EV Ready Program Design Guidance

Version 2.0

Last Updated June 2025

Peninsula Clean Energy and CLEAResult

Table of Contents

Revision Table

Version	Date	Description
1.0	1/15/21	Initial draft
1.1	2/1/21	Minor formatting changes
1.2	5/12/21	Updated circuit and panel sharing definitions and recommended use cases, added Illustration of costs for different electric service upgrades in section 3.1.2, added guidance for PML2 at MUDs in section 3.2.3, added Appendix B for electrical system component nomenclature, updated recommendation to 20A circuits for Level 1 outlets
1.3	9/14/21	Added L1 pricing guidance, added guidance for PML2 at new construction, added guidance for mixed charging needs at single sites
2.0	06/04/25	New design goal of reducing costs for EV drivers, 2024 Interim Cycle CALGreen Updates impacting PML2 charging levels, new design criteria for assigned parking at MUDs to allow for direct billing as part of larger strategy focus on charging affordability, simple load balancing through DCC products, and new operational cost modeling.

1 Overview

To achieve widescale EV adoption, significant EV charging infrastructure will need to be installed quickly. This effort requires design approaches for EV charging installation projects that minimize impacts, such as high capital costs and electrical grid pressure, to achieve the charging infrastructure necessary to facilitate this timely transition from fossil fuels. And increasingly, it also requires design approaches that minimize end user costs, providing a fuel-cost savings potential for drivers who adopt EVs.

These design guidelines provide the high-level framework for how Peninsula Clean Energy, and it's consulting partners, design EV charging infrastructure projects for customers in its EV Ready Program, to help facilitate and a rapid and inclusive transition to EVs. These guidelines are freely available to be used by other CCAs, utilities, implementers, contractors, etc.

A key principle of the guidelines is known as "right sizing," designing projects that are appropriately sized, allowing for greater benefits (such as more chargers) at lower costs. Since the significant majority of San Francisco Bay Area drivers travel less than 30 miles per day, low-power EV charging is sufficient if everyone has access to at-home overnight charging. As a result, these guidelines frequently recommend low power charging at multi-family properties for overnight parking.

Another critical element of PCE's EV Ready Program is to provide EV charging to multi-family residents, a critically underserved population for EV adoption. We believe that cost-effective and right-sized EV charging projects can quickly produce mass quantities of at-home charging for multi-family residents.

PCE EV Ready Design Principles:

1. Maximize the quantity of ports the program achieves to support EV growth overall. Design for a future where every multifamily parking space has a charger or outlet.
2. Provide charging service levels that satisfy the everyday needs of most personal EV drivers (<30mi)
3. Control the cost per port to reduce barriers to installation
4. Minimize grid impacts, including distribution infrastructure and peak generating capacity, by maximizing port count within existing electrical service or transformer capacity
5. Reduce the cost to charge for EV drivers, with the aim of approaching parity with the cost to charge at single-family homes

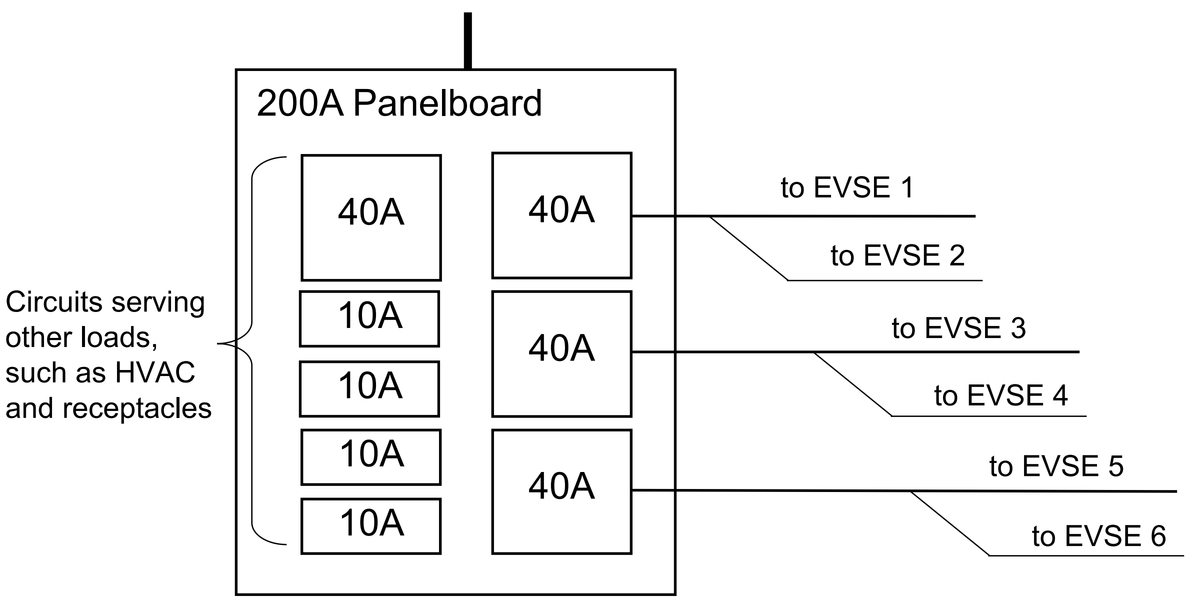
Each of the following design principles supports one or more of these goals. These principles are being used to guide charging infrastructure scope recommendations for EVRP participants receiving technical assistance and are primarily oriented to charging solutions for MUDs and workplaces. They continue to be improved as unique site conditions are encountered and charging technology evolves.

2 Definitions, as Used in EVRP

1. **Automated Load Management System (ALMS), also known as “Power Managed Charging” or “Load Managed Charging”,** is an energy management system that:
   a. Controls multiple EV charging ports to operate safely within a maximum permissible load that is configured during installation and thereafter only modifiable by personnel with detailed knowledge of the site’s electrical design, and
   b. Apportions power delivery among the number of vehicles that are actively charging, either dynamically depending on the energy needs of each vehicle or equally among the vehicles.
2. **Circuit Sharing:** Connecting multiple EV charging ports to a single branch circuit sized to the continuous load of one EVSE using an ALMS that allows:
   a. All ports to operate simultaneously within the maximum permissible load of the branch circuit, and
   b. Individual ports to operate at higher loads – often the maximum rated charging equipment input – when other ports on that same circuit are not in use.

