EV Ready Program Design Guidance

Version 1.3

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Peninsula Clean Energy and CLEAResult

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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

1 Introduction

In San Mateo County, EV ownership will likely exceed 120,000 vehicles by 2030, or roughly 17 percent of registered vehicles. The average commute in San Mateo County is under 40 miles round trip. These estimates inform the EV infrastructure needs to meet future demand within the County.

Peninsula Clean Energy's EV Ready Program (EVRP) addresses the growing charging infrastructure needs, to help to accelerate EV adoption. EVRP is focused on charging for light duty vehicles, though some design guidance may also apply to medium/heavy-duty charging installations. EVRP also includes an emphasis on providing more charging accessibility to multi-unit dwelling (MUD) residents, a market that typically experiences greater barriers to installing charging due to electrical infrastructure and property ownership structures. Peninsula Clean Energy has worked with EVRP's consultant team, CLEAResult and Arup, to prepare a set of guiding design principles that aim to achieve four goals critical to EVRP's success:

1. Maximize the quantity of ports the program achieves to support EV growth overall
2. Provide charging service levels that satisfy the everyday needs of most EV drivers
3. Control the cost per port to reduce barriers to installation
4. Minimize grid impacts, including distribution infrastructure and peak generating capacity

Each of the following design principles supports one of 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 Executive Summary

Guiding Principles

1. Provide charging capacity to meet the majority of daily users' needs (<40 miles) within expected dwell times.
2. Offer low-cost options that avoid expensive distribution service upgrades for the customer wherever that is possible while still meeting principle #1.
3. Maximize port count based on existing electric service or transformer capacity.
4. Anticipate future charging needs that prepare the site for 20% EV adoption by 2030.

Overall Technical Design Guidelines for MUDs and Workplace Installations

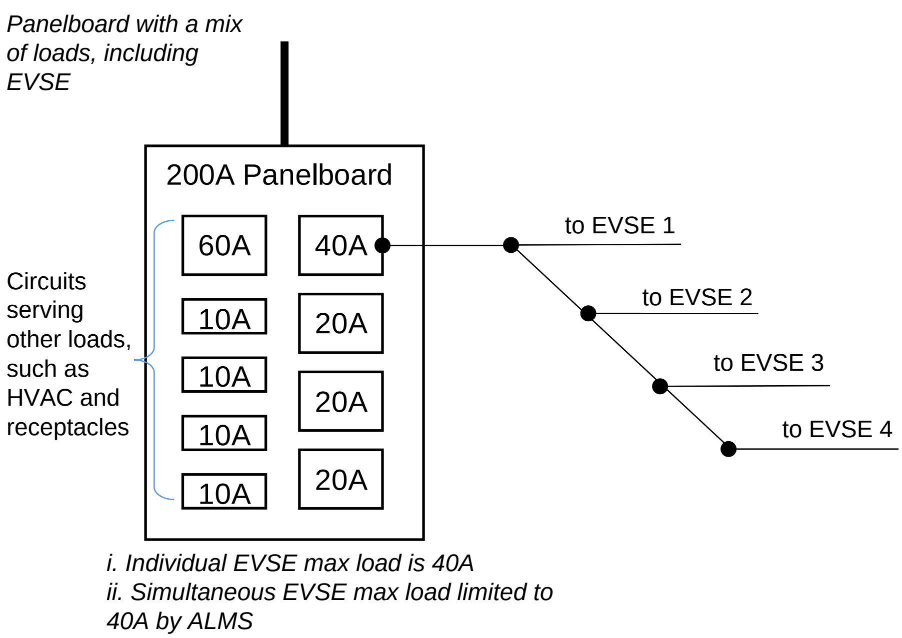
1. Level 1 outlets are preferred for simpler MUD projects and optionally for workplace garages.
2. Power managed Level 2 (PML2) charging is preferred for workplace.
3. Recommend shared PML2 charging for select MUD projects.
4. Level 1 outlets are to be 120V GFCI-protected heavy-duty single-outlet receptacles on dedicated 20A circuits.
5. For all locations where average parking dwell time exceeds 4 hours (and optionally for locations with parking dwell times from 2-4 hours), all Level 2 chargers to be recommended with power-management.
6. Avoid expensive electrical service upgrades or if that is not possible, provide a large-scale project that justifies the higher cost.

