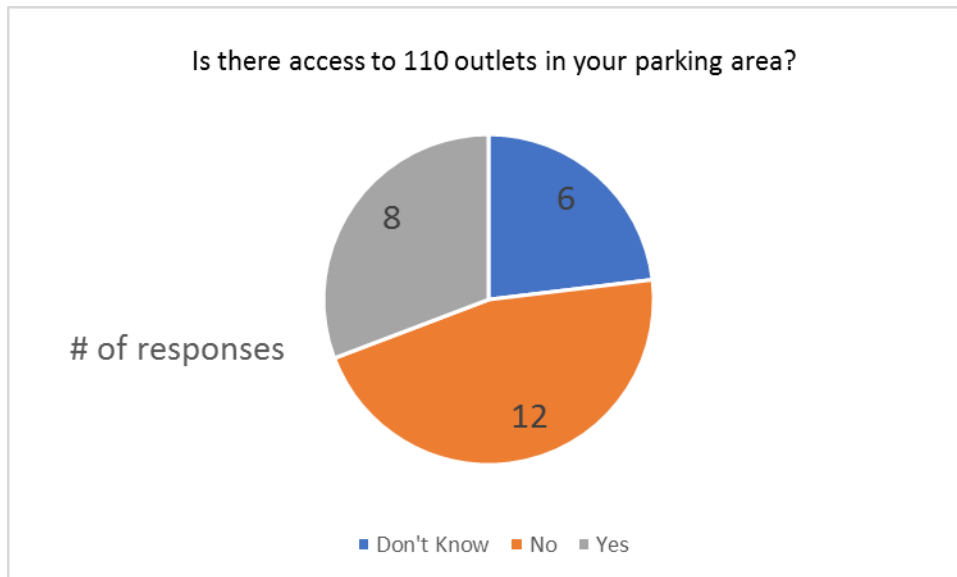
8) Buildings: the number of buildings also varies greatly. Of the 10 respondents who wrote the # of buildings they manage/own, half manage/own 1 building, almost a third have 2-13 buildings, and 2 have 80-100 buildings.



9) More than 50% of tenants are Moderate income, almost a third are Low, and the minority (12%) are Upper.



10) Almost half of parking areas (46%) do not have access to 110 outlets. Almost a third do. About 1 quarter of respondents are not sure.



11) If you'd like to learn more about this topic and be contacted for further questions please provide your email address:

Nine respondents responded that they would like to learn more about the topic and be contacted for further questions.

Appendix G:

Apartment Association of Southern California - EV and EVSE Inquiries, 2016

Customer Service Calls to Southern California Apartment Association

Month (2016)	Total Number of Calls	Total Calls for General Inquiry of EV Charging Regulations	Total Calls Regarding Regulations in Attempt to Avoid Installation
December	6	4	3
November	4	0	4
October	2	2	0
September	6	5	1
August	5	3	2
July	1	0	1
June*	2	2	1

* Apartment Association staff had “almost no calls” about EV or EVSE related questions prior to June, 2016

Appendix H:

South Bay MUD EVSE Proximity Siting Review

PROXIMITY SITING REVIEW: FOR EVSE NEAR HIGH CONCENTRATIONS OF MUD HOUSING IN THE SOUTH BAY

Abstract:

This paper suggests a methodology for siting EVSE in at publicly owned parking areas in proximity to clusters of MUDs. Case Studies were developed for 2 potential sites in 3, respective, South Bay cities. The potential benefits and costs that could be associated with these setups was reviewed.

Prepared by: Michael Hudspith
For the South Bay Cities Council of Governments
December, 2016

Preface

To meet California Governor Jerry Brown's Executive Order for 1.5million zero-emission vehicles on the state's roads by 2025, efforts have begun to create the necessary infrastructure for supporting increased PEV (plug-in vehicle) usage within the South Bay Cities of Los Angeles. A recent study of the UCLA Luskin Center for Innovation revealed that overcoming the barriers to the installation of electric vehicle service equipment (EVSE) in Multi-Unit Dwellings (MUDs) will be necessary for the South Bay to achieve its portion of this adoption goal.

There are many factors to the challenge of building EVSE infrastructure in MUDs. The Luskin Center Report, cited an average of \$5,400 (varying considerably with the charging station level and the scale of necessary construction work). MUD's have on-average far higher installation costs for EVSE systems than single-family homes. This is due, in large part, to the unfavorable parking arrangements found in MUDs. That is, the relationship of parking to electrical outlets and the building's electrical panel. Given the cost of electrical upgrades, anecdotal evidence suggests that both renters and landlords are unlikely to invest in EVSE infrastructure.

To offset the challenges of MUD PEV infrastructure and the buildout of electric vehicle charging stations in apartments and H.O.A.s, this report reviews an alternative EVCS solution for EV owners who live in MUDS: Siting EVSE's within public facilities, in close vicinity to MUD clusters.

Methodology

The South Bay cities selected for this case study were Redondo Beach, Hawthorne, and Torrance. They were chosen for the following characteristics:

- distinct characteristics in average MUD property-values
- Predominant MUD sizes within their boundaries
- Socio-economic differences (i.e. wealthier beach cities versus the more economically and/or air quality disadvantaged inland cities).
- Multiple census tracts that both have dense concentrations of MUD's and have high historic or anticipated 'propensity to purchase levels for PEV ownership – characteristics (per the Luskin report) that would make them ideal candidates for finding suitable public locations to setup EVSE stations.
- The following information and data resources were used to determine the most suitable cities and city-areas for the study:
 - The UCLA Luskin Center Report for quantitative information of city demographic characteristics relating to EVSE and PEV adaptation and usage.
 - South Bay MUD Realty websites and Google Earth: for comparing with the MUD census tract information from the Luskin Report – to determine possible public sites for siting EVSE in proximity to MUDs.
 - The Los Angeles County Office of the Assessor: for comprehensive South Bay property boundary maps – to provide graphic representation for the chosen case studies.

