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INNOVATION IN ELECTRIC VEHICLE CHARGING FOR MULTI-UNIT DWELLINGS

Community Innovation On-Ramp Grant
Final Project Report

November 4, 2020

Prepared for East Bay Community Energy
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Table of Contents

Appendices

Executive Summary

Vehicle electrification provides one of the most promising greenhouse gas (GHG) reduction strategies available today. However, without being able to charge overnight at home, people living in multi-family residences remain very unlikely to convert to electric vehicles (EV).[1] In fact, providing charging reliability at home is the most influential way to encourage consumers to purchase EVs.[2] Homeowners in California are still more than three times as likely to own an EV as those who do not own homes.[3] In the San Francisco Bay Area, more than half of residents live in multi-family properties, but less than 10% of zero-emission vehicles are owned by multi-family residents.[4] The current market for deploying EV-charging infrastructure in the United States, though successful in some sectors, is largely failing in multi-unit dwelling (MUD) properties, especially in low- and moderate-income communities.[5]

The work presented here was undertaken by Ecology Action with funding from an East Bay Community Energy (EBCE) Community Innovation grant to better understand whether and how a specific low-cost "direct installation" delivery model for MUD electric vehicle supply equipment (EVSE) might address the unacceptable trend of disparity in EV ownership between single-family and multi-family residents. The project was undertaken as part of EBCE's commitment to promoting equity among EBCE customers and stimulating rapid growth in EV ownership among MUD tenants. The project's specific goal was to determine whether and to what degree the envisioned low-power turnkey delivery model (detailed below in "Scalable Beta-Design Solution") is applicable to the conditions in the San Francisco Bay Area multi-family housing market. To test the assumptions of the beta design, Ecology Action interviewed 32 MUD property owners and community managers, conducted technical site assessments at 23 properties, and generated electrical and construction cost estimates for nine low-power EVSE installations at MUD properties. The project also included program design refinements and cost modeling with the intent of informing EBCE's investment options for scaling MUD EVSE.

On the basis of the research, we recognize a significant opportunity to deploy MUD EV charging in the region and to scale the deployment at a significantly lower cost than existing programs. Interviews with property operators revealed strong acceptance of a direct installation program model that would meet both the economic and operational needs of residential property owners and managers in ways that the existing commercial EVSE deployment market often does not. The originally envisioned beta design, though technically appropriate for many properties, requires modifications to serve a greater portion of the MUD market. If the modifications recommended in this report are made, we estimate that the direct-installation solution will be technically suitable for approximately 30% of the MUD

[1] Hardman, S. et.al. 2018. "A Review of Consumer Preferences of and Interactions with Electric Vehicle Charging Infrastructure." Transportation Research Part D: Transport and Environment 62: 508–23, p. 517.
[2] Ibid, p. 518.
[3] S. Hardman et al., 2018. "A Review of Consumer Preferences of and Interactions with Electric Vehicle Charging Infrastructure." Transportation Research Part D: Transport and Environment 62: 508–23, p. 518.
[4] Silicon Valley Clean Energy. "Electric Vehicle Infrastructure Joint Action Plan." 2019, p. 7.
[5] Muller, M. "California Approves Novel Low-Income EV Charger Program | NRDC," September 12, 2019. https://www.nrdc.org/experts/miles-muller/california-approves-novel-low- income-ev-charger-program

market and can be deployed at approximately half the cost of the dominant EVSE deployment programs in the California market.[6]

The Scalable Beta-Design Solution

The programmatic solution (aka "beta-design") market tested by Ecology Action combines a very low-cost equipment configuration with an end-to-end installation service package. Together the program elements of the beta design are intended to provide a hassle-free and no-cost solution for the property operator and to provide tenants with 25 to 35 miles of charging per day[7] while meeting an overall price point that is affordable for funding agencies to invest in at scale. This deployment approach is commonly known as "direct installation" in the energy efficiency industry and is a cornerstone method used to serve hard-to-reach market sectors such as MUDs and other small businesses. With EBCE grant funding, a direct install beta design was market tested for its applicability to the Bay Area and the EBCE MUD market. The beta design tested included the following design elements:

- Serves complexes with 20 or more units.
- Uses existing house (common) electrical panel capacity (i.e., no panel or service upgrades).
- Uses only non-networked level 1 charging equipment (J1772 or dedicated 120 v GCFI electrical outlets).
- Conduit runs are mostly over ground and require minimal trenching through softscape and no trenching through or tunneling under hardscape (concrete or asphalt).
- Four to six charging stations or outlets are installed per property, with an average of five.
- EVSE are assigned to single households, not shared among tenants or with the public.
- Property operators agree to reassign electrified spots to EV drivers.
- Payment for electricity is settled via a rent adder based on estimated electricity use.
- Access is controlled by a lock on the charging hardware.
- Property operators agree to own and maintain EV charging equipment for ten years.
- Wraparound direct installation service is provided, including design, permitting, and installation, by a program-vetted contractor.
- All services, products, and installation are provided at no cost to the property operator.
- Average cost is approximately $5,000 per charging port.

[6] Pacific Gas and Electric Company, EV Charge Network Quarterly Report, Report Period: January 1, 2020 – March 31, 2020 and Southern California Edison Company's Charge Ready Pilot Quarterly Report 1st Quarter, 2020, June 1, 2020. Page 18, Table 2.3.

[7] *Daily Miles Traveled.* Metropolitan Transportation Commission, September 2017, https://www.vitalsigns.mtc.ca.gov/daily-miles-traveled. Accessed 1 March 2020.

Methodology for Market Research

Our approach to researching the feasibility of our beta design comprised two types of activities: stakeholder interviews and technical site assessments. Ecology Action contacted MUD property operators (including community managers, asset managers, and owners) by phone and email to offer them the opportunity to be interviewed and to participate in a no-cost technical site assessment to evaluate their properties' potential for EV charging. The interviews focused on understanding the MUD operators' operational preferences and buying criteria for EVSE. The site assessments evaluated common electric circuit panel capacity, electrical conduit runs, and assigned parking configurations that were both acceptable to management and technically compatible with our beta design.

MUD Property Operator Interviews

The objective of each interview was to solicit the decision maker's reaction to the beta design by gathering information on level of acceptance, buying objectives, cost tolerances, and ideas for improvements that would drive design refinements. The interview included a slide presentation describing the beta-design solution and detailing the MUD operators' roles and responsibilities. This format allowed our team to gather responses to pointed questions about a very specific solution idea while gathering open-ended responses about both preferences and objections.

Technical Site Assessments

The objective of each technical site assessment was to determine whether the site was physically suited to accommodate the beta-design solution. Each assessment entailed the evaluation of electric circuit panel capacity, electrical conduit run length and characteristics, and parking configurations. A site was technically suitable for the beta design when

- An existing house panel could accommodate four to six low-power EVSEs without upgrades or replacements, and a minimum of four circuit breaker spaces were available for dedicated circuits for EVSE.[8]
- Short conduit runs (less than 150') were possible from the house panel power source to potential parking spaces where EVSE could be installed.

Site assessment conducted with certified electricians and facilities staff.

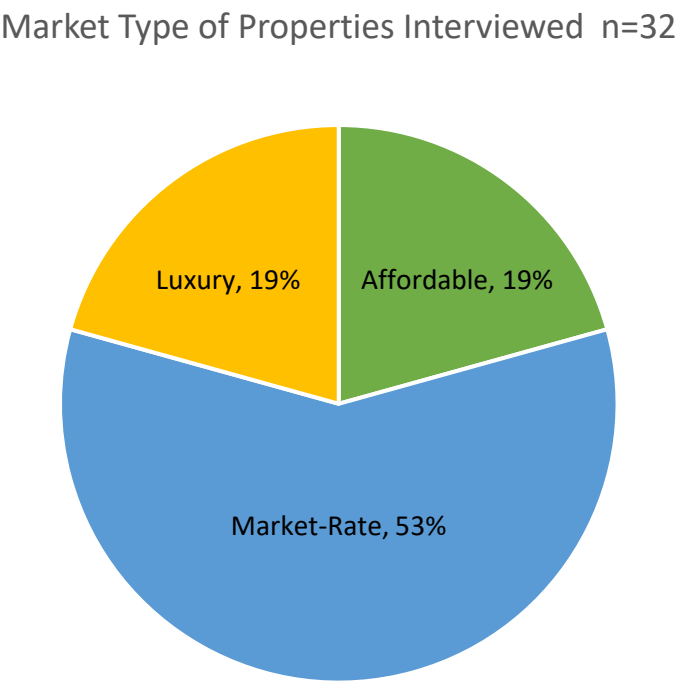
[8] EVSE are designated by the National Electric Code as "dedicated continuous load" and require that 125% of the load is available on the circuit breaker. One 12 amp Level 1 charger or 120 v dedicated receptacle requires one space on the panel for a 15 amp circuit breaker.

- There were at least four contiguous parking spaces adjacent to walls and carport posts for mounting, where conduits could easily be run above ground without penetrating concrete, or adjacent to landscaped areas where the installation of EVSE would require minimal trenching and no modifications to concrete sidewalks or asphalt.

Either a load calculation or a load study with a Dent power meter was completed if all the other technical fit criteria were met. The minimum power requirement for each level 1 EVSE is 12 amps, so the objective of the load calculations or load study was to determine whether 60 amps of capacity was available at the house panel—enough to support an average of five EVSEs.

Results of MUD Property Operator Interviews, and Frequently Cited Objections

Ecology Action contacted a total of 70 multi-family property operators for interview requests. A total of 32 interviews were completed with MUD operators who represented 158 multi-family properties in East Bay Community Energy's service area.[9] Six of the 32 interviews were with affordable-housing MUD operators.