7. Avoid trenching and boring where possible and minimize the length of feeders and branch circuits.

3 Definitions, as Used in EVRP

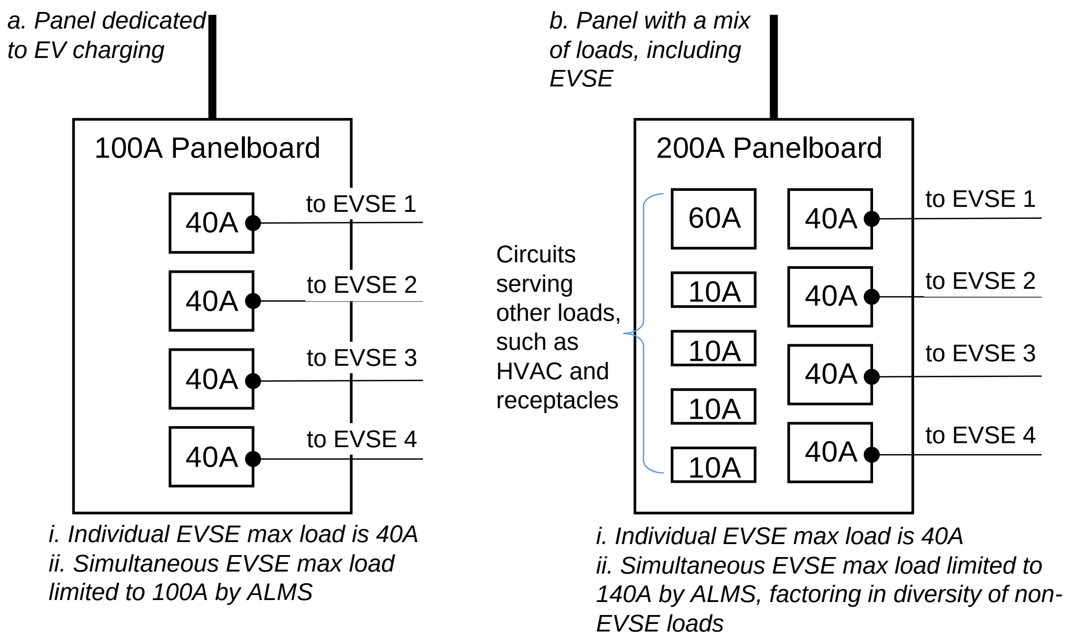
1. **Automated Load Management System (ALMS):** An energy management system that:
   a. Controls multiple EV charging ports to operate safely within a maximum permissible load that is configured during installation and thereafter only modifiable by personnel with detailed knowledge of the site's electrical 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: Example of Circuit Sharing



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 higher loads – often the maximum rated charging equipment input – when other ports are not in use.

Figure 2: Examples of Panel Sharing



4. **Electric Vehicle Supply Equipment (EVSE):** An EV charger, station or port 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. **Power-Managed Level 2 Charging (PML2):** The utilization of ALMS for Level 2, 208-240V, EVSE.

4 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.

4.1 Guiding Principles

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 help bound the options that are worth developing for consideration.

1. **Provide charging capacity to meet typical users' daily needs within expected vehicle 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 or PML2 charging recommendations for sites with long dwell times and varying capacities of PML2 charging 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."

2. **Offer low-cost options that avoid expensive distribution service upgrades for the customer wherever that is possible while still meeting principle #1.** Current electric service rules place much of the substantial cost of new or upgraded electric service from the utility on commercial customers, easily adding $10,000 or much more to a project's cost. By keeping the project's power demands within the customer's existing (a) electrical service or (b) distribution transformer capacity, we can avoid or reduce those additional costs. In addition, it is generally recommended to remain within the maximum demand load for the customer's service type specified by Electric Rule No. 2 to avoid a costly change in the type of electric service provided to the site:

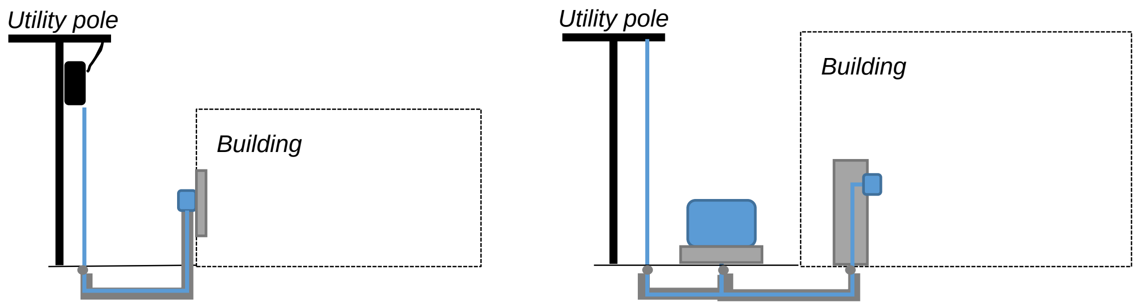
   - 100 kVA[1] is the maximum demand load allowed for a single-phase service, unless an exception is granted by PG&E
   - Maximum demand loads allowed for common three-phase services are:
     - 208Y/120 = 1,000 kVA
     - 240/120 = 300 kVA
     - 480Y/277 = 3,000 kVA

[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.