Within each of the three cities, 2 case study sites were selected for the following reasons:

- Proximity to or within city census tracts that have both high amounts of MUD clusters and pre-existing or anticipated “propensity to purchase” for PEVs.
- No more than a 0.75-mile walking distance from the majority of nearby MUD clusters (approximately a 5-minute walk); a reasonable distance for a tenant to plug in their EV, walk home and return when the charging is completed.

- Proximity to areas considered important community hubs or important commuting or arterial roads.
- All possible EVSE site locations were city owned or operated
- Siting included on-site visits to assess existing electrical infrastructure; this information was used broadly to give some perspective to the financial costs and logistics of installing EVSE at the site.

The legend for the graphics and pictures is as follows:

- Red Dot = The sites for potential charging stations
- Blue Dot = MUD structures of 10+ units within a 0.75-mile walking radius of the charging station(s).
- Purple Lines = Strips with high densities of MUD duplexes and triplexes.

(Note: for reference, pertinent graphics and statistics from the Luskin Center survey report have been provided at the end of this study).

Case Study I: Redondo Beach

City Factors for Consideration

Redondo Beach stands out as a unique case study of the beach cities of the South Bay for the following reasons:

- The 3rd highest percentage of MUD's in the South Bay
- A significantly small number of BEVs (69) are registered within the city limits
- MUD characteristics are predominantly duplex, triplex or buildings with less than 10 units.
- Very few publicly available charging stations within the city's census tracts in locations that have both high existing and latent PEV demand as well as high MUD densities.

With all examples chosen in the three case study cities, the two sites selected featured a high congregation of MUDs in close proximity to one another and shared the characteristic of being within or nearby census tracts with a high PEV adoption rates. The general strategy was to map MUD clusters surrounding the chosen EVSE station points.

Redondo Beach Site A: Miramar Park

Figure 1a. shows the surrounding area of the first designated area, Miramar Park, along the Southern stretch of the Redondo Beachfront.

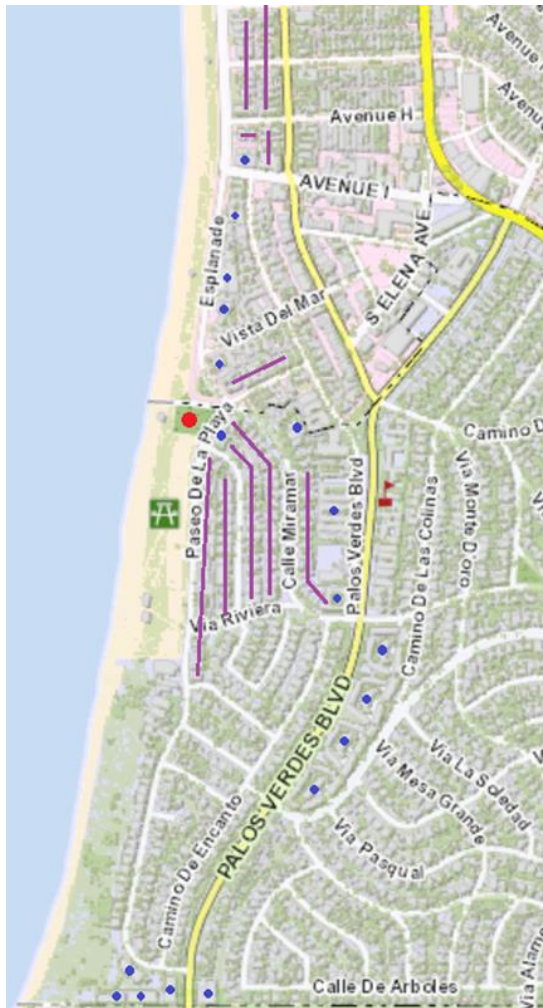


Figure 1a: Miramar Park Area. Retrieved from the Los Angeles County Office of the Assessor

Aside from the evident proximity to a dense cluster of MUD's of various sizes (all within areas of high PEV adoption prospects), Miramar Park also presents additional features that make it a promising prospect for a public EVSE site. It lies within close proximity to the Redondo Riviera Community Hub and the Palos Verdes Drive/Pacific Coast Highway arterials;

individuals retrieving their vehicles following an overnight or afternoon charge. The site appears to already have considerable amounts of pre-existing electrical infrastructure. Images 1a and 1b show a city pumping system and 200 amp electrical control panel respectively. The closeness of such facilities to the Park's parking spaces could reflect relatively low financial cost projections for developing charging stations. Previous charging station surveys within the South Bay, estimated that approximately 80% of expenses accrued in setting up EVSE's come from Labor and Materials, expenses that predictably increase the farther away the EVSE parking space is from an adequate power supply. In this case, the presence of the shown electrical facilities (in addition to others onsite not shown in this report) presents favorable prospects for cost-effective installation at Miramar Park.



3: Electrical Water Pumping Station, alongside Park parking spaces.



2: The 200 amp control panel, on the Park side adjacent to the pump alongside parking spaces

Redondo Beach Site B: Veteran's Park

The second site within Redondo Beach was Veteran's Park, located farther north from Miramar Park along the stretch of the Redondo beach front. Like the previous example, it is well within the designated 0.75-mile walking perimeter of several larger (10+ count) MUD clusters, along with strips of heavy duplex/triplex concentrations. Furthermore, its two-block proximity to Pacific Coast Highway and neighboring Redondo Pier community hub make it ideally located for commuting or localized activities following overnight charging. Figure 1b. provides a more comprehensive view of the area, using the same three-point key system as Figure 1a.