Figure 1: Examples of Circuit Sharing

Panelboard with a mix of loads, including EVSE

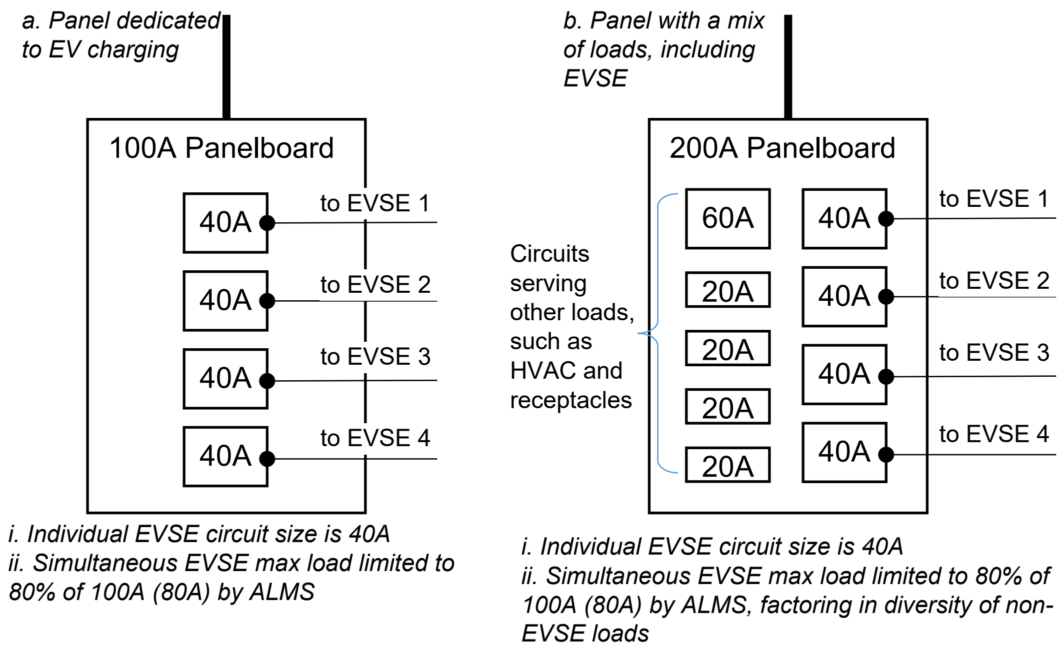


i. Individual EVSE max load is 32A

ii. Simultaneous EVSE max load for each branch is limited to 32A by ALMS

3. **Panel Sharing:** Allowing multiple EV charging ports on independent branch circuits to share a single electrical panel using an ALMS that allows:
   a. All ports and any other loads on that panel – diversifying other loads as permitted by the electrical code – to operate simultaneously within the maximum permissible load of the panel and feeder to that panel, and
   b. Individual ports to operate at the maximum rated charging equipment specification when other ports are not in use.

Figure 2: Examples of Panel Sharing



4. **Electric Vehicle Supply Equipment (EVSE):** An EV charger, station, or outlet that safely delivers power to charge the battery of an EV.
5. **Level 1 Charging (L1):** Charging provided to an EV on a dedicated 120V circuit (20A), either through an EVSE, standard electrical outlet, or smart outlet device.
6. **Low Power Level 2 Charging (LPL2):** Charging provided to an EV on a dedicated 208-240V circuit (20A), either through an EVSE, standard electrical outlet, or smart outlet device.
7. **Direct Wiring:** EVSE are provided with a dedicated branch circuit connected behind the dwelling unit's electrical meter.
8. **Direct Metering:** Installing EVSE such that the charge to use the equipment is billed directly on the driver's utility bill at the utility rate, avoiding additional mark ups to the driver. This can be achieved by either direct wiring or virtual submetering.

3 Design Guidance

The market context and EVRP goals, as well as analysis of technology options and costs, have supported the development of design guidance to be used when recommending EV charging solutions for individual customer sites.

3.1 Guiding Principles

Peninsula Clean Energy follows a design approach referred to as "right sizing." In the context of EV charging this approach leads to L1 charging, LPL2 charging, or PML2 charging recommendations for sites with long dwell times, such as multifamily and workplaces. Varying capacities of PML2 charging is recommended for sites with more moderate dwell times. Right sizing in this context would also include aiming to maximize available capacity and reduce grid impacts. Right sizing is closely aligned with the guiding principle to meet everyday needs within expected dwell times and reduce costs and barriers to installation. Right sizing leads to installing more chargers, more quickly, for a lower cost per port.

When developing the scope for a given charging infrastructure project, there are many choices to be made. To narrow the field of options, we developed these guiding principles that align with EVRP goals and right sizing approach and help present customers with options that are worth developing for consideration.

1. **Maximize the quantity of ports the program achieves to support EV growth overall. Design for a future where every multifamily parking space has a charger or outlet.** Encourage sites to prepare for growing EV demand over time, futureproofing now instead of performing additional retrofits to add more EVSE in the future. This can be achieved with a large number of relatively low-cost L1 or with "make ready" infrastructure for PML2, instead of full deployment, to align near-term utilization expectations with operating costs while allowing for relatively simple scale-up. Panel and/or subpanel upgrades may be desired if they can yield significant additional EVSE without triggering large electrical service upgrade costs from the utility, such as a new site-dedicated transformer. Where service upgrades cannot be avoided, plan for a larger scale project that justifies the cost.

2. **Provide charging service levels that satisfy the everyday needs of most EV drivers (<30 mi) within expected dwell times.** To balance the cost of infrastructure with the benefit derived by the users, we aim to satisfy most drivers' daily driving needs with the charge obtained while parked at the project site. In general, this principle leads to L1 charging, LPL2 charging, or PML2 charging recommendations for sites with long dwell times, such as multifamily and workplaces. Varying capacities of PML2 charging is recommended for sites with more moderate dwell times. Site owner preferences may influence these installation decisions. See recommendations for the number of PML2 ports in section "Guidance for Power-Managed Level 2 Site Design."

3. **Control the cost per port to reduce barriers to EVSE installation. Offer low-cost options that avoid expensive distribution service upgrades for the customer wherever possible.** Recommend inexpensive, low-cost solutions such as Level 1 and Low-Power or Power Managed Level 2 outlets. Incentives are structured to encourage customers to install projects at scale. Where Level 2 chargers are preferred, utilize ALMS to double port count, compared to a standard design wherein each Level 2 EVSE has a dedicated 40-50A capacity, while staying within overall existing power capacity thresholds. If needed, upgrade panel capacity to increase ports where it can be done without exceeding service or transformer capacity.

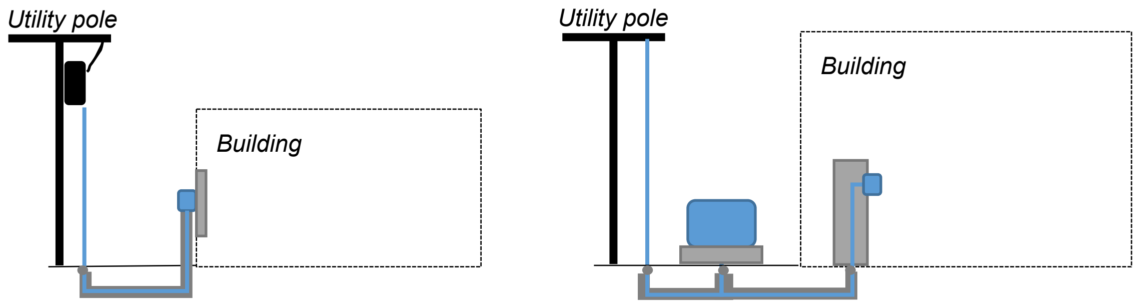
4. **Minimize grid impacts, including distribution infrastructure and peak generating capacity, by maximizing port count within existing electrical service or transformer capacity.** Current electric service rules place much of the substantial cost of new or upgraded electric service on ratepayers, easily adding $10,000 or more in costs and lengthening installation duration by 400+ days. By keeping the project's power demands within the customer's existing electrical service or distribution transformer capacity, additional costs and project delays can be avoided. If, however, transformer or other infrastructure upgrades cannot be avoided, PG&E's Electric Rule No. 29 provides clarification on division of responsibility for costs associated with upstream infrastructure upgrades such as transformer upsizing, new service or distribution lines. Projects installing large quantities of EVSE will require infrastructure investment (panel upgrades, larger transformers, etc.) but the additional time and cost can be justified when considering the added property value and that project costs will be spread out over many chargers resulting in an acceptable price per charger. PG&E's service limits based on the types are:
   - 100 kVA[1] is the maximum demand load allowed for a single-phase service, unless an exception is granted by PG&E
   - Maximum demand loads allowed for common three-phase services are:
     - 208Y/120 = 1,000 kVA
     - 240/120 = 300 kVA
     - 480Y/277 = 3,000 kVA

Figure 3: Illustration of costs for different electric service upgrades

[1] kVA is used in place of kW when discussing transformers due to the importance of power factor on transformer capacity. A single 100 kVA transformer could provide adequate power capacity for roughly 10 single family households.