Figure 3: Illustration of costs for different electric service upgrades

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.*

3. **Maximize port count based on existing electric service or transformer capacity.** Utilize ALMS to expand port count by 2-5 times, compared to a standard design wherein each Level 2 EVSE has a dedicated 40-50A capacity, while staying within overall existing power capacity thresholds stated in #2. If needed, upgrade panel capacity to increase ports where it can be done without exceeding service or transformer capacity.

4. **Anticipate future charging needs that prepare the site for 20% EV adoption by 2030.** 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.

4.2 Overall Technical Design Guidelines for MUDs and Workplace Installations

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.

1. **Recommend L1 outlets as preferred option for simpler MUD projects, particularly those with no shared, surplus, or guest parking and optionally for workplace garages.** Given the long, overnight dwell times expected for residents of MUD properties and the more limited electrical capacity that is generally available at such sites, L1 charging is an effective means of offering large-scale projects which minimizes labor, equipment, and ongoing costs.

This is particularly applicable in garage or covered parking scenarios with little or no trenching. In both site types, management preferences may be a factor. For MUDs with assigned parking where payment is desired, simple monthly payment policies can be utilized. Workplaces may cover the costs. Alternately, smart L1 outlets may be utilized for access control and payment management.

2. **Recommend primarily L1 outlets with a small number of PML2 charging for MUD projects with shared, surplus, or guest parking that can be converted to an EV charging space.** Consistent with the above recommendation, L1 outlets are still to be primarily offered as the daily charging solution for MUD residents in their assigned parking space. However, in instances where an MUD has available parking that is not assigned to a specific unit, it is advantageous to offer a small number of PML2 to complement the L1 outlets to provide higher charging capacity for tenants with atypical commutes or for occasional needs such as long road trips. Reservation systems for the PML2 may be beneficial in these cases.

3. **Recommend primarily shared PML2 charging (4 ports per 40A circuit or equivalent) for select MUD projects.** While L1 ports are generally preferred for MUD projects, PML2 charging is recommended for MUDs with large surface parking lots where significant trenching would lead to high installation costs for many, distributed L1 outlets. This should be considered as an option when doing so would avoid 50 feet or more of trenching through pavement or difficult terrain for a potential L1 installation. However, the additional electrical capacity requirement may limit where this design can be employed. Circuits should be “well utilized” to the extent possible while delivering service minimums (see Power Management section below), typically such that 40A circuits have at least 4 port and 60A circuits have at least 5 ports

4. **Recommend PML2 (3 to 4 ports per 40A circuit or equivalent) charging for workplace.** Workplace dwell times are shorter than at residences and are favorably aligned with peak solar production. Parking also tends to be in large, surface lots where robust, weatherized charging infrastructure is desirable. With these considerations and aligning with the principle of utilizing existing electrical infrastructure where possible, PML2 is the preferred solution.

5. **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. When desired by a site host, smart outlets may be utilized as a Level 1 outlet. Smart outlets provide added benefits such as billing and access controls to site hosts that require these capabilities.

6. **For all locations where average parking dwell time exceeds 4 hours, all Level 2 chargers to be recommended with power-management.** Power management increases the number of vehicles that can charge within a site's existing electrical infrastructure, which aligns very well with Guiding Principles 2 and 3. Moreover, if we are cognizant of site type, it is compatible with Guiding Principle 1. In all applications, each PLM2 will be allowed to draw no less than 8 amps at full utilization, as EVSE manufacturers have advised that devices may cease to function properly below that level. See "Guidance for Power-Managed Level 2 Site Design" for more configuration guidance. Power management may be optionally recommended for locations with dwell times that average between 2-4 hours.

7. **Avoid expensive electrical service upgrades or if that is not possible, provide a large-scale project that justifies the higher cost.** 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. There are many 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.

8. **Locate charging near the electrical service and in few, closely grouped clusters.** 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.