[9] 158 multi-family properties represent just under 2% of the 8,704 MUD apartment-complex properties in EBCE's service area. Source: CoStar 2020.

The following is a summary of survey results and objections to the beta model that were recorded during these interviews. Complete market test survey questions and results can be found in Appendix 3.

Motivation to Install EVSE

- MUD operators' primary motivation for installing EVSE was either to increase the value of the rental (44%) or to respond to tenant demands (27%). Only 7% of respondents reported that city codes were a motivator.
- 53% of property operators responded that tenants or prospective tenants had expressed interest in EV charging in the past. 25% responded that staff had expressed interest in charging, and 21% responded that no one had ever expressed interest.
- 34% of survey respondents reported having installed EVSE at MUD properties they owned or managed. Chargepoint and Evercharge were the dominant vendors cited. MUD operators from affordable-housing organizations that were required by city reach codes to install EVSE in new construction projects consistently reported that EVSEs were not used by tenants, and that very few charging events had occurred since installation.
- Two MUD operators expressed interested in electrifying their company-owned vehicles and offering employees a place to charge.

Budget Available for EVSE Installation

- When asked about their organization's willingness to share costs for EV charging station installation without going into a new budget cycle, 59% of MUD property operators reported that they had no budget available for EVSE installations. Another 28% didn't know. The highest cost-share willingness reported was $5,000 for an EVSE installation project.
- The most frequently cited concern or general condition that would affect the decision whether to install EVSE was that the project must have a neutral or positive impact on net operating revenue. One market-rate property asset manager reported that if there were a cost-share element, there would need to be a two-year payback period, as multi-family property investments are bought and sold frequently. One affordable-housing representative reported that the budget depended on the property, noting that properties with positive cash flow are looking for ways to spend money, while properties not in that position are often unable to share the costs of EV charging.

Assigned vs. Shared Parking

We observed that MUD property operators are generally not well-informed about EVSE and have done minimal thinking about how to deploy EV charging infrastructures on their properties. This corroborates recent findings of the market characterization of property operators by Peninsula Clean

Energy.[10] MUD operators often assumed that shared EV charging was their only option, and they were open to the beta-design solution of assigning a resident to a parking space with EVSE if that solution was offered at no cost.

- 72% of survey respondents said they would be willing to install five or more EV charging stations if a direct installation program were offered at no-cost.
- Only five MUD operators (16%) reported that they preferred to assign tenants to parking spaces with EVSE. 19% responded that their preference was for tenants to share EVSE, and 25% preferred a combination of shared and assigned EVSE. 22% didn't know their preference. A point frequently made was that if the number of EV charging stations was equal to or greater than the number of tenants with EVs, the operational preference was to assign parking. If the number of tenants with EVs exceeded the number of charging stations, it made sense to expand to shared EV charging.
- Only three MUD property operators were willing to pay the additional Americans with Disabilities Act (ADA) costs that would be incurred from shared EV charging. 62% percent said they might be willing to pay additional costs for ADA compliance, but it depended on the cost.
- Most MUDs guarantee one parking space per unit, typically in a covered or protected parking area. Community managers of low- and mid-rise properties in dense urban areas with parking garages were not willing or able to give up any spaces for shared EV charging and were more willing to reassign tenants with EVs to parking spaces with EVSE. Parking reassignment was not an option for communities where spaces are deeded to the unit, such as areas with homeowners' associations.
- Community managers in garden-style or low-rise apartments (81% of total parcels in Alameda County)[11] with more available parking tended to prefer EVSE to be located in existing shared parking spaces in a central area, or decentralized in several non-assigned spaces throughout the MUD property. Garden and low-rise community managers were more reluctant or unwilling to renumber assigned covered parking areas or relocate an assigned, covered parking space to an electrified space when the tenant in that unit purchases or leases an EV.[12]

Outdoor, covered, assigned parking may be more difficult for MUD operators to reassign and renumber than uncovered parking areas.

[10] Energy Solutions. PCE Low-Power EV Charging Pilot: Multi-Unit Dwelling Business Requirements. December 24, 2019. p. 15
[11] Alameda County Multi-Unit Dwelling Building Analysis. East Bay Community Energy, September 2019
[12] At a garden style or low-rise community, the most cost-effective location to install 4-6 EVSE from a nearby house common panel is in a row of assigned parking spaces. In this scenario, tenants currently assigned to spaces where EVSE are installed would remain in those spaces until a tenant purchased or leased an electric vehicle and requested an electrified space.

To summarize the operational needs of MUD operators, where parking is limited to one space per resident, the electrified parking space must be the resident's primary assigned parking space. There is no extra parking space for shared EV charging. In communities where more parking spaces are available, the MUD operator has more flexibility in offering the amenity of an assigned EVSE as the resident's primary or secondary parking space through a monthly rent adder or by establishing fees per kWh or per hour of charge via a third-party payment system.

Payment Approach

- 38% of MUD operators were willing to settle payment for EVSE through a monthly rent-adder fee based on average commute miles and estimated energy use. Market-rate properties were more likely to be able to amend their rental contracts to include a monthly rent adder. MUD operators managing properties subject to rent control ordinances were more hesitant to accept this solution because they didn't know if it would be allowed by their local rent-control boards.
- MUD operators of affordable and low-income properties under Housing Authority jurisdiction expressed concern that the Housing Authority would prohibit them from adding charges to rent to recoup electricity costs from EV charging with a rent adder, because rent is determined by monthly income. For this reason, affordable housing MUD operators consistently preferred a third-party billing system for EV charging that would collect payments separate from rent, and based on electricity consumed or hours of charging time.
- MUD operators who preferred third-party payment collection expressed interest in revenue-sharing models they were familiar with, such as contracts they already had with laundry-service companies (WASH and Coinmach are examples) that charge tenants per use and then share revenues with the property operators so that water and energy utility costs can be recovered.

Maintenance and Operations

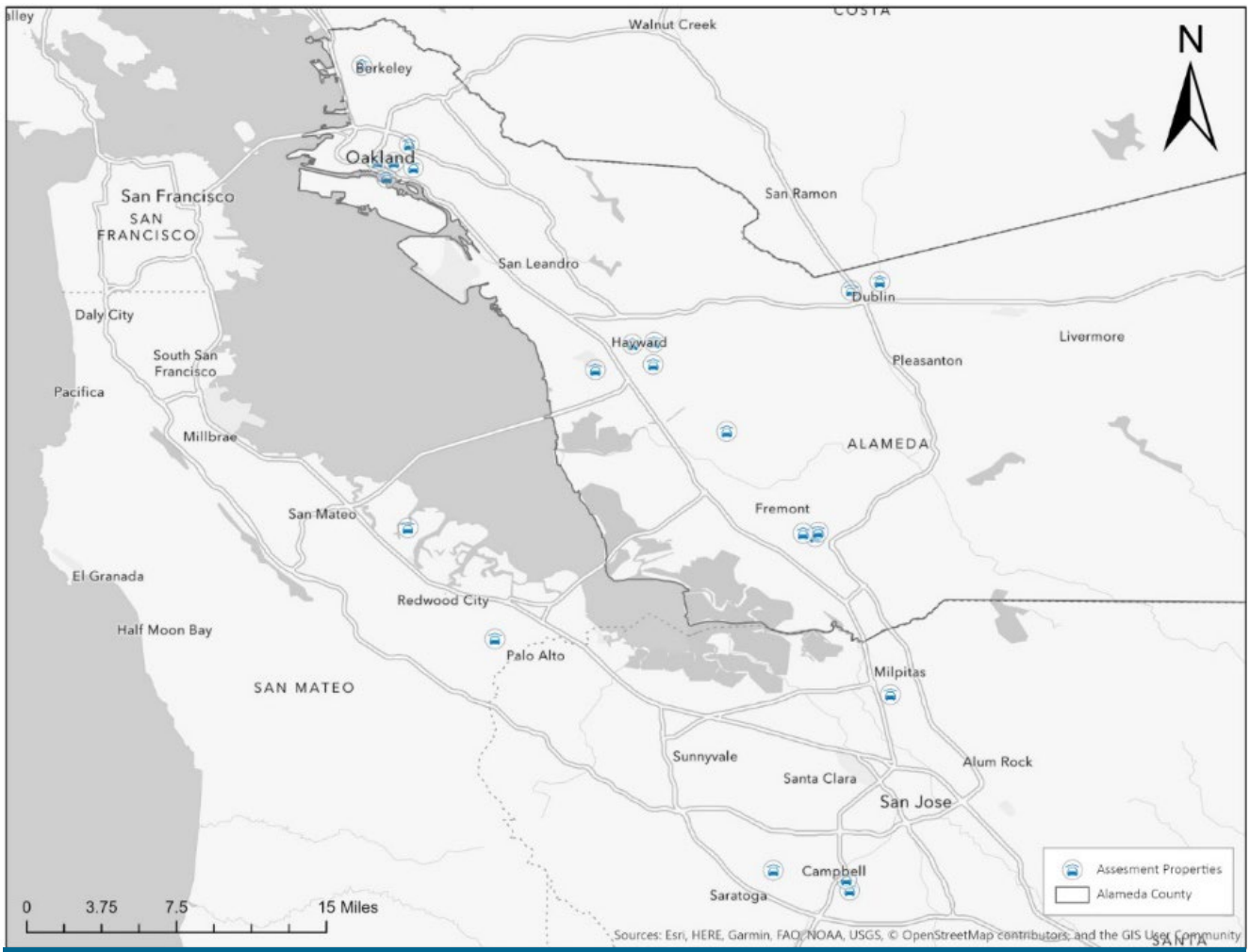
- Only 23% of MUD operators reported willingness to take ownership of EVSE and pay all maintenance and operations costs if equipment breaks within ten years. 46% were not sure and needed more details on the typical operation and maintenance costs for EVSE. Smaller property management companies and owners were more open to the idea of hiring an electrician as needed, rather than paying a monthly subscription to an EV charging service provider. Utilities commonly own and operate EVSE installed on MUD properties for up to ten years.