a. Service upgrade costs borne by smaller customers (<100 kVA) with service from a shared distribution transformer

b. Service upgrade costs usually borne by medium and large customers with site dedicated distribution transformer(s)



Utility: *Up to the customer allowance, covers costs for items in blue. In both cases, this includes the cable and meter. Distribution transformers are also utility covered costs, though a site dedicated transformer is counted against the customer allowance where a shared distribution transformer is not.*
Customer: *Responsible for the costs of items in gray, including trenching, conduit, backfill, compaction, and substructure. Also responsible for utility costs in excess of the service allowance.*

5. **Reduce the cost to charge for EV drivers, with the aim of approaching parity with the cost to charge at single-family homes.** Most EV drivers who live in single-family homes meet their daily charging needs by owning a home charging solution (either an outlet or hardwired L2 station), meaning they pay their home electric rate as the cost to charge. All other EV drivers pay a higher cost to charge as they charge their vehicle primarily using networked chargers, whether in public, at their workplace, or their MUD property-owned chargers. The cost in $/kWh to charge is determined by either the property owner or charging network operator and is largely unregulated. Direct metering for MUD projects avoids this risk of high mark ups by charging the driver directly for their EV charging electricity directly on their utility bill at their home utility rate. This means customers on discount programs would benefit from their discounted home rate. Direct metering can be achieved either by directly wiring the EVSE to the individual residents' electrical meters or by installing technology that employs virtual submetering, a new technology that is being developed with PCE assistance.

While each site features its own unique set of circumstances, after reviewing workplace and MUD property data for San Mateo County, following the Guiding Principles and analyzing the cost of various scenarios, we have identified the following more specific guidance as applicable to nearly all the sites that will be served by EVRP. Workplace installations described below generally do not refer to workplaces that have or plan to have EV fleet vehicles.

3.2 Detailed Guidance for MUD Projects

3.2.1 Level 1, Low Power Level 2, or Power Managed Level 2 Outlets in assigned parking spaces are preferred.

Given the long, overnight dwell times expected for residents of MUD properties and the limited electrical capacity that is generally available at such sites, L1 and LPL2 charging is an effective means of offering large-scale projects which minimizes labor, equipment, and ongoing costs. This is particularly applicable in garages or covered parking scenarios with little or no trenching. Full power L2 charging in assigned parking spaces should be seen as a premium option and is generally discouraged, in favor of more right-sized options. Depending on management preferences, where payment is desired, simple monthly payment policies can be utilized with non-networked outlets. Alternatively, smart outlets can be utilized for access control and payment management. Low-Power or Power Managed Level 2 outlets are approaching cost parity with Level 1 outlets and may be considered as a viable option where there is enough capacity.

3.2.2 Plan for a future where an outlet or charger exists in every resident's parking space.

Access to a dedicated place to plug in at home empowers residents in multifamily to choose an EV. This leads to more equitable access to EVs overall and better air quality in communities heavily impacted by air pollution. This may not be practical for all properties as their first EV charging project. Where possible, service or transformer upgrades should still be avoided. Often property owners may choose to start with a project phase one of as many chargers as the current service allows for and as the current budget and demand at the property lends itself to. Simultaneously, the electrical needs for a future ubiquitous one parking space, one charger project can be evaluated and planned for, so that the property manager is prepared for a larger project as demand increases.

3.2.3 Install Chargers in assigned parking spaces.

Generally, discourage shared-use L2 charging for MUD projects as they trigger costly and challenging ADA considerations. Shared-use L2 charging also provides a poor charging experience for EV drivers whenever demand exceeds the number of chargers. This then requires drivers to rotate the vehicles to avoid extra charges or friction with their neighbors. This may mean moving vehicles late at night or other inconvenient times and inequitably provides more charging access to drivers who are home more hours out of the day. Charging at assigned parking spaces is preferred to provide the best charging experience.

1. For rental properties, we recommend that the property owner either install EVSE in every parking space or install in some percentage of spaces that meets current

demand and can be accommodated within the existing budget and electrical service. In this model the property owner can then assign resident drivers to those EV spaces upon their request.

2. For condos or other owner-occupied buildings, parking spaces are typically deeded to individual dwelling units. In this case EVSE installed in every space must be considered in order to offer a project that benefits all owners. Where only some owners are initially interested in charging, projects may be installed in phases in an “opt-in” basis. Generally, discourage individual home owners from installing their own chargers on an ad-hoc basis. Installing in groups leads to much lower project costs for all homeowners and allows for the allocation of electrical capacity to be planned for at the property-level. When chargers are installed ad-hoc the first few chargers often consume an unequal share of available capacity.

3.2.4 For MUD projects where parking spaces are not transferred or shared, direct wiring is recommended.

When direct wiring, EVSE are provided with a dedicated branch circuit connected to the dwelling unit’s electrical meter. Because the charging is already going to the dwelling unit’s meter and electrical bill, the EVSE can be non-networked outlets rated for EV charging or residential-style Level 2 EV chargers without an integrated payment system. Direct wiring provides significant benefits to EV drivers, allowing them to charge on their residential electrical bill, avoiding price mark ups and third-party billing systems, and enabling cost parity (or near cost parity) with single-family home charging.

This solution is ideal for HOAs and smaller rental MUDs where parking is not ever reassigned. Since this is a hardware-based solution, it is not appropriate for parking setups with frequent reassignment, as changing the configuration would require an electrician to physically relocate them. For larger MUD projects (generally more than 20 units), the cost-effectiveness of direct wiring should be compared to networked EVSE connected to the house meter on a case-by-case basis.

3.2.5 For MUD projects where parking is transferred or shared between residents, networked outlets or chargers connected to the house meter are recommended.

In this configuration the property owner may choose to install residential-style, non-networked EVSE and charge a flat rate fee for charging or to install networked EVSE with billing capacity and a reimbursement model. When installing networked EVSE it is important that the property owner references their electric bill and considers the property’s current electric rate when determining the price to set for their residents. Generally, the best return on investment for EV charging at MUDs is realized not through markups for electricity, but through renter attraction and retention, which goes hand in hand with a positive charging experience. As such, property owners are recommended to set a rate that covers electricity costs without imposing a heavy markup on the cost of electricity. Virtual submetering is another expected option for these properties in the future, providing cost savings to drivers, explained further in these guidelines. Detailed billing guidance is provided further in this document.

3.2.6 Shared PML2 charging is not generally recommended

Shared PML2 is generally not recommended for MUD projects and installed only due to customer preference. While L1 ports are currently preferred for MUD projects, in cases where high project costs are unavoidable, such as where a lot of trenching is required, site hosts may consider higher power delivered by the EV chargers to be worth the investment. A site host may want to consider going with LPL2 or PML2 where tenants will expect a premium charging option and/or typical daily driving needs will exceed 30 miles per day. Another option is to install L1 EV charging but with oversized conduits and extra panel capacity. This way, if the L1 charging proves insufficient, larger wiring could be pulled through the existing conduit to install PML2 and the panel will already have available capacity.

3.2.7 Avoid expensive electrical service upgrades or if that is not possible, provide a large-scale project that justifies the higher cost, while maintaining right-sized principles.

Panel upgrades for additional capacity are encouraged where they do not trigger upgrades of on-site or distribution transformers or other service upgrades with significant costs. Locations with older electrical equipment may be able to support charging by replacing outdated service equipment like-for-like without increasing the electrical service. In other cases, there are situations where the guiding principles 2 and 4 are in conflict; meaning, a site's expected future charging needs cannot be accommodated within existing transformer capacity. If there is adequate existing capacity to meet the site's present needs and those anticipated for the next several years, then we will recommend a design that fits within that capacity. If that is not possible, then we will recommend a design that has many additional charging ports and provides a cost per port that is comparable to other projects supported by EVRP. New charging infrastructure to be installed in the new service will still be right sized to avoid minimizing upstream grid upgrade costs to ratepayers. When a new service is required, provide a dedicated meter for EV charging and take advantage of EV-specific rates.