4.3 Detailed Guidance for Level 1 Outlets

1. Outlets should be a nonlocking, 2-pole, 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.
2. Outlets should be accompanied by platforms or hangers that allows users to keep cords off the ground and minimizes tension on the outlet (see example in Appendix A).
3. Outlets should be installed with signage denoting "Low Power Charging."
4. 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.
5. 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.
6. Customer 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 desired.

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

General

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 range of power expectations. Example: “Power may range from 1.9kW to 7.7kW.”

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.

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 risk of customer impacts are higher.
2. Site-host preference for Level 2 charging 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]).

Minimum Power Requirements: ALMS should be configured to provide no less than 1.9 kW (8 amps) at 100% utilization. A 1.6 kW minimum may be considered at MUD sites with 208V service and other sites on an exception basis, especially if significant costs would be avoided due to local site conditions, but only if the site host is informed of the tradeoff between reduced installation costs and charging limitations. The following table provides the standard program recommendations for circuit sharing PML2 for common installation scenarios. The short duration scenario does not include power management but is included here for completeness.

Expected Parking Duration	Example Location	Ports per 40A circuit	Power Output (@240V)	Min. Charge @ Mid-Point Parking Duration	
				Energy†	Range††
Short (0-2 hr)	Retail	1	7.7 kW	7.7+ kWh	20+ mi
Medium (2-4 hr)	Parking garage	2	3.8 - 7.7 kW	11.5+ kWh	40+ mi
Long (4-12 hr)	Workplace	3	2.6 - 7.7 kW	20.5+ kWh	70+ mi
Overnight (12+ hr)	MUD	4	1.9 - 7.7 kW	23+ kWh	80+ 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.

[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/

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	**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*

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. Indeed, many seem not to make the distinction, as their capability is to manage a given set of chargers within a specific power allowance. In both cases, there are actually two limits to manage, that of the circuit and the often-reduced limit based on the concurrent use of other chargers. The common case appears to be that the circuit-driven limit is either inherent to the hardware design or set with a particular wiring or switch configuration during install and the second is 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 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 increase in diversity of use that happens with more circuits, meaning 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 indeed 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 in excess of $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 rational for universal use of panel sharing in new construction is two-fold. First, the same ability to extract more utilization out of the same capacity applies. Second, when installing many EVSE standard design practice already inclines toward specification of a dedicated EV panel. Hence, in effect you can obtain all of the benefit with no incremental cost.

4.5 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, to a large-scale option in Solution 3. A utility transformer upgrade will often 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 (expected 27% of total EVRP ports)
   a. Solution 1: Any number and type of ports explicitly requested to be evaluated by customer.
   b. Solution 2: A combined total of 20-30 L2s and make ready[a] that provide a cost per port that is significantly lower than Solution 1.
   c. Solution 3: Dedicate 33% of existing spaces to L2 charging, or another amount greater than or equal to 20% if advised by the account manager.

2. Medium/Large, Modern, Garden MUD (expected 11% of total EVRP ports)
   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.
   b. Solution 2: If Solution 1 includes L2, then a dual port L2 in a shared[b] parking area and the maximum number of L1s in assigned parking that can be accommodated within the available transformer capacity and limited trenching.
   c. Solution 3: Provide four power-managed L2s in a shared parking area, plus the maximum number of L1s or power-managed L2s in assigned parking within the available transformer capacity.

3. Small, Older MUD (expected 55% of total EVRP ports)

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 a single port L2 within reach of 2 or more parking spaces or a shared parking area if one exists. The maximum number of L1s in assigned parking that can be accommodated within the available transformer capacity.[c]
c. Solution 3: Provide L1s to all parking spaces that can be reached without trenching or a single trench where one is required to serve any space.

[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

4.6 Level 1 EVSE Price Policy Guidance for MUDs

This guidance is intended to help site hosts set pricing for use of their Level 1 outlets. The recommendations are based on a break-even calculation between energy costs and typical networking fees. It is generally recommended that sites charge based on the amount of energy used on a per kWh basis, as this is the most equitable approach in charging drivers for the actual energy used. 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).

Currently, no smart Level 1 outlet is in compliance with the CDFA rules. The practical impact is for all non-exempt uses, a pricing method other than charging by kWh is needed to impose a charging fee. An “amenity fee” or “pet fee”, which is a monthly flat fee for unlimited usage of the outlet, is an acceptable approach. This simple approach can work for both smart outlets with integrated billing systems and conventional Level 1 charging without any software through an offline monthly rent adder.