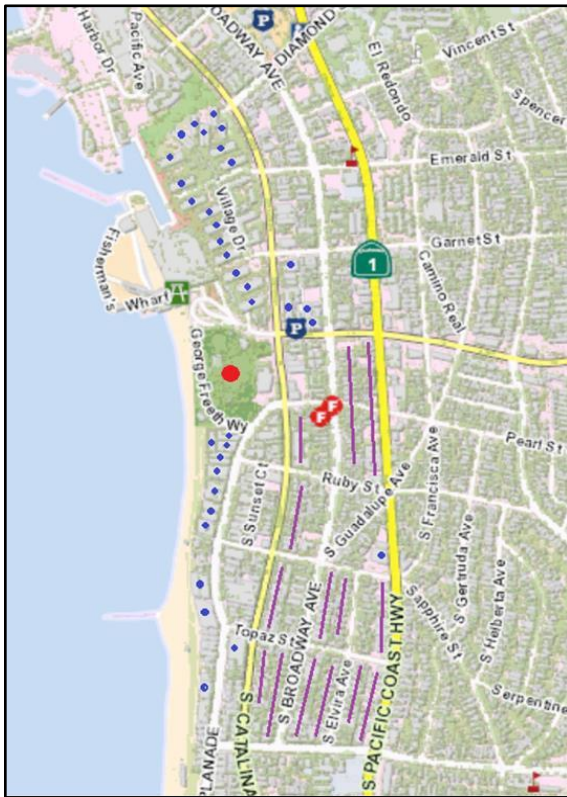


Figure 4: Veteran's Park area. Retrieved from Los Angeles County Office of the Assessor

Like the Miramar Park facilities there is extensive pre-existing electrical infrastructure within Veteran's Park's large public parking lot. Figure 5 shows an example of the electrical infrastructure that can be seen in the park alongside its parking spaces (in addition to several other examples).

Figure 6, shows a general picture of the parking lot layout. And as is the case with the Miramar Park case study, the abundance of such electrical systems is a strong indicator that expenses for supplying the necessary power to any EVSE charging stations set up within Veteran's Park might be mitigated. This would largely be owed to the manageable labor and materials that would need to be covered in a shorter distance from a sufficient electricity supply to the installed charging stations.

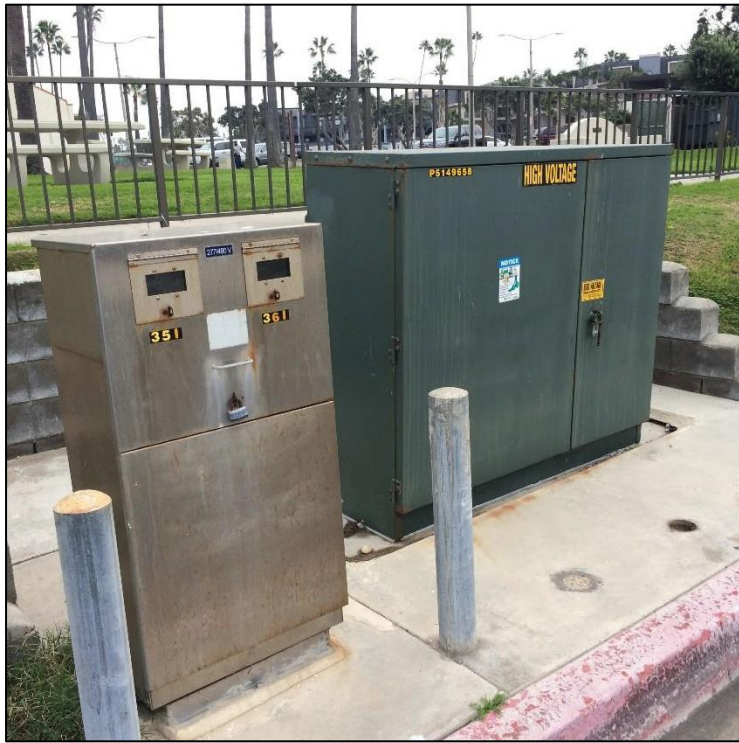


Figure 5: Example of pre-existing electrical infrastructure at Veteran's Park



Figure 6: A panoramic layout of Veteran's Park's parking availability

Case Study II: Hawthorne

City Factors for Consideration

Hawthorne represents a strong candidate for public EVSE charging installations as a representative of the inland cities:

- It has the 3rd highest count of total MUDs in the South Bay.
- 186 Registered PEVs but only 20 publicly available chargers.
- A higher spectrum of MUD types and sizes (though with lower unit values); most common are duplexes and triplexes along with MUDs between 20-49 units.

None of the public available EVSEs are within close proximity to the two census tracts within the city that have both high MUD clusters and the propensity to purchase characteristics. The two census tracts in question are next to one another. As such, it allowed for two case study sites to be selected that were in close proximity to all the MUD clusters inside the tracts.

Hawthorne Sites A and B: County of Los Angeles Hawthorne Public Library and the Hawthorne Memorial Center

Due to the proximity and density of the two census tracts relevant to this report, it was essential to find public locations that would be as close as possible to or within the tracts' perimeters. The Public Library and the Memorial Center, presented the best solution; both have adequate parking and at least some pre-existing electrical infrastructure.

The Figure 7 (below) provides a comprehensive view of the two sites; the census tracts are ones in which MUD tracts with high PEV propensities to purchase can be found. As was the case with the Redondo Beach map legend, red points mark both the Public Library Lot and the Memorial Center Lot for EVSE siting. However, distinct in this example the two census tracts in question are bordered by purple lines. It should be noted that the structures within the purple lines are predominantly duplex/triplex or 4-9 count MUD structures. Any larger MUD structures within the perimeter are marked with blue points.