3.3 Detailed Guidance for Workplaces and Public Charging

3.3.1 Power Managed Level 2 (PML2) chargers are recommended for all locations where the average parking dwell time exceeds 4 hours.

Power management increases the number of vehicles that can charge within a site's existing electrical infrastructure, aligning with Guiding Principles 1 (depending on the site), 2, and 3. See "Guidance for Power-Managed Level 2 Site Design" for more configuration guidance. PML2 charging is recommended for workplaces and any other public sites with longer dwell times and shared parking spaces.

3.3.2 Avoid expensive electrical service upgrades where possible.

Locations with older electrical equipment may be able to support charging by replacing the service equipment without increasing the electrical service. If avoiding a service upgrade is not possible, design a large-scale project that justifies the cost. When feasible, provide a dedicated meter for EV charging and take advantage of EV-specific rates.

3.3.3 Ensure recommended Level 2 equipment is interoperable with a number of network providers

While most Level 2 charging on the market is currently listed as OCPP compliant, the specifics of how easy it is to change EVSE from one network provider to another varies widely in the field. To minimize potential future disruptions if the customer needs to switch to a new network provider, ensure that equipment selected strictly follows OCPP compliance and is demonstrated to be compatible with a number of network service providers.

3.3.4 Compliance with CDFA regulations

If the site host intends to collect EV charging session payment based on a specified unit of measurement (per kWh or hour/minute/second) then California's Department of Food and Agriculture, Division of Measurement Standards (DMS), which is responsible for overseeing the fuel quality, dispenser accuracy, advertising, and labeling of all motor vehicle fuels sold at retail, including low- and zero-emission alternative fuels, would require connected ("smart") EVSE certified by the DMS with a digital interface to collect payment (credit card, smartphone app, RFID fob, or cash). If, however, the site host only charged a flat monthly fee, then the EVSE does not need to be DMS compliant and could be a less expensive EVSE since there is no need for the digital interface to collect payment. However, as noted earlier, the site host may still want to opt for connected EVSE to control charging access, use reporting, remote monitoring of EVSE functional status, and the option of participating in demand response programs. More information on the DMS requirements is available on the DMS website at https://www.cdfa.ca.gov/dms/programs/zevfuels/.

3.3.5 Locate charging near the electrical service and in a few closely grouped clusters and minimize trenching.

The cost of installing conduit and cable can be a significant part of the total project cost, particularly where trenching is required. Minimizing the total distance and grouping chargers to enable sharing of conduit and trenches helps reduce costs. Where a long conduit run is unavoidable, consider installing a subpanel to support clusters of chargers. Avoid trenching and boring where possible and minimize the length of feeders and branch circuits.

3.4 Detailed Guidance for Outlets

3.4.1 Hardware Requirements

1. Level 1 outlets are to be 120V GFCI-protected heavy duty single-outlet receptacles on dedicated 20A circuits. With no EVSE included, these outlets can be used for multiple purposes and will simply be designated as “outlets” in equipment specifications and design drawings. Many portable Level 1 cord-sets are limited to a 12A draw, providing 1.4 kW, however it is desirable to provide a 20A circuit to enable the use of cord-sets and adapters that can increase to a 16A draw, providing 1.9kW. 15A circuits may be considered in highly constrained environments but only if education of the site host is done regarding possible limitations, particularly for larger vehicles and longer commutes. Smart outlets provide added benefits such as billing and access controls to site hosts that require these capabilities and may be utilized as a Level 1 outlet when desired by a site host.
2. Level 1 outlets should be a 3-wire grounding-type, single-outlet, GFCI-protected commercial or heavy-duty grade receptacles rated at 120 volts installed between 3-4 feet off the ground, on a dedicated 20A circuit. Best are commercial outlets designed by the manufacturers for the continuous use associated with EV charging.
3. Level 2 outlets should be a 3-wire grounding-type, single-outlet, GFCI-protected commercial or heavy-duty grade receptacles rated at 208 – 240 volts installed between 3-4 feet off the ground, on a dedicated 20A – 40A circuit. Best are commercial outlets designed by the manufacturers for the continuous use associated with EV charging.

3.4.2 Additional Considerations for Outlets

1. Outlets should be accompanied by platforms or hangers that allow users to keep cords off the ground and minimize tension on the outlet (see example in Appendix A).
2. Outlets should be installed with signage denoting “Low Power Charging.”
3. Outdoor Level 1 installations will need weather shielding for both the electrical outlet and portable cord-set that is provided by the driver, when necessary.
4. Provide security recommendations to site hosts and end users, including utilization of “luggage locks” or similar (many charging holsters have a small hole behind the button that allows for a lock to prevent the holster from being removed while charging) to prevent theft of portable cord-sets.
5. Customers can choose between standard (non-networked) electrical outlets or smart (internet-connected) outlets. Smart outlets may be preferable in certain circumstances if billing and intelligent access controls are desired. Otherwise, physical access controls (e.g., locks) may be employed to limit access to the equipment.

3.5 Detailed Guidance for Power-Managed Level 2 (PML2) Charging

The recommendations below are meant to meet the daily needs of most EV drivers in San Mateo County, delivering 40-50+ miles of range over a 10-hour overnight charge at an MUD and 32-40+ miles of range over 8 hours at a workplace. Minimum power levels may need to be increased, and thus minimum power increased, based on unique use cases or local commuting patterns if these guidelines are to be replicated in a different region. PML2 ports should be installed with signage to describe the range of power expectations. Example: "Power may range from 3.3kW to 7.7kW."

3.5.1 ALMS Functionality

1. Dynamic or equal-share ALMS is the preferred load management approach. With these systems, energy is split among the number of vehicles that are actively charging, either dynamically depending on the power needs of each vehicle or equal among the vehicles. First-in, first-out (FIFO) or sequential load management systems are not recommended.
2. Commissioning of the ALMS should be performed by design or installation personnel who have a thorough understanding of the electrical design and how the ALMS must function for the controlled EVSE to remain within the maximum load permitted for the installation.

3.5.2 When Power-Managed Level 2 Charging is Generally Recommended

1. When there is a mix of short-term (less than 4 hours) and long-term parking (4-10 hours). Note: PML2 is typically not recommended if parking dwell times average less than 4 hours (e.g., short-duration commercial corridor parking) as the risk of customer impacts are higher.
2. Site-host preference for Level 2 vs Level 1 charging.
3. Public/visitor charging (for use by non-tenants and/or non-employees), either in publicly accessible garages or visitor parking, at commercial locations or multi-unit dwellings (note: public charging must comply with 2021 CDFA rules[2]).

3.5.3 Minimum Power Requirements

Effective July 1, 2024, California Green Building Standards Code (CALGreen) requires that each EVSE controlled by an ALMS shall deliver a minimum 30 amperes to an EV when charging one vehicle and shall deliver a minimum 3.3 kW while simultaneously charging multiple EVs in both residential and non-residential buildings. For a 40A circuit for example, this amounts to a 2:1 circuit sharing ratio.

This table below includes circuit sharing scenarios for Level 2 charging, with minimum circuit capacities required to stay above the 3.3kW threshold. The short duration scenario does not include power management but is included here for completeness.

