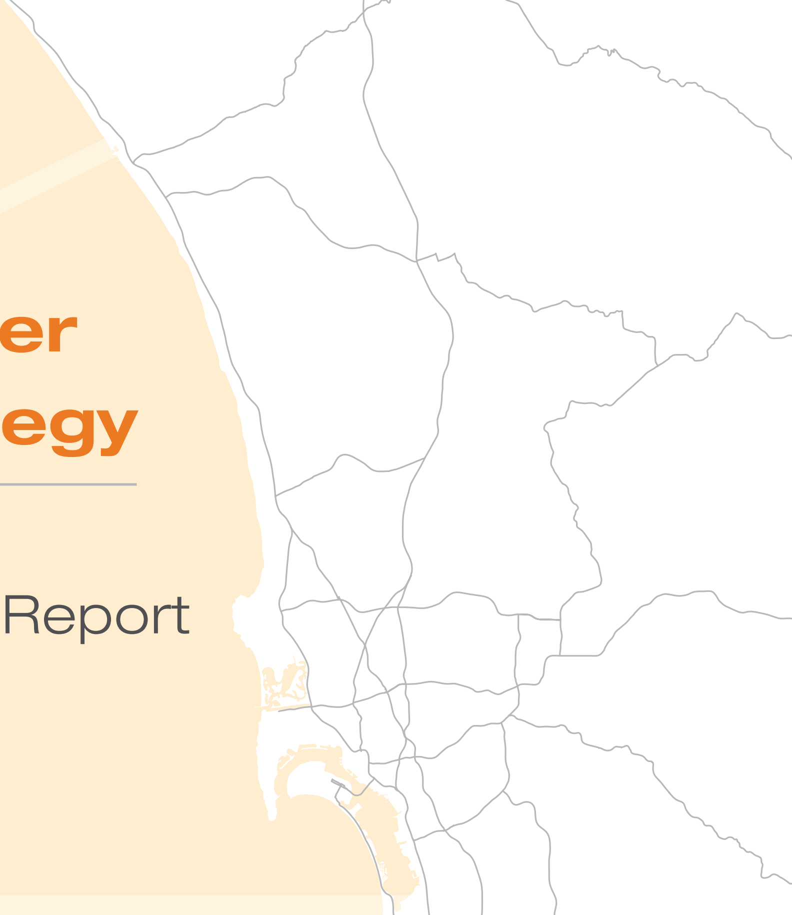
SANDAG

Regional EV Charger Management Strategy

Asset Management Considerations Summary Report

FINAL | March 2022



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1. Introduction and Purpose

The **San Diego Association of Governments (SANDAG)** and North County Transit District (NCTD) were awarded a Caltrans Planning Grant to develop a Regional Electric Vehicle (EV) Charger Management Strategy. The purpose of this strategy is to support the reliable operation and expansion of publicly accessible light-duty passenger EV charging infrastructure located at public parking areas such as park-and-rides (including mobility hubs), transit stations, rest areas, and other commuter lots. Although there is currently a significant local focus on increasing public transit users, achieving sustainable and equitable transportation modernization will take a multi-faceted approach, including increased EV adoption and use. Widescale EV adoption, in turn, necessitates increased charging access, including to historically underserved populations. This report identifies the key considerations for agencies in deploying and managing their EV charging assets throughout the implementation cycle:

- **Siting:** Agencies should ensure that chargers are sited where they will be used. New sites should fill critical charging gaps rather than compete unnecessarily with private charging businesses. These two goals are not always aligned.
- **Power/communications needs:** Agencies should optimize power needs and scope while considering utilization and future charging needs. This includes flexible communications that enable dynamic load management and billing.
- **Funding/Costs:** Although grants or other one-time capital funds have often been used to pay for initial equipment and installation, ongoing operations and maintenance costs should ultimately be supported with revenue generated from charger use.
- **Operations:** To achieve, at a minimum, revenue neutrality and ensure the public receives at least as much benefit as potential vending services, agencies need to keep operating costs down and increase throughput. This goal can be achieved via a fee structure maximize to revenue, parking management to support utilization, and energy management to reduce utility costs.
- **Maintenance:** Agencies should identify maintenance options beyond manufacturer-provided warranties and the extension of existing service plans.
- **End of Life:** Agencies must establish next steps after a charging infrastructure contract is fulfilled or equipment has reached the end of its useful life.
- **Ownership Models:** There are currently several ownership models based on trade-offs and agency expectations regarding responsibility of the full cycle of implementation, from siting through end of life (as above).