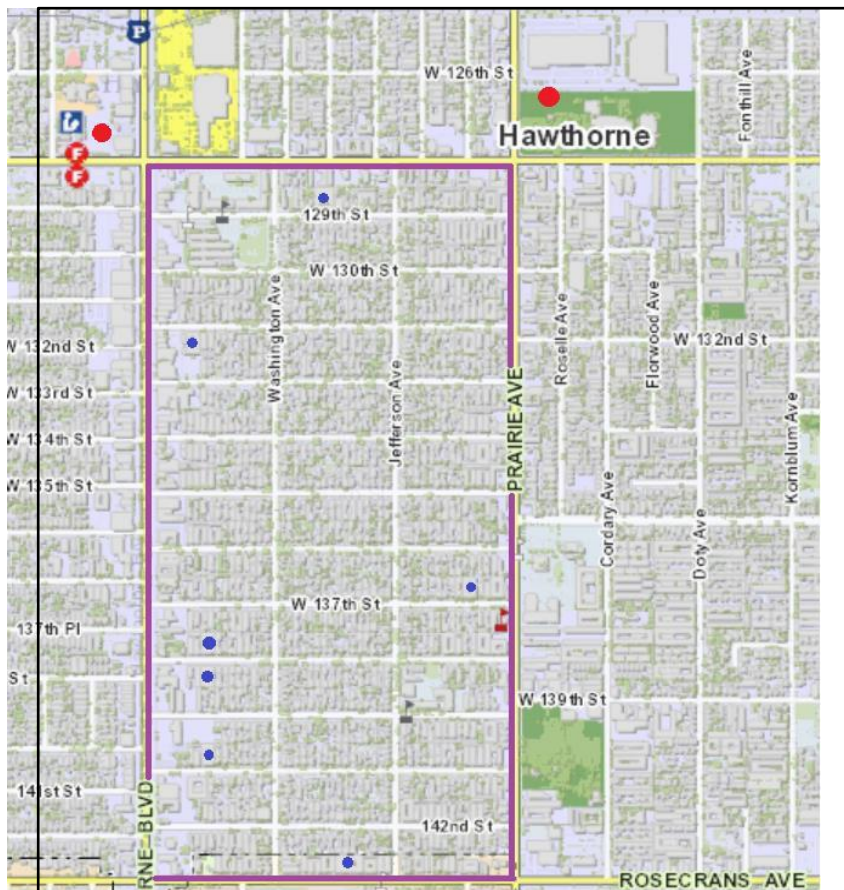


Figure 7: Hawthorne Public Library and Memorial Center Area: Retrieved from Los Angeles County Office of the Assessor.

It is important to note again, that in the case of the two sites, there would still need to be considerable investment in necessary infrastructure to support EVSE installation. The locations largely lacked any noteworthy electrical infrastructure or, they possessed so few car spaces that it would be difficult to prioritize them toward PEV charging without inconveniencing the community. Figures 8 and 9 provide some idea of the pre-existing extent of electrical infrastructure. In the case of the Memorial Center, in particular, the evident presence of little more than a handful of powerlines indicates the likely need for very costly efforts to upgrade the area's parking lots up to standard for EVSE stations.



Figure 8: Library Parking Lot. The lot featured electrical features such as transformers, power lines, and some electrical control panels, indicating a favorable location for EVSE's.



Figure 9: Hawthorne Memorial Center. These power lines are the only noteworthy electrical infrastructure in the parking lot.

Both locations do represent good locations from which to assess the prospects of public EVSE installation in inland and economically disadvantaged cities. Both are within a 0.75 mile walk of most MUD clusters within the census tracts; they are in close proximity to several important commuting streets, such as Hawthorne and El Segundo Blvd or Rosecrans Avenue; and, they both lie within the general heart of the Hawthorne city community, which should allow for greater visibility and awareness of the charging stations.

Case Study III: Torrance

City Factors for Consideration

Torrance presents a unique scenario within the South Bay Cities. It makes a valuable case-study in regards to how this project (of publicly installed EVSE's to compensate for MUD cluster deficits) might relate to the more general movement of increasing PEV adoption within the South Bay, the County, and even the State.

The first reason for this is due to Torrance's MUD characteristics. Torrance is a hybrid South Bay City in that, geographically, it is both a of Beach City and Inland City. With regard to the types of MUD inventory that are represented, the City features a wide spectrum of MUD size levels in large numbers from Duplexes/Triplexes to buildings with 50+ units. Furthermore, it has by far the largest total of MUD households out of any city in the South Bay, although only the 9th largest as a percentage of its total residences due to its large and highly residential area.

Importantly, the second reason is the City of Torrance's continued efforts to support and encourage PEV adoption. This can be seen through the City's "One Mile One Charger" program, that has substantially increased the amount of publicly accessible charging stations within the city limits. The siting process engaged Torrance citizens themselves as to where they would like charging stations available; presumably, some of them lived in local Torrance apartments or H.O.A.'s

This makes Torrance an interesting opportunity in a comparison of methodologies for EVSE installations, and for seeing any potential overlap between this report's methodology for pinpointing MUD demand, and the mindset of the public's PEV-inclined demographics.