[2] For additional guidance on California Department of Food and Agriculture, Division of Measurement Standards rules for EVSE, see https://www.cdfa.ca.gov/dms/programs/zevfuels/

Expected Parking Duration	Example Location	L2 Ports per circuit (and size of circuit)	Power Output (@240V)	Min. Charge @ Mid-Point Parking Duration	
				Energy†	Range††
Short (0-2 hr)	Retail	1 (40A)	7.7 kW	7.7+ kWh	20+ mi
Medium (2-4 hr)	Parking garage	2 (40A)	3.8 - 7.7 kW	11.5+ kWh	40+ mi
Long (4-12 hr)	Workplace	3 (60A)	3.8 – 11.5 kW	30.4+ kWh	106+ mi
Overnight (12+ hr)	MUD	5 (80A)	3.8 – 19.2 kW	45.6+ kWh	159+ mi

†Energy delivery is estimated as the minimum power output multiplied by the midpoint expected parking duration, except in the overnight scenario where the duration used is 12 hours.
††Range delivery is estimated as the product of energy delivery and an assumed vehicle efficiency of 3.5 mi/kWh, rounded down to the nearest 10 due to the wide range of efficiencies and influence of conditions and driver behavior.

Some sites are expected to serve different groups, with decidedly different parking durations. In such cases, multiple power output levels can be specified to suit the varying charging needs of the users. Guidance for several common mixed charging scenarios can be found in the table below with an indicative percentage share for each type. The percentages are guided by the relative vehicle throughput of each type and can be adjusted when information is available about the prevalence of each user type. Proper signage that indicates the power output level will be critical for user satisfaction in these scenarios.

Scenario	Appx. Expected Parking Duration
Public parking used by visitors to a commercial district and workers	Short (40%) and Long (60%)
Public parking used by visitors to a commercial district and MUD residents	Short (40%) and Overnight (60%)
MUD serving visitors and residents	Medium (10%) and Overnight (90%)
Workplace serving visitors and employees	Medium (20%) and Long (80%)
Workplace serving fleets and employees	Short or Medium and Long†

†Fleet size and use must be known to determine parking duration and port allocation

3.5.4 Guidance Regarding Circuit Sharing vs Panel Sharing

Both circuit sharing and panel sharing options are compliant with the language in NEC/CEC 625.42. With this understanding, the recommendations for when to use each approach are guided mainly by the relative costs, which include the hardware and software associated with the ALMS solution, as well as the conduit and wiring to the EVSE.

Based on vendors' statements, there is little difference in their delivery costs for circuit sharing or panel sharing and many do not make the distinction since they manage a given set of chargers within a specific power allowance. In both cases, there are two limits to manage: the circuit (either inherent to the hardware design or set with a particular wiring or switch configuration during install) and the often-reduced limit based on the concurrent use of other chargers (set in the network software during commissioning).

With this understanding of the vendor capabilities and costs, the most significant trade off appears to be between the incremental cost of additional conduit, wiring, and possibly a subpanel for panel sharing, and the benefit of possibly adding more ports relative to circuit sharing. The incremental cost will vary by site, but we believe it is nearly always less than $5,000. The benefit of adding ports is more difficult to quantify. Fundamentally, the ability to add more ports with panel sharing is due to the differences in driver time-of-use and power demands.

To assess the benefit of additional ports, we analyzed a sample of driver needs at multifamily sites and found that there is an ability to add more ports through panel sharing. Specifically, we find that at a threshold of 8 ports we can provide either 8 ports with circuit sharing or 10 ports with panel sharing, with little or no impact to the ability of users to meet their daily charging needs. This incremental port opportunity is certainly of value. The electrical infrastructure portion of an installed port cost is usually around 50% or more. With per port costs commonly more than $5,000, the benefit is equal to or greater than the estimated infrastructure cost. Hence, we reason that with 8 or more ports it is preferrable to implement power management as panel sharing and below that point, circuit sharing is recommended. This is reflected in the two brief design recommendations below. As this is a dynamic area of innovation, these recommendations are subject to change.

- **Circuit Sharing:** Circuit sharing will be used for projects with fewer than 8 ports.
- **Panel Sharing:** Panel sharing will typically be used for existing building projects with 8 or more ports in proximity and in all new construction projects. Panel sharing is expected to increase the quantity of ports per unit of electrical capacity by 20 percent relative to circuit sharing in these situations.

The rationale for universal use of panel sharing in new construction is two-fold:

1. The same ability to extract more utilization out of the same capacity applies.
2. When installing many EVSE, standard design practice already inclines toward specification of a dedicated EV panel. Hence, in effect you can obtain all the benefits with no incremental cost.

3.5.5 Power Managed Devices

An alternative to an ALMS is a hardware solution known as a "power management device." One such product currently available is the DCC-9 Electric Vehicle Energy Management System (EVEMS) from RVE. The DCC-9 is a 14" x 14" x 7.5" box installed between the main breaker and the unit panel near the meter. The software in this device allows an EV charger circuit to be pulled off that service when capacity is available. The EV circuit is deprioritized and will drop out when the apartment unit needs more power. The PCE EV Ready Program expects devices like the DCC-9 to be used in situations where parking is unlikely to ever be reassigned (e.g., condominiums and apartments). In this use case, the charging load is directly connected to the individual residential meter, so EV drivers are paying for their EV charging on their regular monthly electrical bill (as opposed to a credit card tap on the machine or payment through an app). Connected EV chargers require monthly fees to access load management software while the DCC-9 does not have ongoing fees which can result in significant cost savings over the life of the product.

3.6 Site Type Applications in EVRP

Applying the Design Guidelines to expected site scenarios produces the following practical applications of acceptable design recommendations for EVRP. Each recommendation, or “Solution”, aligns with the design guidance overall, while placing a varying degree of emphasis on a customer scope request or minimum project scale in Solution 1, a large-scale option in Solution 2, and a “Dream Big” option for Solution 3. A utility transformer upgrade will sometimes be required to accommodate Solution 3; hence these recommendations include a large number of ports to justify the additional infrastructure cost. When a customer doesn’t have a specific target number of EVSE to be installed, 10% of parking spaces is the standard recommendation. The following are examples of compliant EVRP applications.

1. **Large, Modern Office >100 parking spaces**
    a. Solution 1: Any number and type of ports explicitly requested to be evaluated by customer.
    b. Solution 2: If the customer’s request is relatively small (<5% of parking spaces), recommend at least 20% of existing spaces to L2 charging, or a larger amount if advised by the account manager. Solution 2 can include futureproofing measures to facilitate future EV charging expansion, such as make-ready[a] stub-outs ending in a junction box at parking stalls.
    c. Solution 3: Depending on the customer’s initial request, a third solution may not be warranted. If the initial request is relatively small (<5% of parking spaces) and solution 2 recommends 20% of parking spaces, solution 3 could dedicate 33%-50% of existing spaces to L2 charging, as advised by the account manager. The goal of showing a much larger installation is to make the customer aware of changing price points that take advantage of economies of scale. Solution 3 can include the futureproofing measures from Solution 2 plus additional measures such as oversized conduit, additional panel capacity, and even more make-ready stub-outs ending in a junction box at parking stalls.

2. **Medium/Large, Modern, Garden MUD**
    Note: Guidance for Garden MUDs might also vary significantly on local site conditions and trenching required to provide power to distinct parking areas.
    a. Solution 1: Any number and type of ports explicitly requested to be evaluated by customer.
    d. Solution 2: If Solution 1 includes L2, then solution 2 should include a dual port L2 in a shared[b] parking area (if requsted by the customer) and the maximum number of L1s in assigned parking that can be accommodated within the available transformer capacity and limited trenching. Solution 2 can include futureproofing measures to facilitate future EV charging expansion, such make-ready stub-outs ending in a junction box at parking stalls.

b. Solution 3: Provide the maximum number of L1s or power-managed L2s in assigned parking within the available transformer capacity at assigned parking spaces. If customer is interested in installing EV charging at every parking space in a single phase, a service upgrade may be needed and would be included in this solution. Solution 3 can include futureproofing measures from Solution 2 plus additional measures such as oversized conduit, additional panel capacity, and even more make-ready stub-outs ending in a junction box at parking stalls.