Results of Technical Site Assessments

Characteristics of Properties Evaluated

Ecology Action completed 23 technical site assessments at multi-family properties to determine what portion met the technical requirements to be served by the beta design (i.e., five contiguous parking spots that could be electrified, conditions that would allow low-cost conduit runs, and existing electrical capacity). In accordance with the agreed-upon scope, 75% of the project's goal of 20 assessments were completed in East Bay Community Energy's service area. The remainder were completed at properties in Santa Clara, San Mateo, and Santa Cruz Counties.

- Fourteen sites were garden-style or low-rise properties with o
- Outdoor and covered parking.
- Nine sites were mid-rise properties (four stories or more) with parking in the garages.
- The properties represented 2,198 units and ranged in size from 19–306 units, with a median of 78 units.



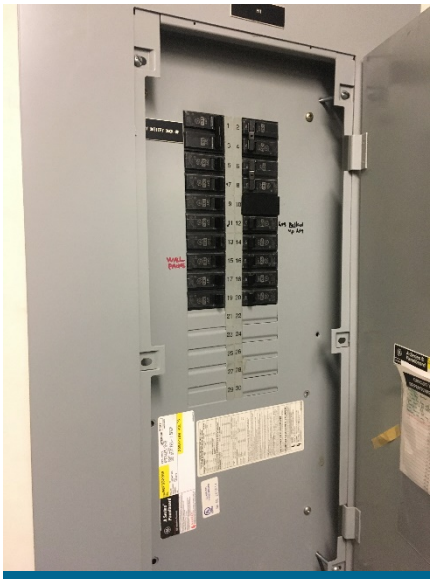
Location of Technical Site Assessments

Evaluating the Technical Fit of the Beta Design

1. Existing Panel Capacity for EVSE: Eleven properties (48%) had additional space for circuit breakers and at least 60 amps of capacity available at the house panel. Available power was confirmed with load calculations or a power meter.

2. Conduit run possible without trenching concrete or hardscape: Only four properties were disqualified by physical limitations observed during visual inspections. Nineteen of the 23 properties (83%) had conduit runs of less than 150 feet that did not require alterations or penetration through or under concrete or asphalt.

3. Five contiguous parking spaces**:** 21 of the 23 properties (91%) met the beta-model criteria of having five contiguous parking spaces within 150 feet of a house electrical panel.



200 amp panel with 10 breaker spaces available.

Short trenching distance with no concrete between house panel and parking spaces.

Of the 23 MUD properties assessed, only ten (43%) met all three technical criteria of our beta design. Of those ten, seven had indoor parking garages and three had outdoor, uncovered parking.

It is worth noting that these 23 MUD properties were not a random sample. They were selected for assessment on the basis of their likelihood of meeting beta-design solution parameters. Thus these technical findings are not a representation of how many properties in the actual MUD market would meet individual or combined technical requirements described in the original beta-design solution.

Common Electrical System Limitations & Opportunities

Overall, our investigation of existing house panels found that available breaker space was not as limiting as available power. The following table summarizes the typical conditions of electrical systems we encountered during technical site assessments. Each includes a corresponding technical solution that would allow L1 or low-power L2 EVSE to be installed. These solutions are presented in order of increasing cost and complexity.

Table 1: Technical Solutions for a Range of Existing House Panel Conditions

Condition of House Panel	No. of MUD Sites with Condition	Technical Solution
1. Existing 200+ amp house panel has 60-120 amps of spare capacity and space for additional circuit breakers. Ideal for original beta design.	7	• Install 4 to 8 level-1 chargers or 120-v smart outlets with dedicated circuits and power metering. • Install 4 to 8 level-2 chargers using load balancing system.
2. Existing 100- or 125-amp house panel has 30–60 amps of spare capacity and space for additional circuit breakers	4	• Install 2 to 4 level-1 chargers or 120-v smart outlets with dedicated circuits and power metering. • Install 2 to 4 level-2 chargers using load balancing system.
3. At least 30 amps of electrical capacity is available from the existing house panel and electrical service, but a sub panel is required to provide spare breaker space.	4	• See technical solutions for 1 and 2 above. Expect a cost increase of $1,500 to $2,000 for a new sub-panel installation
4. At least 30 amps of electrical capacity is available from the existing house panel and electrical service, and breaker space is available, but a main feeder breaker is undersized or a house panel upgrade is required.	2	• Upgrade size of main breaker and conductors to house panel, increase bussing size, or upgrade existing house panel to accommodate as many EV chargers as the existing loads on the main distribution panel will allow.
5. Less than 30 amps is available at the existing house panel. The panel is pre-1980 and needs complete replacement.	3	• Install 2 level-1 chargers or 120-v smart outlets.

Highest-Likelihood Candidate Properties for Beta Design

Through our investigations, we identified several common characteristics among properties that would likely be technically suited to be served by the original beta-design solution. Multi-family properties most likely to have 60 amps of power available for EV charging were constructed after 1980 (the panel is more likely to have a higher amp rating and GCFI breakers) and have a three-phase house panel located in a parking garage fed by a main distribution panel and a service disconnect that is not connected to individual building units. The next best candidates are newer or recently renovated garden-style or low-rise apartments where parking spaces are adjacent to landscaped areas with no sidewalks near utility rooms or house panels. Most of these pre-qualification parameters can be screened for through sources such as CoStar that provide information about the property type (garden-style, low-rise, mid-rise, or high-rise), number of units, age of construction, and parking type.

Locations of Highest-Likelihood MUD EVSE Installation Opportunities for Beta Design

In EBCE's service area, there are 203 mid-rise and high-rise MUDs constructed after 1980 that would be likely candidate properties for the beta-design. The majority of these MUDs are located in the communities of Oakland and Berkeley where household income is less than 80% of area median. Source: CoStar and US Census Data

Technical Potential for the Beta-Design Solution in EBCE's Service Area

Our assessments confirmed that fewer garden-style and low-rise properties are technically suited for two reasons. Parking is generally a greater distance from the house or common panel and more likely to require costly conduit runs through hardscaped areas. Second, these properties do not typically have elevators or other mechanical motors, and therefore do not have three-phase house electrical panels. Mid-rise and high-rise properties (four stories or greater) are more likely to have three-phase panels and parking garages where electrical conduit and EVSE can be attached to walls and ceilings, which is less expensive than outdoor parking configurations for make-ready work. Although three-phase service is not in itself required, panels with this capacity more often have enough unused power to be allocated to several low-power charging ports.

5 contiguous spaces adjacent to an electrical room are typical in parking garages

Ecology Action's projection for the original beta design was that 30% of the market could adopt the envisioned solution. An expected outcome of this market testing was to develop a more informed estimate of the technical potential. Through the research project, it became clear that the beta design as originally conceived would be applicable to 7% of existing properties.

Table 2: Potential Beta-Design Installation Projects and EVSE Potential by Property Type

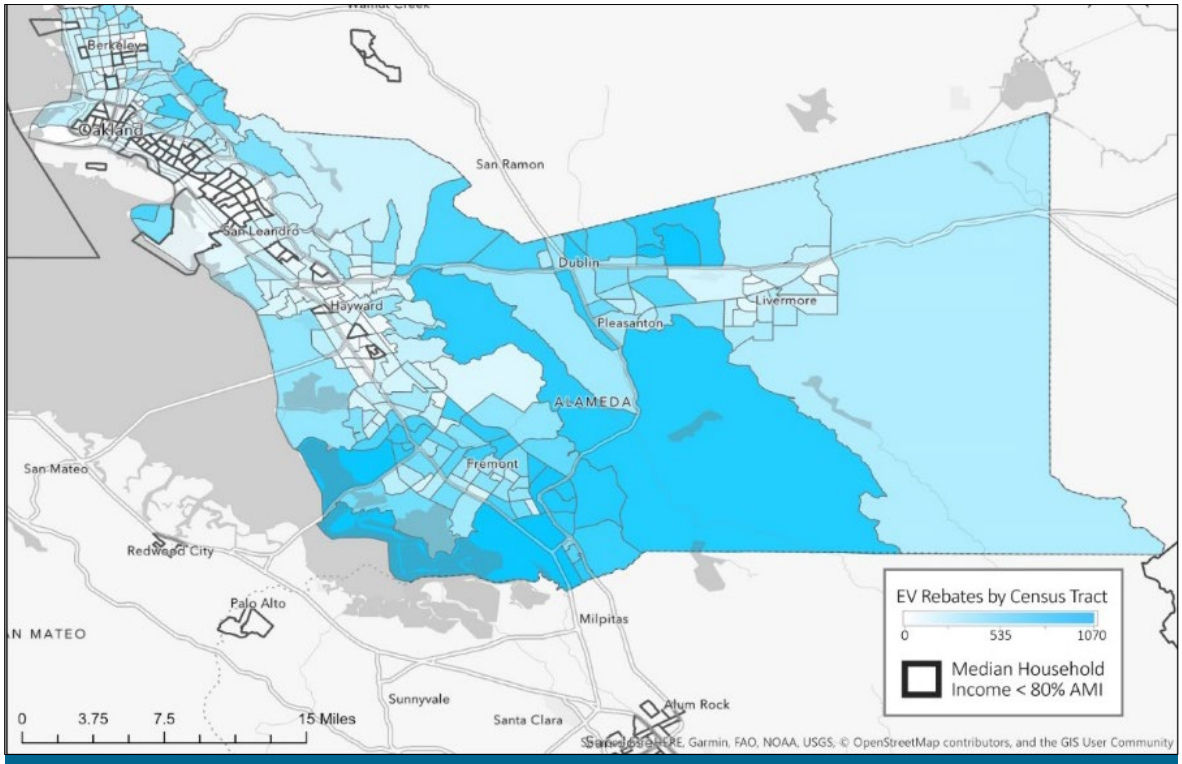
Property type	Total MUD properties over 20 units	Multiplier, based on site assessment results*	No. of properties likely to meet beta-design technical criteria	Avg. no of EVSEs per property	Total EVSE potential per property type
Low-Rise	694	21%	149	5	744
High-Rise	10	78%	8	5	39
Mid-Rise	430	78%	334	5	1672
Garden	358	21%	77	5	384
TOTAL	**1492**		**568**		**2838**