Torrance Site A: Victor Park

Using the methodology developed in this report, the first identified site was the Victor Park/Isabel Henderson Library Parking Lot. Like previous site examples, it lies within immediate proximity to census tracts noted by the Luskin Center Report to have both high concentrations of MUD residences (predominantly 20 and over count MUD's) and high existing or projected 'propensity to purchase' PEV's. Figure 10 shows this along the same 3-point key system that has been previously exhibited in this report:

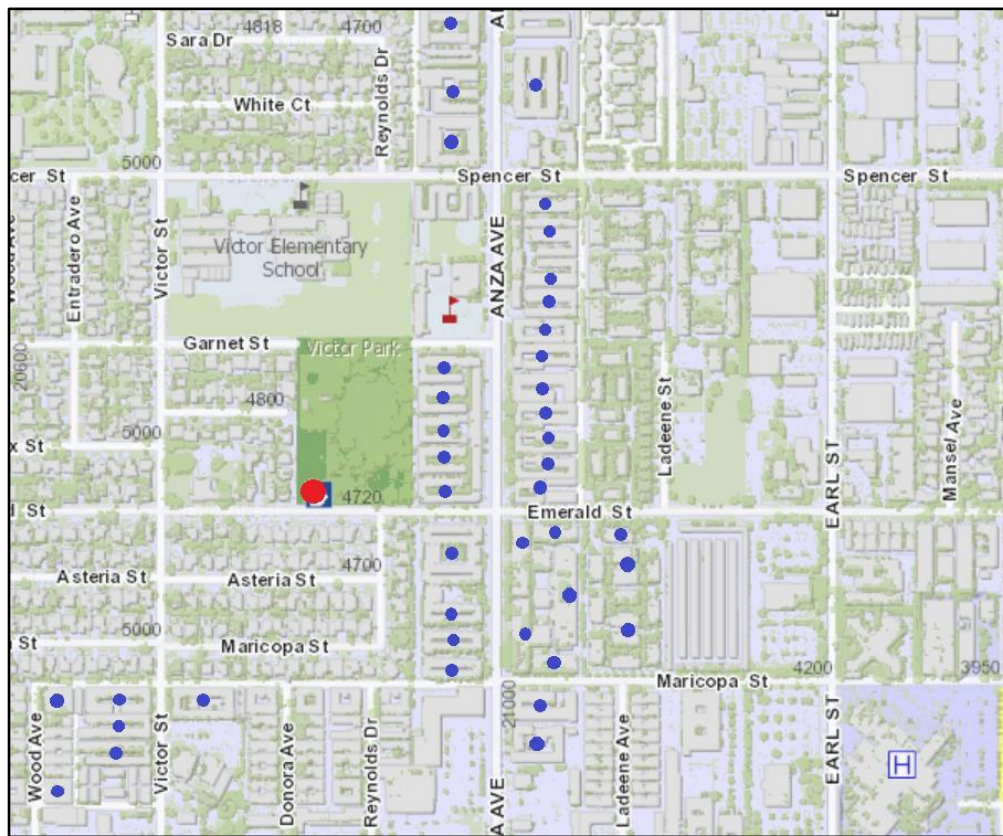


Figure 10: Victor Park Area: Hawthorne Blvd is 1 block directly east of the Park. Retrieved from Los Angeles County Office of the Assessor.

The site is, once again, close to important arterial routes and high concentrations of MUDs; presumably, making it a perfectly suitable option for overnight charging. The challenge is that there appears to be little evident electrical infrastructure within the parking lot grounds (all of it coming from the Isabel Henderson Library's drawing upon the adjacent power lines, as seen in Figure 11). However, given the proximity of the park to such a substantial amount of

larger-scale MUD structures, and Torrance's generally strong propensity towards PEV adoption, this site could be seen as a further investment in support of the "One Mile One Charger" program.

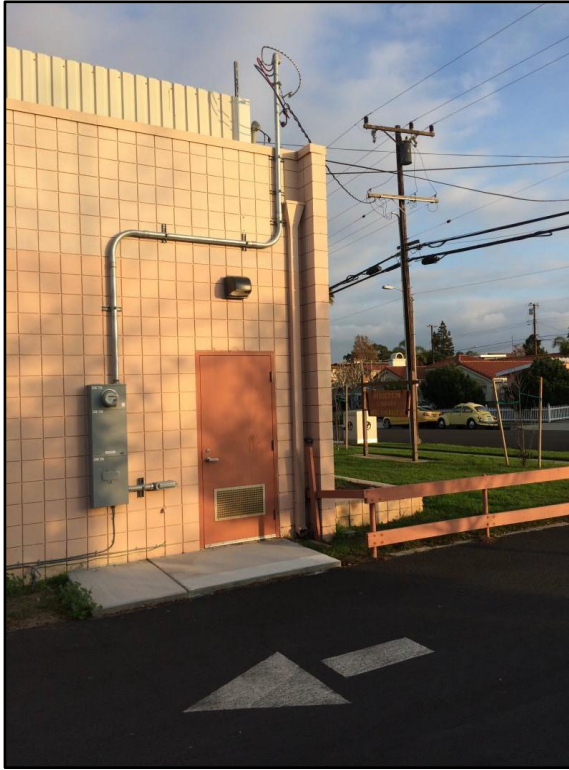


Figure 11: The existing electrical infrastructure within Victor Park, all connected to the I.H. Li



Figure 12: The Victor Park Parking Lot. The Isabel Henderson library is the structure on the far right.

Torrance Site B: Charles H. Wilson Park

The second case study site is closely situated near a congregation of larger-sized MUD complexes. Additionally, it is located near large concentrations of existing or planned EV charging stations. The deployment of these stations was largely the result of the City's public outreach and input for the "One Mile One Charger" program. Uniquely, these stations were sited to accommodate employees who work in nearby businesses during the day. This area features a few EVSE's that have been set up in the neighboring parking lots of Charles Wilson Park itself, as can be seen in Figure 13.



Figure 13: Examples of existing EVSE's at Charles Wilson carpark, with additional electrical infrastructure in the background.