3. **Small, Older MUD**
    a. Solution 1: Any number and type of ports explicitly requested to be evaluated by customer.
    b. Solution 2: If Solution 1 includes L2, then solution 2 should include a single port L2 within reach of 2 or more parking spaces and/or the maximum number of L1s in assigned parking that can be accommodated within the available transformer capacity[c]. Solution 2 can include futureproofing measures to facilitate future EV charging expansion, such make-ready stub-outs ending in a junction box at parking stalls.
    c. Solution 3: Provide L1s for all parking spaces that can be reached without trenching or a single trench where one is required to serve any space. Solution 3 can include futureproofing measures from Solution 2 plus additional measures such as oversized conduit, additional panel capacity, and even more make-ready stub-outs ending in a junction box at parking stalls.

[a] *While a make ready is not technically a port, it is future capacity to add a port and is included in the cost/port calculation*

[b] *Shared parking is not public parking, but spaces that are available for use by any resident and their guests*

[c] *For reasons of panel age or limited capacity, many older MUDs may have no viable options without a panel and service upgrade; return to the guiding principles to develop appropriate scenarios*

3.7 EVSE Price Policy Guidance for MUDs

3.7.1 Operating Models

The expectation of our program is that the Return on Investment for electric vehicle charging is generally realized through the added benefits of customer, worker, or renter attraction and retention. This is especially true for workplace and MUD projects. There are several ways site hosts and MUD property managers can approach collecting payments from EV drivers for using their EVSE:

1. **Make charging free:**
    a. Some site hosts elect to make the EV chargers a complimentary amenity.
    b. This option works with both connected ("smart") EVSE and non-connected outlets or residential chargers
2. **Charge EV drivers per kilowatt hour of electricity:**
    a. Requires connected ("smart") EV chargers or outlets which are subject to weights and measure standards and regulations

    b. Requires a subscription to a network service provider which will incur a recurring subscription fee
    c. Gives site hosts options to features like access control and fee setting depending on EV driver and time of charging (which ensures the site host can collect sufficient payment to cover electricity costs)
3. **Charge EV drivers a flat monthly fee to access the electrified parking stall**
    a. Site host can use non-connected, residential outlets or chargers which are less expensive than connected (“smart”) EV chargers and do not require an ongoing subscription and associated fees
    b. There is a risk the cost of the electricity consumed by the EVs will be greater than the monthly fee charged by the site host.
    c. This option doesn’t factor in time of use rates or encourage drivers to charge during off-peak hours with cleaner grid electricity.
4. **Operating Model with Direct Wiring**
    a. Where EVSE has been installed directly wired onto individual dwelling unit meters, there is no reoccurring expense for the property manager. As such the property manager does not need to charge any fee for access to the chargers or outlets in order to cover costs.

3.7.2 Setting a rate for charging

It’s recommended to provide site hosts suggested rates to charge EV drivers to use EV chargers considering several factors. As such our pricing recommendations are meant for EV equipment owners to at least recoup their costs for electricity, with the possibility of adding a small incremental fee to cover network fees or other associated operating and maintenance costs.

1. **TOU Rates**: Electricity providers use time of use (TOU) rates to encourage their customers to use electricity at certain times and discourage them from using electricity at other times. For electric vehicle TOU rates, prices are higher between 4:00pm – 9:00pm to discourage customers from charging an electric vehicle because this is when electricity demand is highest, and electricity production is lowest. An operational model proposed to a site host should contain a "time of use rate" (TOU rate) model based on the utility’s electric vehicle TOU rate. Customers should refer to their electricity bill to determine the rate schedule, and set a price to charge that matches their electric rate

ENERGY STATEMENT
www.pge.com/MyEnergy

Account No: 0123456789-0
Statement Date: 12/14/2023
Due Date: 01/04/2024

Details of Peninsula Clean Energy Electric Generation Charges

11/07/2023 - 12/07/2023 (31 billing days)

Service For: 123 MAIN ST
Service Agreement ID: 0123456789 ESP Customer Number: 0123456789

11/07/2023 – 12/07/2023

Rate Schedule: E-1				
Generation - Total	170.000000 kWh	@ $0.14388		$24.46
		Net Charges	24.46	
Energy Commission Surcharge				0.05

Peninsula Clean Energy is your community's official electricity provider.
You are receiving clean electricity at low rates!

Total Peninsula Clean Energy Electric Generation Charges **$24.51**

Service Information

Total Usage 170.000000 kWh

For questions regarding charges on this page, please contact:
PENINSULA CLEAN ENERGY
2075 WOODSIDE RD
REDWOOD CITY CA 94061
1-866-966-0110
PenCleanEnergy.com
info@PeninsulaCleanEnergy.com

Additional Messages

Your city has chosen to receive electricity sourced by Peninsula Clean Energy. Peninsula Clean Energy is a not-for-profit, public agency that sources energy that is least 50% renewable and 100% clean. Its energy generation charge replaces that of PG&E's, but at a lower rate.

Energy **generation** is one component of your overall electric bill. PG&E continues to own and operate the infrastructure and charge for the **delivery** of the electricity. PG&E is responsible for all gas services and gas charges.

2. **DMS Compliance:** California's Department of Food and Agriculture Division of Measurement Standards (DMS) is responsible for overseeing the fuel quality, dispenser accuracy, advertising, and labeling of all motor vehicle fuels sold at retail, including electricity dispensed through an EV charger. More information on the DMS requirements is available on the DMS website at https://www.cdfa.ca.gov/dms/programs/zevfuels. **If a site host wants to collect EV charging session payment based on KWh, they must use networked ("smart") EV chargers that have a digital interface to collect payment (credit card, smartphone app, RFID fob, or cash) and that equipment should be certified by the DMS.** The advantages of charging per kWh is that you can fine tune your pricing to align with PCE's TOU rates, protecting you from being forced to absorb costs of higher electricity rates if EV drivers are charging during peak hours. Often networked chargers offer the ability to charge customers time variable pricing to mirror TOU supply costs. However, recent regulations from the California Department of Food and Agriculture (CDFA) have added additional requirements (such as readable displays on the outlets, accuracy testing, etc.) to charging devices that impose a per kWh fee. These rules apply for public charging, including multi-family housing. Public agencies and non-public charging (e.g., workplaces) are exempted. According to CDFA staff, tenant-only charging is interpreted as public charging for these regulations and needs to comply.

Note: In contrast to this CDFA judgement, the California Air Resources Board (CARB) EVSE Standards that require a credit card reader for publicly available EVSE explicitly exclude tenant-only charging (California Code of Regulations, Chapter 8.3 of Division 3, Title 13).

3. As of Q2 2025, no smart Level 1 outlet complies with the CDFA rules and there are no approved methods to test Level 1 outlets to CDFA standards, which means a pricing method other than charging by kWh is needed for all non-exempt uses. One acceptable approach is a flat monthly fee tenants pay to have access to an EV parking stall, similar to amenity or pet fees. This simple approach can work for both smart outlets with integrated billing systems and conventional Level 1 charging without any software.

3.7.3 Operating Model Examples

The PCE EV Ready program's Charging Evaluation Reports typically provide site hosts with both dollar per kilowatt hour ($/Kwh) and flat rate per month operating cost model estimates to assist in determining rates to charge EV drivers for use of the installed EV chargers. Site hosts may elect to completely ignore these recommendations, use the recommendations to break even, use a higher than estimated fee to the EV driver (so the EV chargers generate profit), or use a lower than estimated fee (so the EV chargers operate at a net loss to the site host). Regardless if the site host is setting the EV charging fees as a $/Kwh or flat monthly rate to EV drivers, the site host is advised any proposed rates are generated using assumptions that may differ from their site and, as such, they are encouraged to revisit any rate they set on a quarterly basis for at least the first year to make sure they are reaching their intended outcome.