**21% based on 3 of 14 garden and low-rise sites meeting beta-design criteria; 78% based on 7 of 9 mid-rise and high-rise sites meeting beta-design criteria.*

Approximately 17% of the MUDs (1,492 properties) in EBCE's service area meet the primary beta-design criteria of having more than twenty units (and thus being more likely to allocate five parking spaces for EVSE). The majority of these are older, garden-style or low-rise apartments that are least likely to have available power for five chargers at the house panel. When a multiplier from the site assessment data is applied, 568 MUDs are likely to meet the original parameters of the beta design. Assuming that 25% of the 568 properties might choose to participate in a no-cost direct installation program, a program based on the original beta-design may result in EVSE being installed at 142 MUD properties.

In Ecology Action's work in the MUD and commercial markets, we have found that an overall technical potential of at least 30% is necessary to warrant investment in creating a solution that is specifically tailored to a given market. Using this threshold, we would not recommend investment in the original beta design. However, with the program-design refinements recommended below, we estimate the modified version of the beta design could readily serve at least 30% of the MUD market. For East Bay Community Energy, this translates to 2,611 MUD properties and 13,055 EVSEs.[13]

Increasing reliable access to EV charging at MUD facilities where many low- and moderate-income households reside will result in a more equitable distribution of clean vehicle ownership in the region.



EV sales are lower in census tracts in Oakland, Berkeley and Hayward where a higher proportion of multi-family properties rent to low and moderate-income households. Note that this data represents rebates issued through the CA CVRP program and does not represent all EV sales. Source: Center for Sustainable Energy (2020). California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics. Data last updated 5/15/2020. Retrieved 5/19/2020 from cleanvehiclerebate.org/rebate-statistics

[13] 30% of 8,704 properties in Alameda County identified using CoStar data (excluding the City of Alameda)

Recommended Changes to Beta-Design Solution

On the basis of survey feedback from MUD operators and the technical site assessments, we recommend several modifications to the original beta design to meet the widely varying requirements of a disparate MUD market. These recommendations are summarized in Table 3 below.

It is important to highlight the elements of the design that remain as originally conceived. These includes providing a turnkey "direct installation" service package to eliminate hassle for MUD property operators, assuring that EVSE projects are delivered at no cost to the property operator, and installing primarily level-1 EVSE in assigned parking spaces.

Table 3: Summary of Recommended Modifications to the Beta Design

Beta Design Element	Recommended Modification
Serves complexes with 20 or more units.	Serves complexes with fewer than 20 units.
Uses only existing house electrical capacity (no panel or service upgrades).	Pursues some lower-cost 200-amp sub-panel upgrades when building service is adequate.
Direct installation service is provided, including design, permitting, installation, and commissioning by a program-vetted contractor.	No change.
Between 4 and 6 EVSEs are installed per property, with an average of five.	Average of five remains; range is from 1 to 10. Draw power from more than one house panel if necessary.
Conduit runs are mostly over ground and require minimal trenching through softscape and no trenching through or tunneling under hardscape (concrete or asphalt).	Upsize conduits and conductors to allow for future level-2 power delivery (i.e., "future-proofing" in anticipation of eventual panel-capacity upgrades). Allow budget for tunneling under sidewalks and short trenching runs.
Chargers are assigned to one household, not shared among tenants or with the public. Property operators agree to reassign electrified spots to EV drivers.	Primary focus remains on electrifying assigned spaces but includes networked level-2 charging in shared spaces when requested by the property operator, if other property conditions allow for low-cost make ready.
Uses only non-networked level-1 charging equipment (J1772 or dedicated electrical outlets).	Adds the installation of low-power level-2 with load balancing to share the existing panel capacity. This provides future-proofing for eventual panel-capacity upgrade.
Chargers are not networked.	Add a networked option that measures energy throughput to support property operator's need for third-party payment collection and funders that need to claim low-carbon fuel standard (LCFS) credits.
Access is controlled by lock and key hardware.	Use digital access-control options offered by hardware and software companies through smartphones.
Payment for electricity is settled via a rent adder based on estimated electricity use.	Include an option for third-party payment collection to settle billing via phone apps and based on actual kwh delivered or a flat monthly rate. (Federally subsidized housing rules do not allow rent adders.)
All services, products, and installation are provided at no cost to the property operator.	No change.
Property operator agrees to own and maintain systems.	Add an option for a funder such as CCA or a utility to own and operate.
Direct installation services are provided at no cost to the property operator.	No change.

Discussion of Select Program Elements:

Direct Installation Deployment

Direct installation is an implementation model that typically requires no cost sharing from property operators and is designed to be as hassle free as possible. This includes end-to-end services that allow the customer to provide approval and some limited input on system design. The installation is done by licensed and certified trades that are either vertically integrated into the third-party implementer businesses or are separate, vetted independent contractors.

Level-1 EVSE in Assigned Parking Spaces

Because the average vehicle in the Bay Area travels less than 25 miles per day, low-power charging paired with the long-dwell parking at MUDs can meet the needs of most electric vehicle drivers. Access to an assigned level-1 EVSE will assure MUD tenants considering their first EV purchases that they will have reliable access to overnight charging.

UC Davis researchers have determined that MUD households are more likely to buy plug-in hybrid electric vehicles (PHEVs) because these households are more likely to own just one vehicle and need a longer driving range.[14] PHEVs have an average battery range of 21.5 miles and therefore do not take as much time to charge as longer-range battery EVs. In this common MUD-use case, the level-1 charging rate of 1.3 kw, or 3–5 miles of range per hour, is more than adequate for PHEV drivers.

One of the lowest-cost options we have researched is a "smart outlet." These networked, level-1 charging solutions allow property operators to retrofit existing 120-v outlets and control tenant and staff access to house power via a smartphone application. Pricing is determined by metered electricity use, which also allows for claiming of LCFS credits. The smart outlet solution requires users to bring their own charging cables, which are a standard accessory for electric vehicles, reducing operation and maintenance cost of EV charging-cord repair and replacement, which would otherwise be the responsibility of the MUD operator.

Plugzio is an example of a "smart outlet" that allows a MUD operator to be reimbursed for house power used for EV charging by retrofitting an existing 120v outlet on a dedicated 15 or 20 amp circuit.

Optional Low-Power Level-2 EVSE in Shared or Assigned Parking Areas

Our investigation found that the average existing house panel capacity for additional electrical loads ranged from 30 to 60 amps, which is only enough power to support one level-2 EVSE. In this situation, combined with a MUD operator's preference for shared charging, load management systems are an opportunity to maximize the number of EVs that can be charged at once time with existing panel capacity, using one of two types of load management.

[14] Gil Tal, August 21, 2020. UC Davis Plug-in Hbrid & Electric Vehicle Research Center - California EV Market Background [Powerpoint] Presented at Energy Innovation MUD EV Charging Workshop

Static load management

Static load management distributes a pre-set level of charging power to all charging stations across several EVSEs, no matter how many of the individual EVSEs are actually in use. Every station is allocated the same charging power. For example, if the house panel has 60 amps of capacity, each EVSE will be wired to a 15-amp breaker and set at 12 amps, so that 60 amps is never exceeded.

Dynamic load management

By contrast, dynamic load management modulates the power delivered among multiple EVSEs. When installed, it still requires a breaker or set of breakers, which determines the maximum load the EVSE can use. For example, if five chargers are placed on a 60-amp circuit, a lone charging car would get 32 amps, two cars would get 24 amps each, three would get 16 amps each, and so on. The additional advantage of dynamic load management is that as one car's charge is completed, it frees up that power to be used by others. In garden-style and low-rise dwellings where parking is decentralized (in contrast to a parking garage), load balancing can be done at the pedestal. For example, when one car is charging, it receives a faster charge using all 32 available amps. When two cars are parked, power is shared at 16 amps, and each car charges more slowly. Several EVSE vendors offer this single-pedestal dynamic load balancing option, which may be networked or non-networked.

Future Proofing Conductors to Accommodate Faster-Power EV Charging

In anticipation of main panel or service upgrades, all electrical conductors (wires) installed to EVSE should be 10 or 8 AWG wire. These wire gauges can accommodate individual 32- or 40-amp level-2 chargers. Likewise, electrical conduits should be sized to accommodate multiple strands of 8 or 10 AWG wire.

Panel and Service Upgrades

Existing panel capacity is the most limiting factor in a MUD's ability to meet beta-design criteria. An EVSE direct-installation program that funds some electrical panel upgrades at older MUD properties with 60- to 125-amp house panels is necessary to scale EV charging in the multi-family market.