Given the EVSE infrastructure that has been built out in proximity to MUDs this location presents an interesting prospect for understanding EVSE demands within MUD's. If a small amount of charging stations were to be added onto the ones already in place, and paired with a marketing or educational strategy directed specifically toward MUD tenants than to commuters, it might be possible to observe whether proximity siting near MUDs - at the Charles Wilson Park site - can play in supporting EV adoption by apartment renters.

Closing Summary and Comments

This report looked at a nascent methodology for siting EVSE in public owned or operated locations – near high concentrations of MUD inventory – in three distinct South Bay Cities. Six sites were identified and described as potential proximal locations for EV drivers who live in nearby MUD housing to charge within walking distance of their homes. The following methodology was developed:

- A data set was created from an overlay of census tracts of likely PEV owners or future purchasers of PEVs with concentrations of MUDs.
- Using the above data set, this information was plotted on a map to describe the proximity of these MUD clusters of likely PEV owners near public owned or operated parking locations.
- Potential sites for EVSE proximity siting near MUD clusters of likely PEV owners were identified. Six possible locations were identified.
- Field observations and notes were taken to further assess the viability of the potential EVSE locations.

Beyond this basic siting exercise, there are additional important factors that will need to be included as part of a more comprehensively and practical methodology for EVSE proximity siting. These factors include:

- I) Electrical Infrastructure: Beyond a general observation of available electricity at any given location it is clear (from the Luskin Center Report's surveys with qualified electricians) that it is critical to understand both the electricity capacity as well as the potential capacity that might be needed for upgrades to the location in question. Any "next steps" to the viability of installing EVSE will depend on the costs associated with upgrade and the costs associated with where the EVSE locations will be sited.
- II) Getting the word out: Should the approach be taken by the South Bay cities to set up publicly located and available EVSE's for MUD tenants (to encourage PEV adoption), a full-fledged marketing strategy would need to be simultaneously adopted to ensure that MUD tenants and renters became fully aware of the new opportunities, and the benefits they entailed. An example of such approach may be reaching out to these sites through their owners and

through local media outlets. Such means would enable the cities and their affiliates to educate the target demographics about EVSE availabilities.

- III) Security Measures: Concerns about the safety of EV vehicles left to charged overnight in public venues needs to be addressed. Permanent security installations (such as security guards or surveillance systems) may need to be included in future siting analysis and cost estimates.
- IV) Overnight parking: As is typical with public parking venues, the sites above often have time limits or hours of non-operation permanently in force. It would be necessary to find the appropriate means to ensure that owners of PEV's charging at stations within the sites were appropriately exempted from these restrictions. It would also need to be determined whether this should apply to only MUD tenants with registered PEV's, or PEV owners in general.

In theory, the concept of using publicly accessible EVSE's to offset the MUD barrier to PEV adoption has potential viability as a complementary EV charging strategy to support the development of zero emission vehicles in the South Bay. The challenge, in the long term, is that this strategy is unlikely to be sufficient for completely supporting widespread PEV adoption amongst MUD tenants. This is because, there are few (if any) locations in the South Bay cities that have sufficient size and existing electrical infrastructure to completely support a large-scale adoption of PEV adoptions. If the six sites observed are any reflection of others in the South Bay that are suitable for EVSE installations, the locations that do have remotely sufficient parking space (and are within a reasonable distance of MUD clusters), would have to be overhauled to accommodate mostly or solely PEV drivers. This, at best, would provide marginal EVSE opportunities while incurring (likely) significant costs through the improvements to the public parking areas.

The mindset that should likely be taken (with the observations of this survey in mind), is that this methodology could serve as a great tool for increasing PEV interest and demand in MUD clusters. This could be stepping stone to bridge the gap for MUD EV owners to charge in advance of the time that tenants and owners are ready, willing and incentivized towards upgrading the MUD structures' electrical capacities for home-based MUD charging.