3.7.3.1 Dollar per Kilowatt Hour ($/Kwh)

This guidance is intended to help site hosts set $/Kwh pricing for use of their EVSE by EV drivers and the recommendations are based on a break-even calculation between energy costs and typical networking fees. It is generally recommended that sites bill for EV charging based on the amount of energy used on a per kWh basis, as this is the most equitable approach in charging EV drivers for the actual energy used. That said, charging based on $/Kwh triggers the need for DMS Compliance and is more likely to require connected EV chargers (which comes with ongoing network fees).

The following table illustrates how we currently present the site's estimated annual operating costs for the quantity of chargers in a particular solution followed by a potential revenue breakeven operating model:

Solution 1 Operating Model				
	Off-Peak	Partial-Peak	Peak	Total
Annual Estimated Charger Utilization (kWh)				
L1/L2 Outlets	634	1,884	3,739	6,257
Total Energy Use	634	1,884	3,739	6,257
Annual Estimated Operating Costs				
Utility Rate	B-1-B			
L1/L2 Outlet Electricity Cost	$ 202	$ 580	$ 1,243	$ 2,024
Electricity Demand Charges	$0			
L1/L2 Outlet Network Fees	$0			
Total Annual Operating Cost	$2,024			
Other Annual Costs				
Potential Revenue				
Revenue Model 1				
L1 User Fee ($/kWh)	$0.32	L1/L2 Outlet Estimated Revenue		$2,024
		Net Operating Revenue		$0

* Maintenance costs shown in table are optional maintenance contract average costs. These are not used in the calculations.

3.7.3.2 Rate Guidance for EV Ready

The rates below are current as of Q2 2025 and provided for information only and only applicable to devices that comply with CDFA regulations for collecting charging session fees.. The rates shown in the table were calculated including demand charges associated with a 20-outlet project that adds 28kW in peak demand. We recommend that property owners who install EVSE on their house meter check their electric bill as utilization of the chargers increase and adjust the rate they charge for electricity accordingly.

Rate	Hourly Rate On-Peak 4-9 pm	Hourly Rate Off-Peak (all other hours)
E1	$0.41	$0.41
TOUC	$0.46	$0.38
B1	$0.47	$0.44
B6	$0.56	$0.41
B10	$0.44	$0.39
B19	$0.46	$0.41
BEV	$0.39	$0.19

** The Business EV (B-EV) rates include a demand charge subscription that is dependent on the number of chargers that are used concurrently. For these calculations, we use 20 outlets (28 kW demand) for the B-EV 1 rate. Actual prices will depend on the number of chargers per site.*

Peak: 4:00 pm to 9:00 pm, Every day including weekends and holidays, all year
Off-Peak: 9:00 pm to 9:00 am And 2:00 pm to 4:00 pm, Every day including weekends and holidays, all year
Super Off-Peak: 9:00 am to 2:00 pm, Every day including weekends and holidays, all year

3.7.3.3 Flat Rate Operating Models

Another strategy is to charge EV drivers a flat monthly fee to access an EV charger. While not as dynamic as a $/kWh charge from a business perspective, flat rates offer some advantages such as possible decreased needs for networked EVSE or meeting DMS requirements (which reduces upfront and ongoing costs). Flat monthly fees may also be easier to communicate to tenants.

Flat monthly fee estimates are currently calculated by dividing the site's aggregate total cost of per driver annual kWh and charger operations cost by twelve months. This approach is based on several assumptions:

1. Each EV charger is being used by only one EV.
2. The EV is a Class 1 commuter vehicle.
3. The EV is averaging 3.5 miles/Kwh.
4. 30 EV miles are being driven each day.

The following table illustrates one way to present this information to the site host:

Revenue Model 1			
L1 User Fee ($/kWh)	$0.33	L1/L2 Outlet Estimated Revenue	$10,442
L2 User Fee ($/kWh) Peak	$0.38	L2 Charger Estimated Revenue	$42,619
L2 User Fee ($/kWh) Part Peak	$0.35		
L2 User Fee ($/kWh) Off Peak	$0.33		
Flat Fee plan - L1		Minimum monthly charge/user	$87
Flat Fee plan - L2		Minimum monthly charge/user	$355

Here are several factors that should be taken into consideration when setting a flat rate fee:

1. **Anticipated charging needs of the EV drivers:** Are typical users driving more or less than the average daily commute of 30 miles? The site host should be prepared for higher utility costs If they are driving more, and lower costs if they are driving less.
2. **The specific hours the chargers are being used:** Utility rates can differ significantly throughout the day when a site is on a "Time of Use" (TOU) rate plan, and it can be difficult to predict when tenants will charge their EVs. As such, site hosts are encouraged to closely monitor their total electric utility bills for the first year after installation to make sure the monthly fee they set is meeting their desired outcome.
3. **Usage profile for the particular site.** Site hosts need to be aware that usage can vary drastically depending on the type of site. For example, times the EV chargers are being used will be very different for an MUD (typically overnight charging) compared to an office building (charging during business hours).
4. **Number of EVs per port:** Site hosts should plan on 20-30% of occupied parking stalls in a parking facility to be used by EVs in the next 5 years, with that percentage expected to rise significantly in the next 10 years.

4 Appendix A

Example of Level 1 Outlet and Cable Management

Source: George Kopf

5 Appendix B

Low-Voltage Power Distribution Component Descriptions and Sample MUD Site Layouts

Key System Components

Transformer

- An electrical device that is used in AC power distribution systems to safely "step up" or "step down" voltages to meet the power requirements of connected equipment.
- Utility-owned transformers convert distribution voltages (4-33 kV) to service voltages (120-480V). They may be dedicated to an individual customer or shared by multiple customers; the distinction being important because a customer will be responsible for the cost of upgrade to a dedicated transformer
- Customer-owned transformers convert the service voltage to other voltages required by loads at the site

1

2

1Eaton
2Larson Electronics

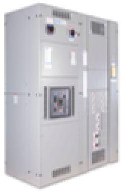
Switchgear

- Electrical switchgear refers to a centralized collection of circuit breakers, fuses and switches (circuit protection devices) that function to protect, control and isolate electrical equipment.
- The circuit protection devices are mounted in metal structures. A collection of one or more of these structures is called a switchgear line-up or assembly.
- Uncommon to find on EVRP projects, as this usually refers to "primary" distribution voltage switching and most EVRP customers are taking "secondary" service
- Switchgear is commonly found throughout electric utility transmission and distribution systems as well as in large commercial or industrial facilities

Eaton

Switchboard

- Switchboards are used to safely distribute electricity and divides an electrical power feed into branch circuits while providing a protective circuit breaker or fuse for each circuit in a common enclosure.
- Often this is the location where the utility service lands, with the utility meter integrated in the switchboard
- In most cases, circuits from the switchboard feed other panels in the facility rather than individual loads.
- Typically have a maximum incoming current rating of 6000 A



Eaton

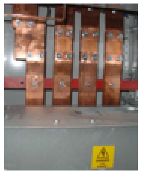
Panelboard

- Panelboards are used to safely distribute electricity and divides an electrical power feed into branch circuits, while providing a protective circuit breaker or fuse for each circuit, in a common enclosure.
- Referred to as a "main panel" when directly downstream of the utility meter or a "sub panel" when downstream of another panel
- Main panels often serve a mix of large loads and sub panels.
- Sub panels typically serve loads that are common in terms of load type (e.g. lighting panel) or location (e.g. garage panel)
- Typically limited to a maximum incoming current of 1200 A