Including funding for house panel upgrades for older MUD properties with 60 amp panels will increase the direct installation program's market reach.

When load studies at a MUD property reveal that less than 30 amps are available at the existing house panels or main distribution panel, the only solution for electrification is to engage with utility engineers to determine whether there is power available at the transformer, or if a service upgrade is required. If 200 amps of additional capacity is available or is made available at the transformer, a new house panel and dedicated meter for EV charging can be installed to supply up to four or eight level-2 EV chargers. The advantage to this approach is that property operators can take advantage of a utility's EV commercial charging rates. Potential wait times of up to one year are typical when a utility's service and planning department must be called to evaluate a property's electrical system capacity, and payment for utility and electrical engineers' time makes this route cost prohibitive.

Resident and Community Outreach

To increase the likelihood that the EVSE installed will be used by tenants, multi-family community outreach is critical to the success of any multi-family direct installation model solution. As part of the LCFS program, CARB specifically calls out the use of LCFS holdback funds for Holdback Credit Equity projects including EV charging infrastructure in multi-family residences, and for multilingual marketing, education, and outreach designed to increase awareness and adoption of EVs and clean mobility options. The outreach should include information about the environmental, economic, and health benefits of EV transportation; basic maintenance and charging of EVs; electric rates designed to encourage EV use; and local, state, and federal incentives available for purchase of EVs. Tenant outreach should take place after technical pre-qualification. A tenant survey designed to increase awareness of EV incentive programs can be done before or during construction so that tenants who are interested in purchasing an EV or plug-in hybrid can be quickly assigned to an electrified parking space. Door-to-door canvassing with pre-notification is an effective community outreach strategy.

Low Carbon Fuel Standard (LCFS) Credit Proceeds

LCFS credits are a critical source of revenue for key stakeholders in the EVSE business ecosystem. The total value of a credit is approximately $.20 – $.25/kWh, depending on the trading price at the time. Roughly two-thirds of this value can be attributed to base credits and one-third to incremental credits.

For LCFS claiming purposes, EVSEs sited within MUD properties are most often deemed by CARB to be residential charging applications rather than non-residential. To be considered nonresidential, the EVSE must be open to the public 24/7. We find that MUD operators are rarely interested in encouraging 24-hour public access to their properties, citing safety and liability concerns. Although it is relatively rare, one example of a potential nonresidential classification would be mixed use with commercial uses on the first floor.

In all residential EVSE applications, a load-serving entity (i.e., CCA, IOU, POU) is eligible to claim the LCFS base credits. Likewise, the LSE has first position in a hierarchy of claiming incremental credits, in front of automakers and other potential claimants such as electric vehicle equipment providers. The serial number of the charger and the VIN for the vehicle that is expected to use it are required for CARB's approval of the claim.

CARB's regulation does not establish a standard for meter quality nor require a certification. However, CARB reviews the metering capability of the installed EVSE and can approve or deny LCFS claim on the basis of that equipment evaluation. The metering hardware and software used by all common L2 systems in the market are currently being used to successfully claim LCFS credits. The networked L1 solutions of the envisioned direct installation program should be reviewed by CARB for approval before being deployed.

Equipment Specification

Ecology Action identified several attributes that electric vehicle service providers (EVSPs) must possess to technically and economically meet the needs of MUD operators, tenant drivers, and the entities that fund the multi-family EVSE installations. EVSPs must be able to bring the following capabilities to a multi-family charging program:

- Commence billing at such time as an EV driver is assigned to the newly electrified parking space, rather than at the time of equipment activation.
- Collect payment from the driver and then reimburse the property operator for the electricity.
- Offer a maintenance option that is built into the price billed to the driver, rather than being paid for directly by the property operator.
- Meter electricity sufficiently to facilitate claims of LCFS credits.
- Deliver an L1 EVSE or outlet in a cost range of $200 to $800 per port.
- Offer load-balanced L2 EVSE that can run on a minimum of 12 amps in a cost range of $700 to $1,500 per port.
- Collect EV charging amenity fees from drivers that are no greater than the cost of gasoline for 25 miles per day, 5 days per week, including wraparound O&M costs.

Through interviews with seven EVSPs we found these attributes to be widely available.[15] We recommend that any EVSPs considered for inclusion in a program be evaluated on the basis of the company's commitment to aligning its business model with the needs of the MUD market ecosystem. The EVSPs interviewed did not include all EVSPs that might possess these attributes.

[15] Interviews were conducted with Clipper Creek, Enelx, EverCharge, EV Box, Greenlots, OrangeCharge, and Low Power EV Charging representing Plugzio.

Direct-Installation Program Model Costs

To test the cost projections used in the original beta design, EVSE construction estimates were gathered for nine design scenarios at six multi-family properties that met our beta-model criteria.

The average cost of installation per non-networked L1 or low-power L2 EVSE was $2,035. The average installation cost per networked L2 EVSE was almost double, at $4,005. The lowest-cost installations were in parking garages. The highest-cost installations were in garden-style or low-rise properties where panels had capacity for only one or two chargers and thus required decentralization of EVSE and increased labor costs for multiple conduit runs and associated trenching through landscapes. (See Appendix 4 for detailed construction estimates.)

For a rough sense of scale, if the refined beta-design solution were deployed at all technically suited properties (~30% of total properties) this would translate to serving 2,611 properties with a total of 13,055 ports.[16] With a range of $8,000–$12,000 per port, this would require a budget of between $104M and $156M, depending on the actual conditions encountered in the field. This per-port cost remains significantly below the dominant utility programs in the state.

The cost for required direct-installation services are roughly equal to the cost of EVSE, equipment, and installation labor.

Table 4: Cost Distribution across Program Functions

Assumptions: Installations use existing panel capacity, or, in select situations, panel and service capacity are upgraded. EVSE are a mix of level-1 and level-2 load-managed. EVSE count is from 1 to 10 chargers per property, with some properties pulling power from more than one house panel to reach this count. Conduit runs include above-ground, underground, and through hardscapes.

Function	% of total program cost	Notes
Enrollment and technical pre-qualification	20%	Includes marketing, customer engagement, and site and panel assessment. Includes sunk cost for properties that do not advance (4:1 close rate assumed).
Design, permitting, construction, oversight, and completion	26%	Includes technical assistance, design, permitting, proposal development, installation contractor oversight, user training, system commissioning, ongoing customer support, quality assurance, and reporting. Includes cost for properties that do not proceed to installation.
Installation labor	29%	Site prep, make-ready, charger installation, signage installation.
Installation equipment	25%	Conduit, conductors, EVSE, signage, panel, bussing.
Total	100%	

[16] 30% of 8,704 properties in Alameda County identify using CoStar data (excluding the City of Alameda)

Safety and Cost Considerations

Because of the danger of electric shock, the state's Division of Occupational Safety and Health (Cal/OSHA) specifies that only qualified employees can work on electrical equipment or systems, including removing the face plate of an electrical panel to determine the size, condition, and code compliance of energized wiring and circuits. A person without Cal/OSHA or electrician certification may perform a basic visual inspection of panel breaker space but would not be able to determine with any certainty the panel's capacity to support EV charging. For this reason, any program to assist MUD operators in installing EV charging must provide resources for electricians qualified to do panel assessment and install power meters for determining existing loads (approximately $1,500 per site).

Power meter installation by licensed electrician.

Lowering the Cost of Customer Acquisition and Technical Prequalification

Customer acquisition (program enrollment), prequalification, and technical assessment activities make up 20% of the overall program delivery cost. Cost-cutting modifications include using existing data sources and mapping tools, and leveraging existing outreach channels to MUD property owners and managers. We recommend several cost-cutting modifications to the refined beta design. We anticipate that use of the tools and approaches below can reduce the total program cost structure by about 5% and should be incorporated into program design.

Leveraging Existing Relationship Channels

Local Community Choice Aggregators (CCAs) and Utilities: A direct-installation program will be more cost effective if CCAs and utilities can provide MUD operators' contact information to the program implementer for the purposes of targeted outreach. Ideally, a list of MUD property addresses would contain each property's electric rate schedule so that the program implementer can quickly prioritize larger properties that can install more EVSEs per site, thus reducing both soft costs and procurement costs.

Energy Efficiency and Building Electrification Programs: The existing activity conducted in these areas could be coordinated to create operational efficiency for all causes. For example, the Bay Area Regional Energy Network (BayREN) contracts with the Association for Energy Affordability (AEA) to implement a cash rebate and financing program for energy efficiency projects at multi-family residential communities that implement energy efficiency projects to achieve a 15% reduction in energy use. AEA's contacts with multi-family property operators and financing programs may be leveraged to refer

decision makers to any available EV charging direct-installation program. Further, constant energy loads such as parking garage lighting conserved at a site with LEDs ultimately make more power available for EV charging. A second phase of the BayREN program seeks to reduce GHG emissions by replacing gas water heaters with electric heat pump heaters. One electric heat pump retrofit for 20 units requires approximately 70 amps, which is roughly equivalent to the power required for five low-power EVSEs. Program staff trained in assessing house panel loads may be able to ensure that upgrades for installing electric heat pumps are upsized to accommodate EV charging. For example, a 125-amp house panel that might be upgraded to a 225-amp panel for a heat-pump heater could allow for electrification of the building's water heating system and EV charging at a nominal materials cost.

Real Estate Developers: It is more cost effective to install infrastructure for EV charging during construction or remodeling. Extending the offer to participate in a multi-family direct-installation program to recently sold multi-family properties that are being renovated by real estate developers with the intent of being resold is one strategy for ensuring that any planned electrical system upgrades can accommodate additional loads for EVSE.