The prices below reflect an expected monthly break-even cost for conventional Level 1 charging. The pricing model assumed Affordable Housing and apartments will likely have more plug-in hybrids with less charging needs, while condos and more premium apartments will have more all-electric vehicles with greater charging needs. Smart outlets, if utilized, are expected to add roughly $10/month to the prices below.

Small Commercial Rates (B1 and B6) Flat Fee:

Monthly Flat Rate: Affordable Housing and Apartments	Monthly Flat Rate: Condos and Premium Apartments	Approximate Comparison to Price of Gas
$60	$80	$2/gallon

Small Commercial Rates (B1 and B6) Hourly Rate (only for exempted uses such as workplaces and outlets owned by public agencies):

The pricing guidance below is for information only and typically not relevant for multi-family housing, with the exception of outlets that are owned by a public agency, due to the CDFA regulations mentioned previously. The costs below include a premium of $0.04/kWh for expected networking fees.

Rate	Hourly Rate ($/hour)
B1	$.42
B6	$.41
B-EV 1* (< 100 kW demand)	$.34

** 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.*

5 Appendix A

Example of Level 1 Outlet and Cable Management

Source: Renault/Nissan Z.E. Cable Flexi Charger holder (Zoe Leaf Tesla) by stv-is-iti, https://www.thingiverse.com/thing:3692796

6 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

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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

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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