Eaton

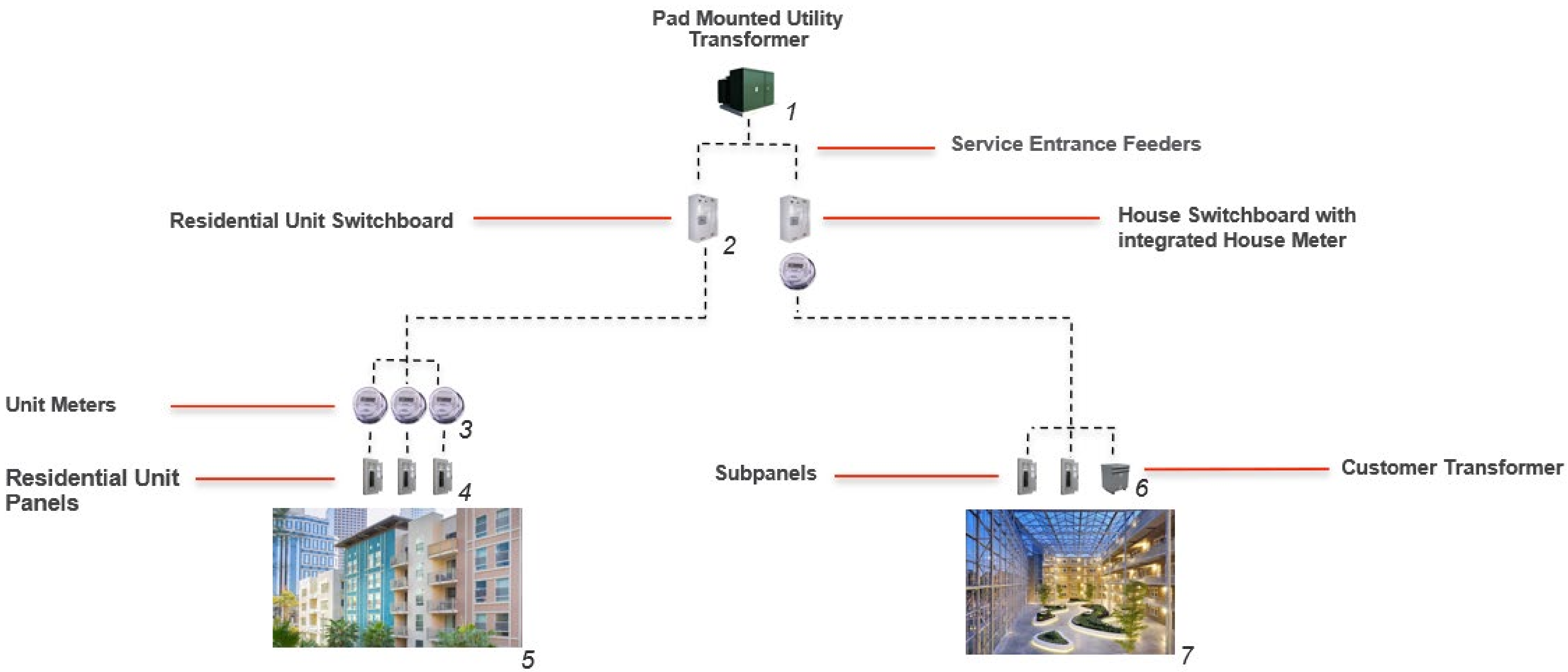
Bus bars

- Metal bars designed to conduct large currents inside and between electrical system components
- Usually found inside Switchboards and Multi-Unit Dwelling (MUD) main panels. Used for distribution to unit meters in MUD's



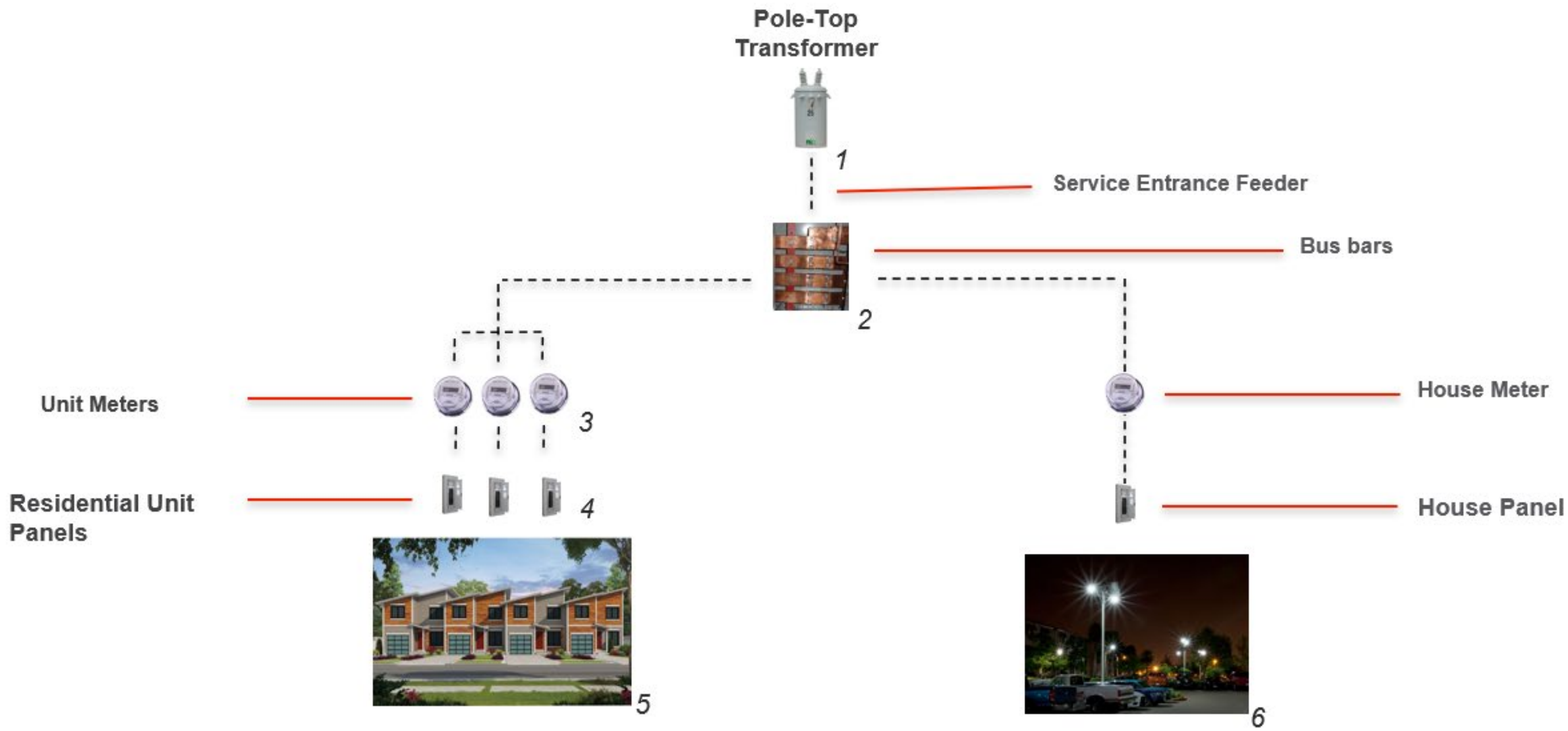
Wikimedia commons, Ali@gwc.org.uk

Sample MUD Site Electric Overview – Medium to Large and/or Post 1980 Site



1Larson Electronics
2Eaton
3Solar-electric.com
4Eaton
5Equity Apartments
6Maddox
7WBDG

Sample MUD Site Electrical Overview – Small to Medium and/or Pre 1980 Site (4-30 units)



1Larson Electronics
2*Wikimedia commons*, *Ali@gwc.org.uk*
3Solar-electric.com
4Eaton
5House Plan Shop
6Sepco Solar Lighting