Solar Contractors: Multi-family property operators that are installing solar photovoltaic systems may be open to installing EV charging infrastructure as a means to store and use excess power. An outreach campaign to solar companies that are already engaging with permitting agencies to design and upgrade a building's electrical infrastructure for PV systems is a prime opportunity to ensure that any house panel or service upgrade is sized to accommodate EV charging infrastructure. Solar companies participating in the Solar on Multi-Family Affordable Housing Program are an easily identifiable target audience. Solar companies in contract with a direct-installation program could receive a guaranteed payment by such a program for incorporating make-ready costs for EV charging into their construction bids.

Remote Technical Prequalification

Because a direct installation program is more cost-effective when serving MUD properties with specific parking configurations, low-cost conduit runs, and existing electrical capacity, it is extremely helpful to eliminate unsuitable properties from consideration remotely. Remote evaluations reduce the staff time and travel expenses required for customer acquisition and on-site technical prequalification. The team experimented with multiple tools and recommends several to remotely eliminate such properties, including

- Google Earth: Useful for verifying the location of landscape and hardscape areas in relation to building structures when no trees are blocking the view.
- Apartments.com: Free access to site information such as type of parking, amenities, and general contact information.

- CoStar: A real estate asset database that allows one to query by multi-family property type, parking type, and number of units. CoStar also provides property operator and community manager contact information to facilitate outreach calls. The cost of access to the database per county is approximately $3,600/year, and it would quickly pay for itself through efficiencies from the insights it offers.
- Utility data: Knowing peak kilowatt (kW) demand can help in determining the existing capacity of house panels to support EV charging before ever visiting the site. Peak kW demand data may be available from the CCA or utility with a customer's permission. It is worth noting that MUD properties with solar net metering do not have the same peak kW demand data available, and PG&E meters of MUD properties with A-1, A-6, and A-10 rate structures do not record peak kW demand. Determining peak demand and house panel load capacity remains a costly element of the program design.
- Customer data: Customer acquisition, which begins with the offer of a technical site assessment, is largely a sales enterprise and was the most challenging and costly aspect of the research project in terms of labor. The labor costs for researching MUD asset managers' contact information could be lowered if utilities or CCAs were willing to share multi-family operator and customer contact information with a third-party MUD EVSE program implementer.

EVSE Incentive Program Alignment with the Direct-Installation Model

As part of this project, Ecology Action looked at the broad policy and regulatory frameworks that provide incentives and regulate EVSE and their deployment. Currently, there are significant challenges around MUD EV charging incentives due to misalignment of program requirements (limitations) and timing.

For example, the CALeVIP program from the California Energy Commission (CEC) has been rolled out in many California counties, but there are typically limited funds available. MUD property operators must be ready to apply within the first year of the grants becoming available or they may miss the window for applying. The CALeVIP program does not fund L1 charging and requires shared, networked L2 EVSE, which conflicts operationally with many MUDs that manage tenant parking through parking space assignment to individual units.

The BAAQMD Charge! Program does have allowances for L1 and low-power L2, which are MUD-friendly features. However, it requires shared charging and has a metering and payout requirement. This necessitates EVs being deployed within the same timeframe as the EV infrastructure. In this program, a portion of the incentive payment is also withheld from MUD operators until the EV charging reaches a minimum power-use threshold. The payment delay is a barrier because MUD operators are less likely to take an investment risk when they have no budgets allocated for the installation of EV chargers and no experience or confidence that tenants will request access to chargers. Even the federal tax credit for EVSE is uncertain, as it has often expired for a year or two only to be extended. The current tax credit is in place only until the end of 2020.

EVSE Policy and Regulation Alignment with Direct-Installation Model

The following regulatory rules and requirements should be examined or clarified for a multi-family EVSE direct-installation model to succeed.

California Food and Agriculture Department (CDFA) Rules

New changes to California Code of Regulations Title 4, §§ 4001 and 4002.11 require electric vehicle charging stations for commercial use installed on or after Jan. 1, 2021 to comply with new CDFA rules regarding the metering of electricity used in the charging process.

EVSEs that are not available to the public (e.g., those used for residential or workplace charging) are exempt from the CDFA regulation. The CDFA has confirmed that the term "residential" applies only to single-family cases, and that when an EVSE installed in a multi-family residential property is used to measure electrical energy and then charge a user for the measured quantity, this constitutes commercial use.[17]

Alternative EV charging payment options for multi-family property operators that would not trigger these annual inspection and certification fees include the following:

- Offering electrical energy at no cost to the user, provided this fact is clearly indicated on the charging device (unlikely).
- Billing the user for parking without an associated electrical energy fee, either through
    - Electric vehicle charging based on parking time, or
    - A flat amenity fee or monthly rent adder.

These options would not preclude metering of energy throughput as required by CARB so that LCFS credits may be claimed.

The CDFA regulations affect the multi-family EVSE charging market because property operators that prefer or are required (by local rent control ordinances or the Housing Authority) to collect payment from tenants for EV charging based on the amount of energy consumed will be required to pay additional annual inspection and certification fees levied by the county agricultural commissioner. Market-rate multi-family property asset and community managers are running a real estate business and prefer that EV charging not affect their net operating revenues. They are likely to pass the cost of these fees on to their tenants through the charging rate, increasing the cost of charging for MUD tenants over that for EV drivers living in single-family residences. Fees will be determined at the county level by county agricultural commissioners. Clarity on the fees and the inspection process will be necessary for disclosing this information to multi-family property operators as they decide on charging options and pricing.

[17] 7/31/20 e-mail communication from Kevin Schnepp, Environmental Program Manager 1 Laboratories Branch, ZEV Special Projects, California Department of Food and Agriculture

Rent Control Regulations

AB-1796 - Rental property: electric vehicle charging stations, gives lessors of MUD dwellings subject to rent control ordinances the ability to amend a lease agreement to charge a monthly rental amount for an assigned parking space with an EV charger for any lease signed after January 1, 2019.[18] During market test interviews, several MUD property owners cited concerns that local rent control boards might prohibit them from charging tenants monthly fees for access to EVSE in their assigned parking space to cover the cost of providing electricity from the house electrical panel. Affordable housing MUD operators were even more certain that Housing Authority would not allow a monthly fee, or 'rent adder'. Although we were unable, within the scope of this work, to verify whether the Alameda County Housing Authority or rent control boards in each City of EBCE's service area maintain policies prohibiting rent adders as a mechanism to settle payments for EVSE, the deployment of networked L1 and L2 chargers with third party billing capability, as recommended here, would solve this potential dilemma.

Before a direct installation program is implemented, rent control boards and the Housing Authority should be engaged to determine what fair and acceptable payment strategies MUD landlords can use to recoup electricity and operations and maintenance costs for EVSE installed in in a resident's assigned parking space. One helpful outcome of this engagement would be standardization of EVSE payment collection strategies allowed throughout the region, supported by a written one-page guidance document that could be distributed by rent control boards to MUD property operators and tenants.

Americans with Disabilities Act Requirements

The 2019 California Building Code, Section 11b 228.3.2, states that where a range of five to twenty-five EVSEs are provided for public or common use, one van-accessible and one standard-accessible space are required. An exception written into this section of code provides that "*EVSE not available to the general public and intended for use by a designated vehicle or driver shall not be required to comply with Section 11B-228.3.2".*

The recommended program model would assign newly installed EVSE to specific drivers and specific vehicles in parking areas that are not intended for use by the general public. As such these MUD EVSE installations would fall under the exemption to Section 11b 228.3.2. When a MUD operator prefers the EVSE installation to be located within parking areas open to the general public, all provisions of the ADA code would apply.

[18] California Civil Code Section 1947.6 (a)(4) and (e)

Conclusions and Potential Cost Reductions via Scale and Partnership

Several opportunities for cost reduction that were not built directly into the cost model should continue to be explored.

Co-Investment from Property Operators

The advent of higher levels of EV ownership and higher penetration rates of on-site EVSE will create natural demand among MUD property operators. The increased EV ownership will require MUD operators to have on-site charging to attract and retain tenants, increasing the likelihood they would be willing to co-invest in EVSE deployment. Likewise, higher EVSE penetration at MUD properties will establish a business norm that accelerates EVSE adoption among late adopters, who will likely see on-site EVSE as an amenity they must pay for to catch up with the rest of the market. We predict this market transformation will occur in higher socioeconomic communities first and work its way to market-rate, moderate, and eventually lower-income markets. A cost-share requirement could be instituted by market segment accordingly.

Co-Investment from Electric Vehicle Service Providers (EVSPs)

In situations where the MUD property operator is comfortable dedicating shared parking spaces for EV charging and is willing to allow the general public to charge on their private property, it is likely that some EVSPs will find a business case compelling enough to offset development or operational costs in exchange for access to a portion of the long-term charging revenue generated by the system. The EVSPs we have encountered with business models that could support this approach rely heavily on ownership of LCFS credits.

Strategic Utility Partnerships

Partnerships with load serving entities and utilities could help reduce costs in two ways. Load serving entities such as EBCE that provide ready access to peak demand on house/common panels can reduce the staff costs of qualifying properties, helping to eliminate or reduce the on-site and load study work required to determine if there is existing capacity to host EVSE. Secondly, investor-owned and public utilities could provide grid side asset details that would streamline identification of properties that would be least expensive to upgrade.