Appendix

Luskin Center Images

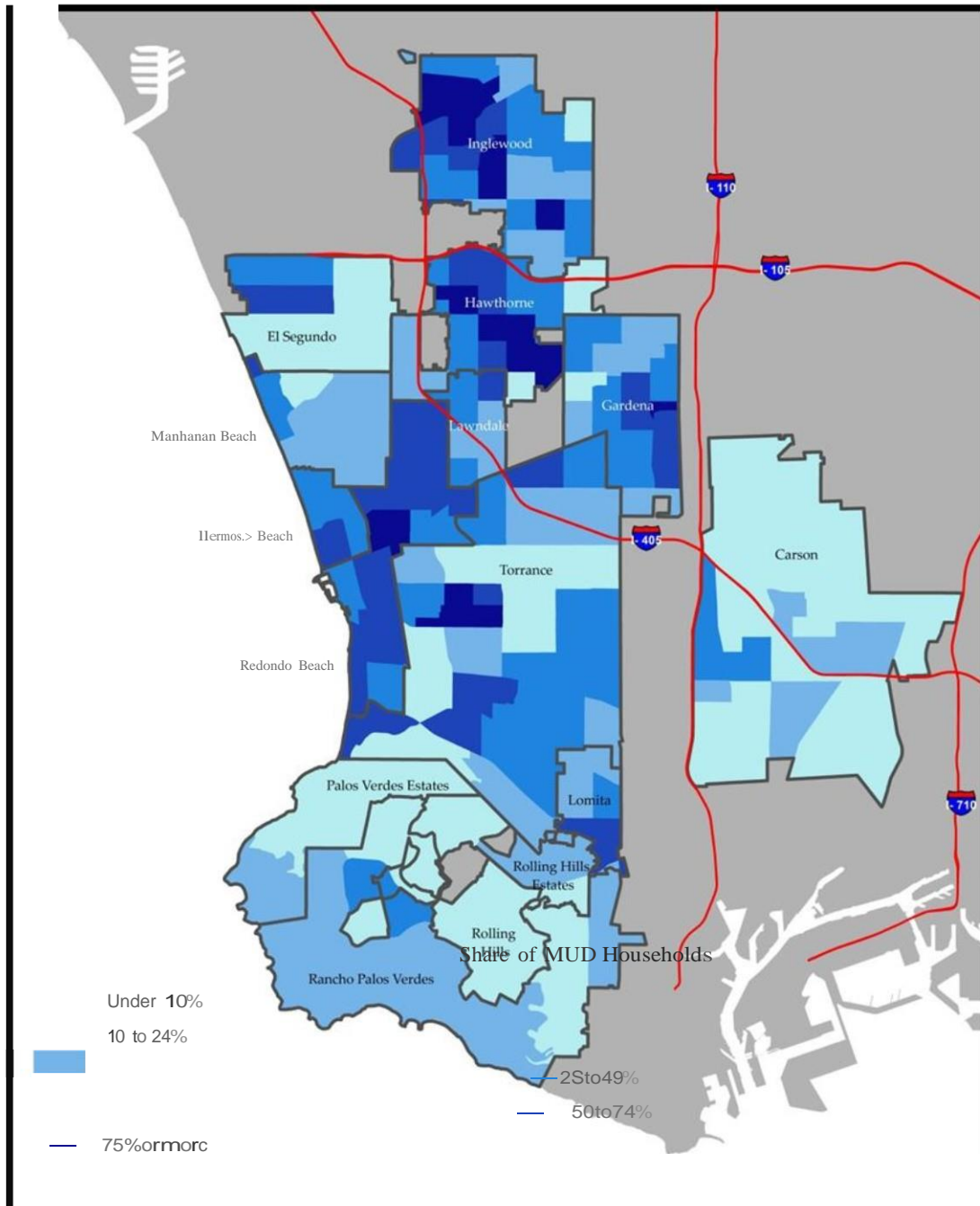


Figure 14: Density of MUD households in cities and their census tracts.

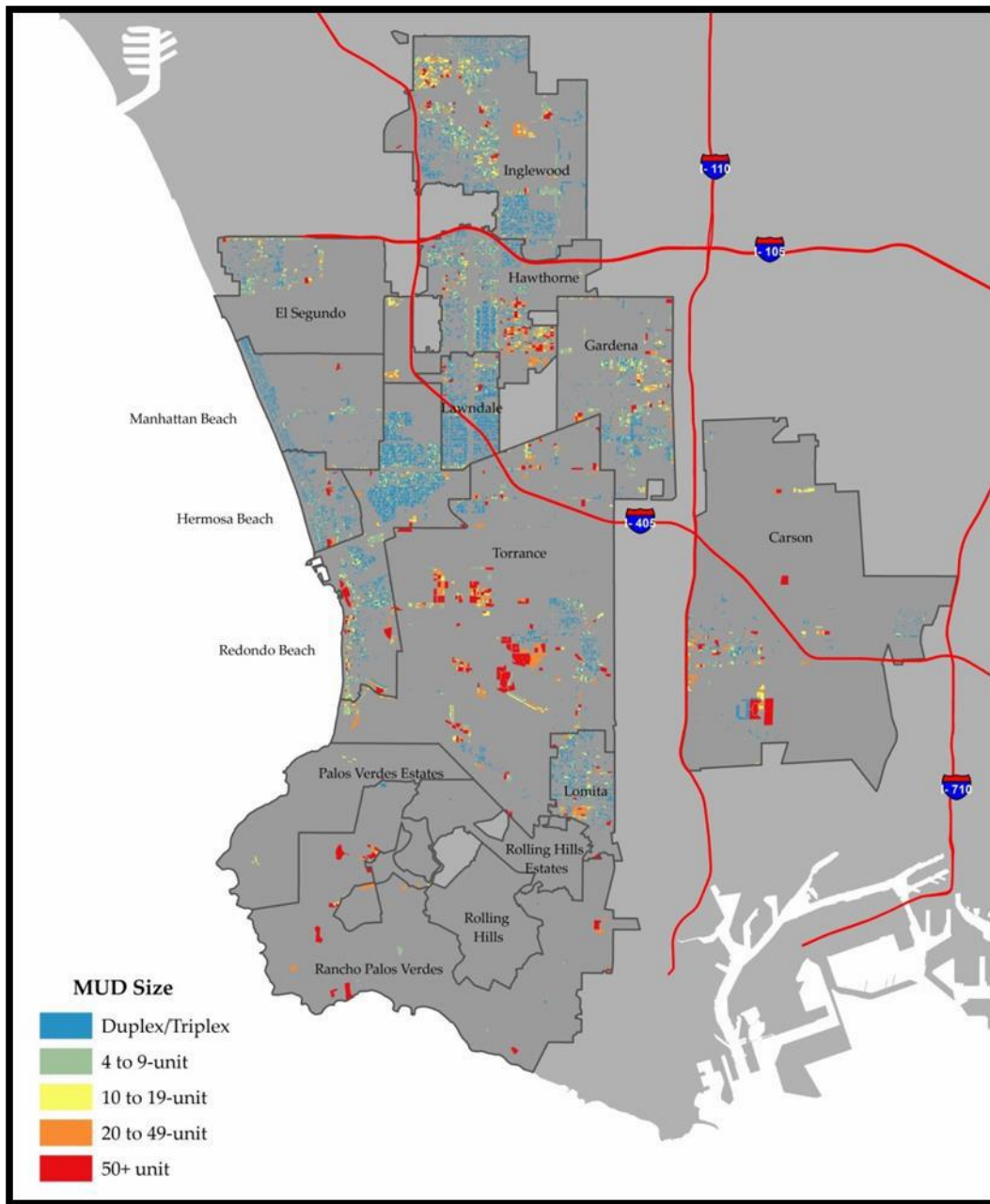


Figure 15: Size categories and distributions for MUD's within the South Bay.