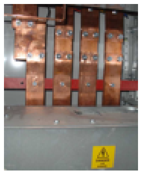
Panelboard

- 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



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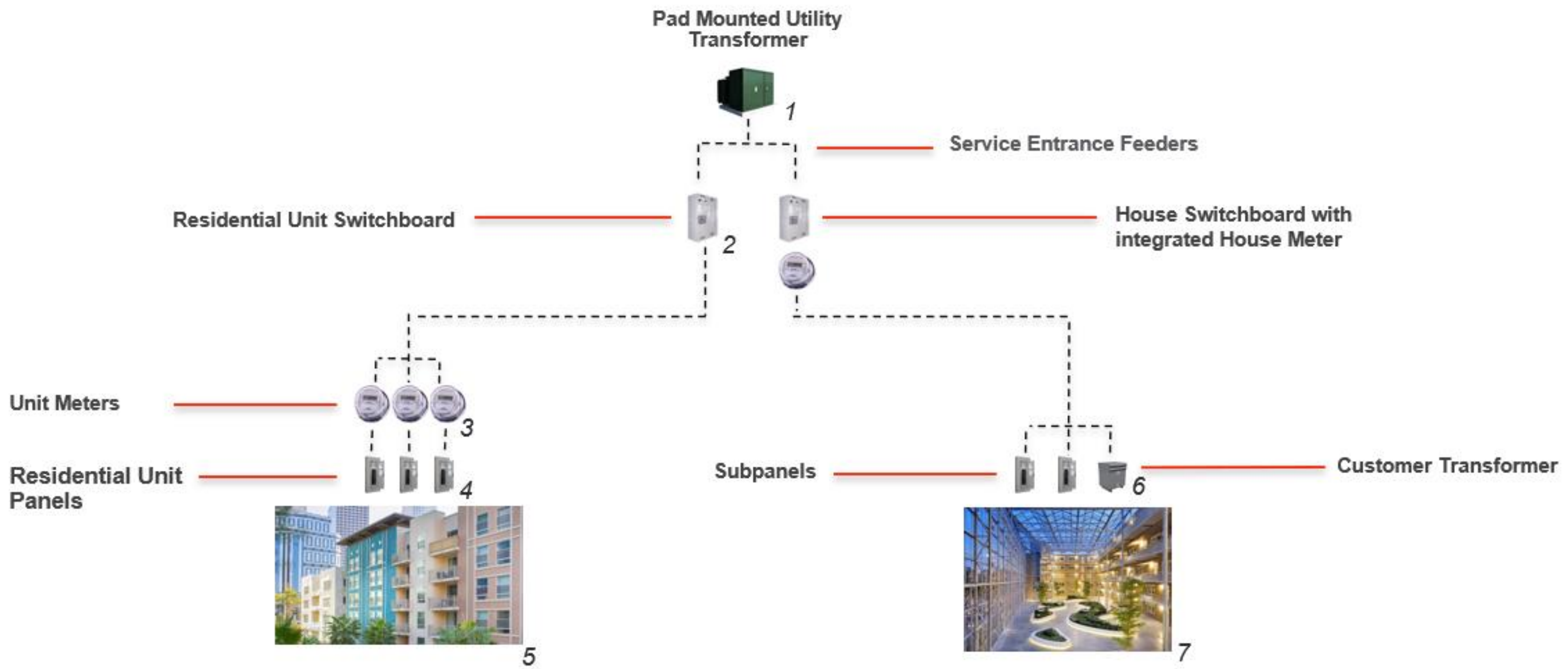
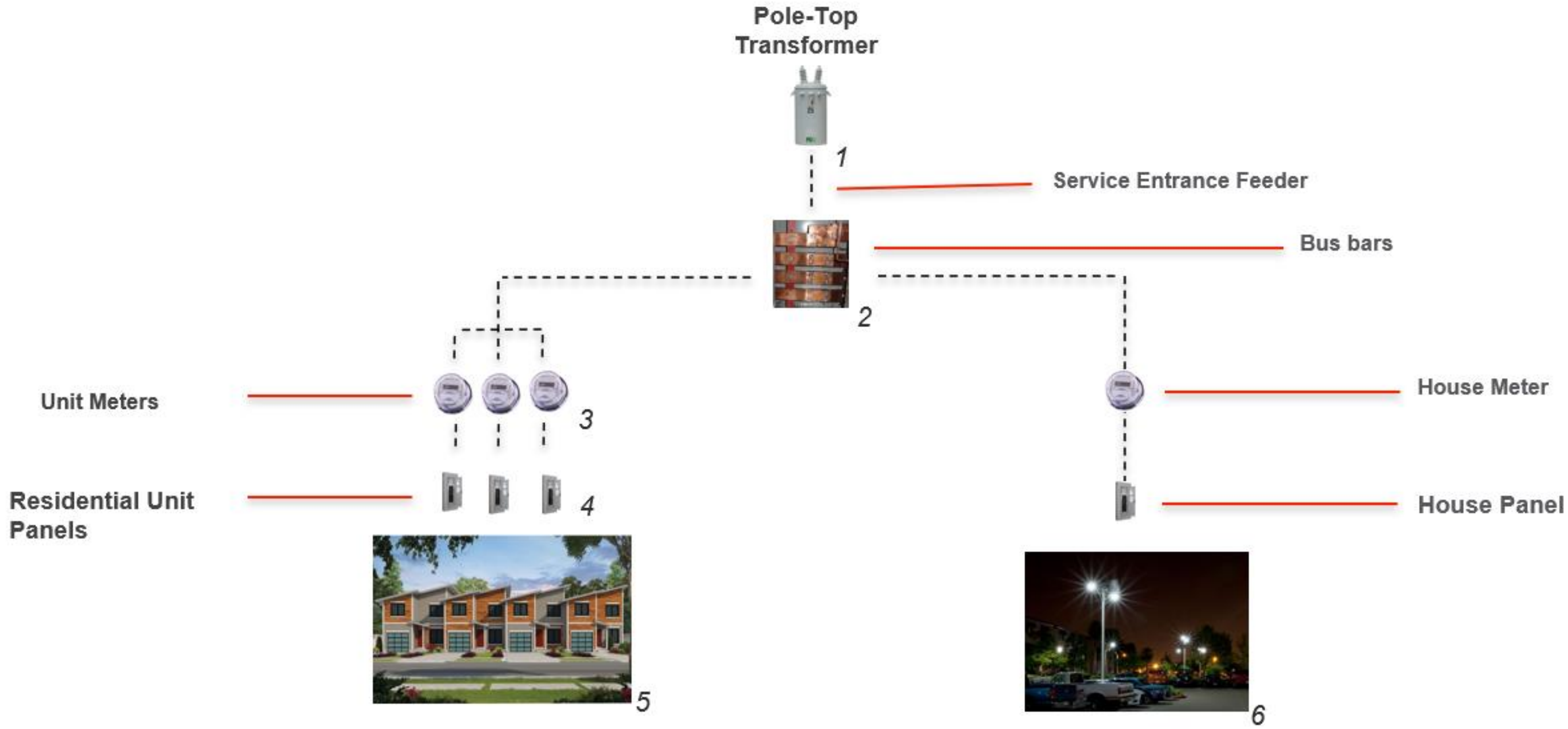
Sample MUD Site Electric Overview – Medium to Large and/or Post 1980 Site



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
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3Solar-electric.com
4Eaton
5House Plan Shop
6Sepco Solar Lighting