Permit Streamlining

The California Governor's Office of Business and Economic Development (GO-Biz) is engaging in a Permitting Olympics, a new concept to overcome permitting difficulties and achieve the EVSE permit streamlining called for in AB 1236 (Chiu, 2015). These efforts encourage and support local jurisdictions and their building departments to reduce the costs and complexity of permitting MUD EVSE throughout California. If successful, this will reduce staff costs and fees required. Most importantly, EVSE permit standardization will make the direct-installation model more readily scalable across a wider geography. At the time of publication, all but two of EBCE member communities are streamlined and AB 1236 compliant. The other two are on a pathway to compliance.

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APPENDICES

Appendix 1: List of Property Owners and Managers Interviewed

Market Test Interview Date	Company/Organization	Name	Title	Number of Properties in EBCE Service Area	Market Sector
6/8/20	Axis HOA	Tony Gutierrez	General Manager	0	Luxury
7/20/20	Bridge Housing	Kranti Malik	Sustainability Associate	14	Affordable
8/24/20	Bridge Housing	Salette Thimot Campos	Community Manager		Affordable
3/16/20	BWG Enterprises	Tom Carr	Resident Manager	3	Market Rate
2/5/20	Canyon Pacific Management	Kelly Wallace	Community Manager	1	Market Rate
2/14/20	CHISPA	Jonathan Bohorquez	Director of Housing Management	0	Affordable
2/14/20	Community Housing Development Cor	Leticia Sweet	Director of Property Management	9	Affordable
12/19/19	East Bay Rental Housing Association	Joshua Polston	Board Member	15	Market Rate
3/16/20	East Shore Properties	Donna Rivera	General Manager	13	Market Rate
8/13/19	Eden Housing	Tom White	Sustainability & Energy Asset Manager	46	Affordable
8/20/19	First Community Housing	Hamid Kaheli	Sustainable Facilities Program Manager	0	Affordable
4/7/20	First Community Housing	Branden Sarkassian	Asset Manager		Affordable
9/13/19	Hinds Property Company	Dwight Hinds	Owner	0	Market Rate
2/14/20	KEMS, Inc.	Matthew McCaffrey	Owner	1	Market Rate
6/9/20	Land and Houses, USA	Gina Ishida	VP- Aquisitions		Market Rate
6/9/20	Landmark Property Management, Inc.	Steve Han	Asset Manager	0	Market Rate
3/11/20	Mercy Housing	Caitlin Rood	National Sustainability Director	7	Affordable
7/20/20	MidPen Housing Corporation	Amélie Besson	Design & Construction Program Manager	25	Affordable
2/27/20	Pinnacle / Nuveen	Patricia Padilla-Mendoza	Community Manager	7	Luxury
2/27/20	Pinnacle / Nuveen	Gladys Floro	Community Manager		Luxury
2/27/20	Pinnacle / Nuveen	Franklin 299 Manager	Community Manager		Luxury
2/27/20	Pinnacle / Nuveen	Eesha Kaur	Community Manager		Luxury
3/3/20	Pinnacle / Nuveen	Ashley Johnson	Community Manager		Luxury
12/19/19	Private Owner	Siddharth Sanhgvi	Owner	4	Market Rate
1/17/20	Private Owner	Chris Thomas	Owner	1	Market Rate
3/7/20	Private Owner	Harold Breen	Owner	0	Market Rate
3/7/20	Private Owner	Rick Galliani	Owner	0	Market Rate
7/10/20	Private Owner	Will Perng	Owner	3	Market Rate
5/7/20	Reliant Group Management	Paul Sawyer	Asset Manager	2	Market Rate
3/12/20	Swans Market Co-Housing	Hilary Near	Co-Owner	1	Market Rate
2/24/20	TCG Capital	Angelo Trinh	Asset Manager	6	Market Rate
9/11/19	Veritu Investments (Private Equity Firm)	Duncan Hatch	Vice President Business Development	0	Market Rate
			Total Properties in EBCE Service Area	**158**	

Appendix 2: Locations of Technical Site Assessments at MUD Properties

Site Assessment Da		Company/Organization	MUD Name	MUD Address	# of Units	Market Sector	Property Type	Existing Panel Capacity for 4-6 EVSE?	Conduit run possible without trenching concrete or hardscape?	5 continuous parking spaces?
5/9/19	1	First Community Housing	Bay Ave Senior Apartments	750 Bay St. Capitola, CA	109	Senior - Affordable	Garden	No	No	No - Outdoor, uncovered
5/16/19	2	First Community Housing	Craig Gardens	2580 S Bascom Ave. Campbell, CA	90	Senior - Affordable	Low-Rise	Yes	No	Yes - Outdoor, uncovered
5/16/19	3	First Community Housing	El Paseo Studios	4980 Hamilton Ave. San Jose, CA	98	Family - Affordable	Mid-Rise	Yes	Yes	Yes- Garage
5/16/19	4	First Community Housing	Villa Montgomery	1500 El Camino Real Redwood City, CA 94063	58	Family - Affordable	Mid-Rise	Yes	Yes	Yes - Garage
11/12/19	5	Eden Housing	Wexford Way	6900 Mariposa Circle Dublin, CA 94568	130	Family and Senior - Affordable	Garden	Yes	Yes	Yes - Outdoor, uncovered
11/12/19	6	Eden Housing	Glen Eden Apartments	561 A Street Hayward, CA 94541	37	Family - Affordable	Mid-Rise	Yes	Yes	Yes - Garage
11/12/19	7	Eden Housing	Walker Landing	1433 North Lane Hayward, CA	78	Family - Affordable	Garden	Yes	No	Yes -Covered Parking
1/21/20	8	AP One, LLC	281 MacArthur	281 McArthur Blvd Oakland, CA	19	Market Rate	Mid-Rise	No	Yes	Yes - Garage
2/19/20	9	Canyon Pacific Management	Portobello Homeowners Assoc	7 Embarcadero West Oakland, CA	200	Market Rate	Low-Rise	Yes	Yes	Yes - Garage
2/27/20	10	Sares-Regis	Indian Creek Garden Apartmer	801 Marine Parkway Redwood City, CA	185	Market Rate	Garden	No	No	Yes - Outdoor, uncovered
3/6/20	11	KEMS, Inc.	1829 6th Ave	1829 6th Ave Oakland, CA	24	Market Rate	Mid-Rise	No	Yes	Yes-Garage
3/12/20	12	TCG Capital	1300 Delaware	1300 Delaware Berkeley, CA	42	Market Rate	Low-Rise	No	Yes	Yes - Outdoor, uncovered
5/8/20	13	Private Owners	Swan's Market Cohousing	930 Clay St Oakland, CA	20	Market Rate	Low-Rise	Yes	Yes	Yes - Garage
5/22/20	14	Reliant Group Management	Amador Valley Apartments	7581 Amador Valley Blvd Dublin, CA	80	Market Rate	Garden	No	Yes	Yes-outdoor, covered
7/2/20	15	Land and Houses USA	Parc at Pruneyard	255 Union Ave, Campbell, CA	252	Market Rate	Garden	Yes	Yes	Yes- Outdoor, uncovered
7/10/20	16	Private Owners Hansen M Perng &	Lake Park Terrace Apartments	1448 Madison St, Oakland, CA	40	Market Rate	Mid-Rise	Yes	Yes	Yes- Garage
8/3/20	17	MidPen Property Management Co	Mission Gateway Apartments	33155 Mission Blvd. Union City, CA	121	Affordable	Mid-Rise	Yes	Yes	Yes-Garage
8/3/20	18	Private Owners	Cinnamon Apartments	23924 2nd St Hayward, CA	31	Market Rate	Mid-Rise	No	Yes	Yes-Garage
8/3/20	19	Private Owners	Plaza Verde Apartments	550 Berry Ave Hayward, CA	50	Market Rate	Low-Rise	No	Yes	Yes- Outdoor, uncovered
9/8/20	20	MidPen Property Management Co	Laguna Commons	41152 Fremont Blvd, Fremont, CA	64	Affordable	Low-Rise	Undetermined	Yes	Yes - Outdoor, uncovered
9/8/20	21	MidPen Property Management Co	Main St. Village	3615 Main St., Fremont CA	64	Affordable	Mid-Rise	Undetermined	Yes	Yes-Garage
9/8/20	22	Bridge Properties	Irvington Terrace	4109 Broadmoor Common, Fremont CA	100	Affordable	Low-Rise	Undetermined	Yes	Yes-Garage
9/16/20	23	Bridge Properties	Monte Vista Apartments	1001 S. Main St., Milpitas. CA	306	Affordable	Garden	No	Yes	No - Outdoor, uncovered

MFR Electric Vehicle Charging Market Test Questions

This survey is intended to gather your input on level of acceptance, cost tolerance, and ideas for improvement to inform Ecology Action's design solution for multi-family residential electric vehicle charging. We will contact you within 5 business days to our responses and schedule a no-cost technical site assessment for your multi-unit property. Thank you for participating!

* Required

1. Company name *

2. Contact email *

3. Contact Name & Phone *

4. Property Address (where charging would be installed)

5. What is motivating you to install EV charging stations? (Please mark all that apply) *

- [ ] City Codes
- [ ] Internal Company Sustainablility Goals
- [ ] Tenant Demand
- [ ] EV Charging amenity adds value to rental
- [ ] Other

6. Has your organization added electric vehicle (EV) charging installations to any of your existing multi-family residential properties? *

- ◯ Yes
- ◯ No
- ◯ Not sure
- ◯ Other

7. If you have already installed EV charging ports at one or more of your multi-family properties, what model of EV charger has been installed?