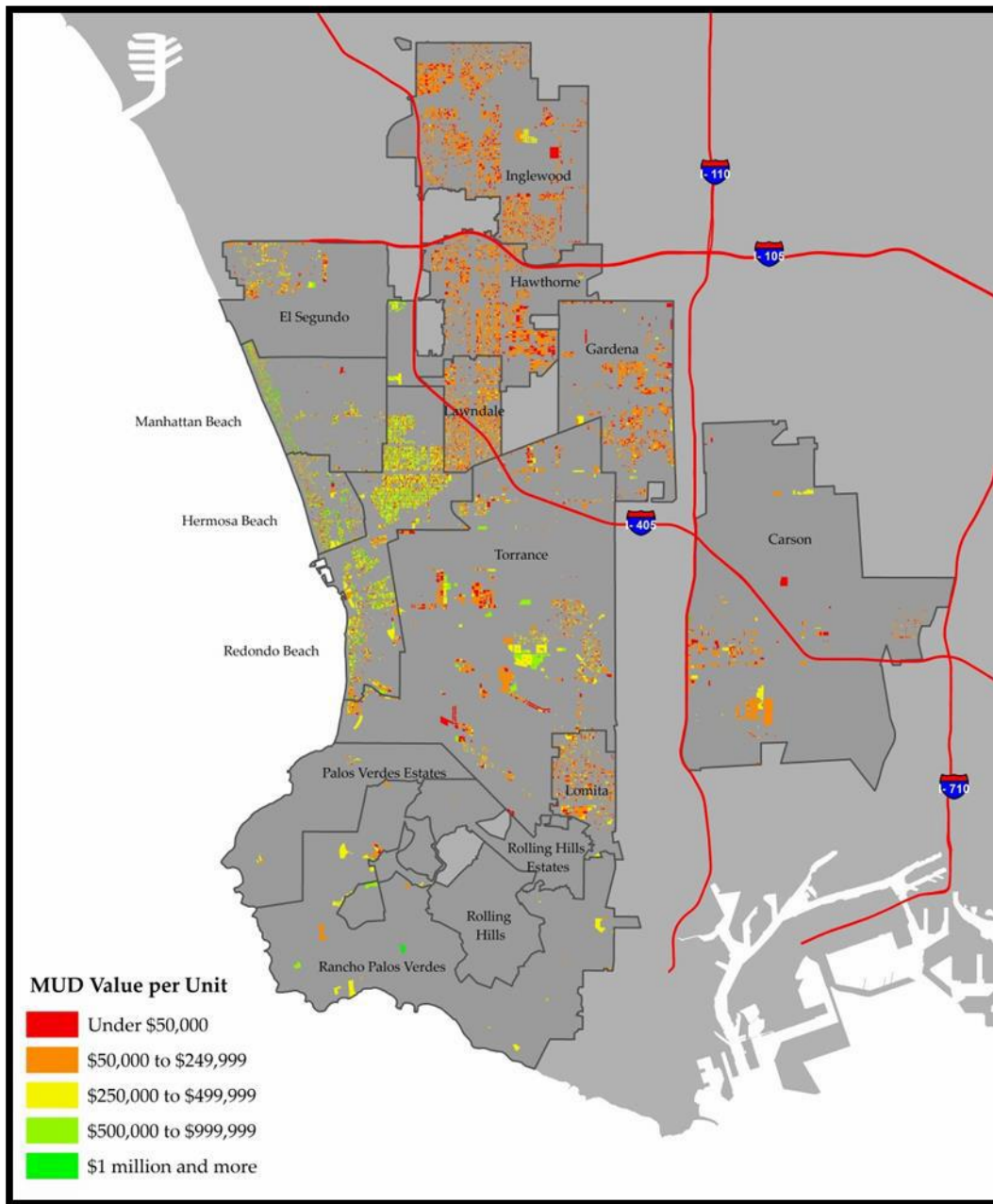


Figure 16: Overall financial value of South Bay MUD's.

South Bay City Statistics	
<u>Redondo Beach</u>	
<i>City MUD Count</i>	20,778
<i>% of city housing</i>	57.00%
<i>Nominal/% rank in the South Bay</i>	4th/3rd
<i>Predominant MUD Designations</i>	Duplex/Triplex and 4-9 count
<i>Portion of the above designation</i>	13,274/20,778
<i>Current PEV Registration</i>	69 PEV's
<i>Current Available Chargers</i>	13 Public EVSE's
<u>Hawthorne</u>	
<i>City MUD Count</i>	23,033
<i>% of city housing</i>	68.00%
<i>Nominal/% rank in the South Bay</i>	3rd/1st
<i>Predominant MUD Designations</i>	4-9 and 20-49 count
<i>Portion of the above designation</i>	12,000/23,033
<i>Current PEV Registration</i>	186 PEV's
<i>Current Available Chargers</i>	20 Public EVSE's
<u>Torrance</u>	
<i>City MUD Count</i>	26,250
<i>% of city housing</i>	42.00%
<i>Nominal/% rank in the South Bay</i>	1st/9th
<i>Predominant MUD Designations</i>	200-49 and 50+ count
<i>Portion of the above designation</i>	16,987/26,250
<i>Current PEV Registration</i>	1080 PEV's
<i>Current Available Chargers</i>	24 Public EVSE's