   Example: Evercharge - AC Charge Station 30 Amp

8. Who has expressed interest to you about EV charging in the past? *

- [ ] Tenants
- [ ] Staff
- [ ] Community Managers
- [ ] No one has ever expressed interest in having access to EV charging stations
- [ ]

Other

9. Are you willing to survey your tenants regarding their interest in purchasing an electric vehicle if EV charging stations were available? *

- ◯ Yes
- ◯ No
- ◯ Maybe

10. Assuming that panel capacity is available, and an EV Charging direct installation program would be offered at no-cost, would it be acceptable to allocate existing common (house) panel capacity to power five (5) or more EV charging stations? *

- [ ] Yes
- [ ] No
- [ ] Not sure
- [ ]

Other

11. PARKING - Please mark your organizations preference: *

- ◯ We prefer tenants to share EV charging stations in a common parking area
- ◯ We prefer to assign a tenant with an EV to an assigned space with an EV charging station
- ◯ We prefer a combination of shared and assigned EV charging stations
- ◯ Don't know
- ◯ Other: _____

12. ADA (Americans with Disabilities Act) requirements may be triggered by the installation of shared, EV charging stations available to the public. Is your organization willing to pay for the infrastructure changes necessary to meet ADA requirements? *

- ☐ Yes
- ☐ No
- ☐ Maybe - Depends on the cost
- ☐ Other: _____

13. PARKING - If EV charging stations were installed, is there anything (eg: rental agreement language, tenant relations, etc) that would prohibit you from assigning parking spots with EV chargers to individual tenants who own electric vehicles? *

- ☐ Yes
- ☐ No
- ☐ Not Sure
- ☐ Other: _____

14. PARKING - Are there any legal reasons why an amenity such as an EV charging station could be provided to some, but not all tenants? *

- [ ] Yes
- [ ] No
- [ ] Not sure
- [ ] Other

15. ACCESS - Would your organization be willing to provide assigned tenants access to EV charging stations by issuing a code with combination lock? *

- [ ] No access control is required
- [ ] Yes
- [ ] No
- [ ] Not sure
- [ ] Other

16. CONDUIT - Do you mind running electrical conduit above ground, attached to existing structures? *

- [ ] Yes
- [ ] No
- [ ] Not sure
- [ ] Other

17. PAYMENT - Is your organization willing and/or legally able to amend your rental agreement with tenants assigned to EV charging stations by adding a monthly, flat-fee payment based on average use and electrical costs for electric vehicle charging (approximately $30-$50/month)? *

- [ ] Yes
- [ ] No
- [ ] Don't Know
- [ ] We do not need to collect payment for EV charging from tenants
- [ ] Other

18. BUDGET - What amount would your organization be willing to cost share for EV charging station installation per property without going into a new budget cycle? *

- [ ] $0 - There is no budget availble for EV charging stations
- [ ] $0-$1,000
- [ ] $1,000-$2,000
- [ ] $2,000-$3,000
- [ ] $3,000-$4,000
- [ ] $4,000-$5,000
- [ ] $5,000-$10,000
- [ ] More than $10,000
- [ ] Don't know
- [ ] Other

19. BUDGET - Is your organization willing to take ownership of EV charging stations and pay for all maintenance and operations costs if installed EV charging equipment breaks within 10 years? *

- [ ] Yes
- [ ] No
- [ ] Not sure
- [ ] Other

20. What is the approval process for contract signing in your organization? *

5. What is motivating you to install EV charging stations? (Please mark all that apply)

City Codes	3
Internal Company Sustainablili...	7
Tenant Demand	12
EV Charging amenity adds val...	20
Other	3

6. Has your organization added electric vehicle (EV) charging installations to any of your existing multi-family residential properties?

Yes	11
No	19
Not sure	2
Other	0

7. If you have already installed EV charging ports at one or more of your multi-family properties, what model of EV charger has been installed? Example: Evercharge - AC Charge Station 30 Amp

11
Responses

Latest Responses
"Evercharge - AC Charge Station 30 Amp, required by reach codes i...

8. Who has expressed interest to you about EV charging in the past?

Tenants	20
Staff	6
Community Managers	2
No one has ever expressed int...	7
Other	3

Questions Responses 32

9. Are you willing to survey your tenants regarding their interest in purchasing an electric vehicle if EV charging stations were available?

Yes	18
No	5
Maybe	9

10. Assuming that panel capacity is available, and an EV Charging direct installation program would be offered at no-cost, would it be acceptable to allocate existing common (house) panel capacity to power five (5) or more EV charging stations?

Yes	23
No	0
Not sure	9
Other	3

11. PARKING - Please mark your organizations preference:

We prefer tenants to share EV ...	6
We prefer to assign a tenant ...	5
We prefer a combination of sh...	8
Don't know	7
Other	6

12. ADA (Americans with Disabilities Act) requirements may be triggered by the installation of shared, EV charging stations available to the public. Is your organization willing to pay for the infrastructure changes necessary to meet ADA requirements?

Yes	3
No	11
Maybe - Depends on the cost	18
Other	2

13. PARKING - If EV charging stations were installed, is there anything (eg: rental agreement language, tenant relations, etc) that would prohibit you from assigning parking spots with EV chargers to individual tenants who own electric vehicles?

Yes	5
No	20
Not Sure	7
Other	5

14. PARKING - Are there any legal reasons why an amenity such as an EV charging station could be provided to some, but not all tenants?

Yes	0
No	20
Not sure	10
Other	5

15. ACCESS - Would your organization be willing to provide assigned tenants access to EV charging stations by issuing a code with combination lock?

No access control is required	2
Yes	11
No	6
Not sure	11
Other	3

16. CONDUIT - Do you mind running electrical conduit above ground, attached to existing structures?

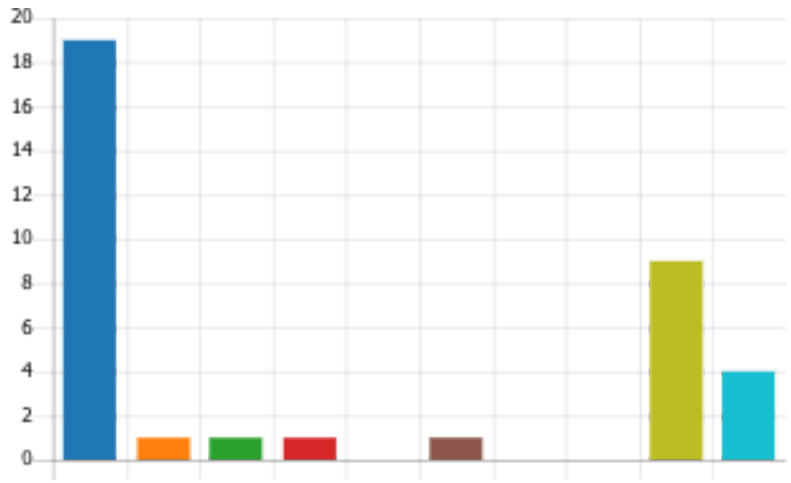
Yes	3
No	23
Not sure	6
Other	1

17. PAYMENT - Is your organization willing and/or legally able to amend your rental agreement with tenants assigned to EV charging stations by adding a monthly, flat-fee payment based on average use and electrical costs for electric vehicle charging (approximately $30-$50/month)?

Yes	12
No	9
Don't Know	9
We do not need to collect pay...	1
Other	7

18. BUDGET - What amount would your organization be willing to cost share for EV charging station installation per property without going into a new budget cycle?

$0 - There is no budget availbl...	19
$0-$1,000	1
$1,000-$2,000	1
$2,000-$3,000	1
$3,000-$4,000	0
$4,000-$5,000	1
$5,000-$10,000	0
More than $10,000	0
Don't know	9
Other	4



19. BUDGET - Is your organization willing to take ownership of EV charging stations and pay for all maintenance and operations costs if installed EV charging equipment breaks within 10 years?

Yes	8
No	6
Not sure	16
Other	5

EV Charging Costs - Summary Sheet	Electrician	EVSE Vendor	EVSE Quantity	Level 1 Total Installation Cost	Level 1 Cost per EVSE	Level 2 - Networked, Load Balancing Total Installation Cost	Level 2 - Networked, Load Balancing Price per EVSE
Parking Garage; 4-6 chargers installed per location; future-proofed for level 2.							
7 Embarcadero West, Oakland (ceiling mount)	EV Charge 4 U	EnelX - Juicbox	4			$ 18,811.00	$ 4,702.75
Glen Eden, Hayward (wall mount)	GRID Alternatives	Evercharge	5			$ 13,040.60	$ 2,608.12
1448 Madison, Oakland (wall mount)	Low Power EV Cha	Plugzio	5	$ 11,432.90	$ 2,286.58		
Garden Style - Centralized. 4-6 chargers installed in a row; future-proofed for level 2.							
Wexford Way, Dublin	GRID Alternatives	Clipper Creek	5	$ 9,191.23	$ 1,838.25		
Wexford Way, Dublin	GRID Alternatives	Evercharge	5			$ 14,794.47	$ 2,958.89
Wexford Way, Dublin	EV Charge 4 U	EnelX - Juicbox	5			$ 22,275.00	$ 5,568.75
Craig Gardens, Campbell	Dave Wiegel	Clipper Creek	6	$ 10,868.00	$ 1,811.33		
Villa Montgomery	Dave Wiegel	Clipper Creek	6	$ 13,221.00	$ 2,203.50		
Garden Style - Decentralized- 2 chargers installed per building, future proofed for 3 additional chargers							
Wexford Way, Dublin	GRID Alternatives	Evercharge	8			$ 33,513.91	$ 4,189.24
		AVG Cost per EVSE			**$ 2,034.91**		**$ 4,005.55**