In developing this strategy, the project team interviewed key local agencies operating EV charging infrastructure, as well as peer agencies in California and across the nation.

This report explores the critical factors that influence public EV charger operations and management; it identifies current gaps in the regional charging network and provides analysis of different operating scenarios. These scenarios also offer technical specifications that can be used to support future procurement. The concepts and recommendations herein will be further explored in the draft Regional EV Charger Management Strategy.

2. Existing Charging and Gaps

Current Charging Counts

The project team sought to establish the current extent of public charging in the region and to determine how many chargers were sited on public property. The results were used as a baseline for how many more drivers in the region could be satisfied by charging sited on public properties, and the social equity considerations of these sites. The project team used information from the U.S Department of Energy's Alternative Fuels Data Center (AFDC) and the SDG&E Power Your Drive (PYD) map to identify current charging installations in the region. This dataset was combined with SANDAG land use designation files to establish land use type and ownership. From the baseline, we identified which existing public chargers were located in high-need areas (using California state designations of disadvantaged community [DAC] and low-income community [LIC]). Each site represents a distinct location with charging; each site may have more than one charging port.

Table 1. Public EV Charging Site and Port Counts in the San Diego Region

Alternative Fuels Data Center Charging Statistics				
	Sites		Ports at Sites	
	Level 2	DC Fast Charge	Level 2	DC Fast Charge
Total	919	90	1,999	374
Total in LICs	250	28	500	72
Total in DACs	26	7	61	20
Total on Public Parcel	162	7	380	20
Total on Public Parcel in LICs	87	7	186	20
Total on Public Parcel in DACs	1	7	4	20
Source: AFDC December 2021 https://afdc.energy.gov/stations/#/analyze?region=US-CA&fuel=ELEC&show_map=true				

The AFDC counts do not include private workplace sites installed as part of SDG&Es PYD Program, nor do they include projects funded by the California Electric Vehicle Infrastructure Project (CALeVIP) that were not in operation at the end of 2021. Nonetheless, more charging is needed everywhere to meet the goals established in Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment, which identifies a need for more than 24,000 public Level 2 ports and 1,400 direct current fast charging (DCFC) ports in San Diego County by 2030 (Table C-15).[1] Public agencies can identify spatial gaps, consider which can be filled, and prioritize investments in areas that are underserved.

[1] California Energy Commission, "Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030," https://www.energy.ca.gov/publications/2020/assembly-bill-2127-electric-vehicle-charging-infrastructure-assessment-analyzing.

The numbers above strongly indicate that those underserved areas include DACs and LICs, which remain underrepresented in terms of charging infrastructure (as well as vehicle adoption). The number of sites and ports in DACs is relatively small, at around 3% of the total in the region. There is a clear need for continued focus on serving those areas through both education and infrastructure funding. Many existing DAC and LIC DCFC sites and ports are located on public property, highlighting the influence public agencies have in those neighborhoods to enable EV ownership.

Non-Public Charging

Many non-government entities have incentives to help electrify the California transportation system, and agencies can coordinate with these organizations to maximize efficiency while ensuring optimal coverage. For example, several utilities have been conducting electrification demonstration projects, and SDG&E's PYD program focused on charging installations. PYD installed over 3,000 charging ports across 150 workplaces and 100 multi-unit dwellings (MUDs). While considered private, these charging stations are scheduled to continue operating for over ten more years and make up a large portions of the region's available charging. Prior to the pandemic's onset in 2020, daily charging was still increasing, approaching 15 MWh a day (or the equivalent of around 50,000 miles). Examples of workplace charging showed each charging port could service multiple users daily. Some locations could support after-hours and weekend charging if elected by the hosts, which may be a "low-hanging fruit" approach to increasing regional charger access.

Recognizing the likely continued growth in demand and the program's effectiveness, the California Public Utilities Commission (CPUC) has approved PYD 2.0, essentially a continuation of the program. Agencies would benefit from reviewing lessons learned from PYD 1.0 and staying informed about PYD 2.0. The extended program may have some differences including limitations on utility operation of stations, which will require hosts to make operating decisions as outlined elsewhere in this report.

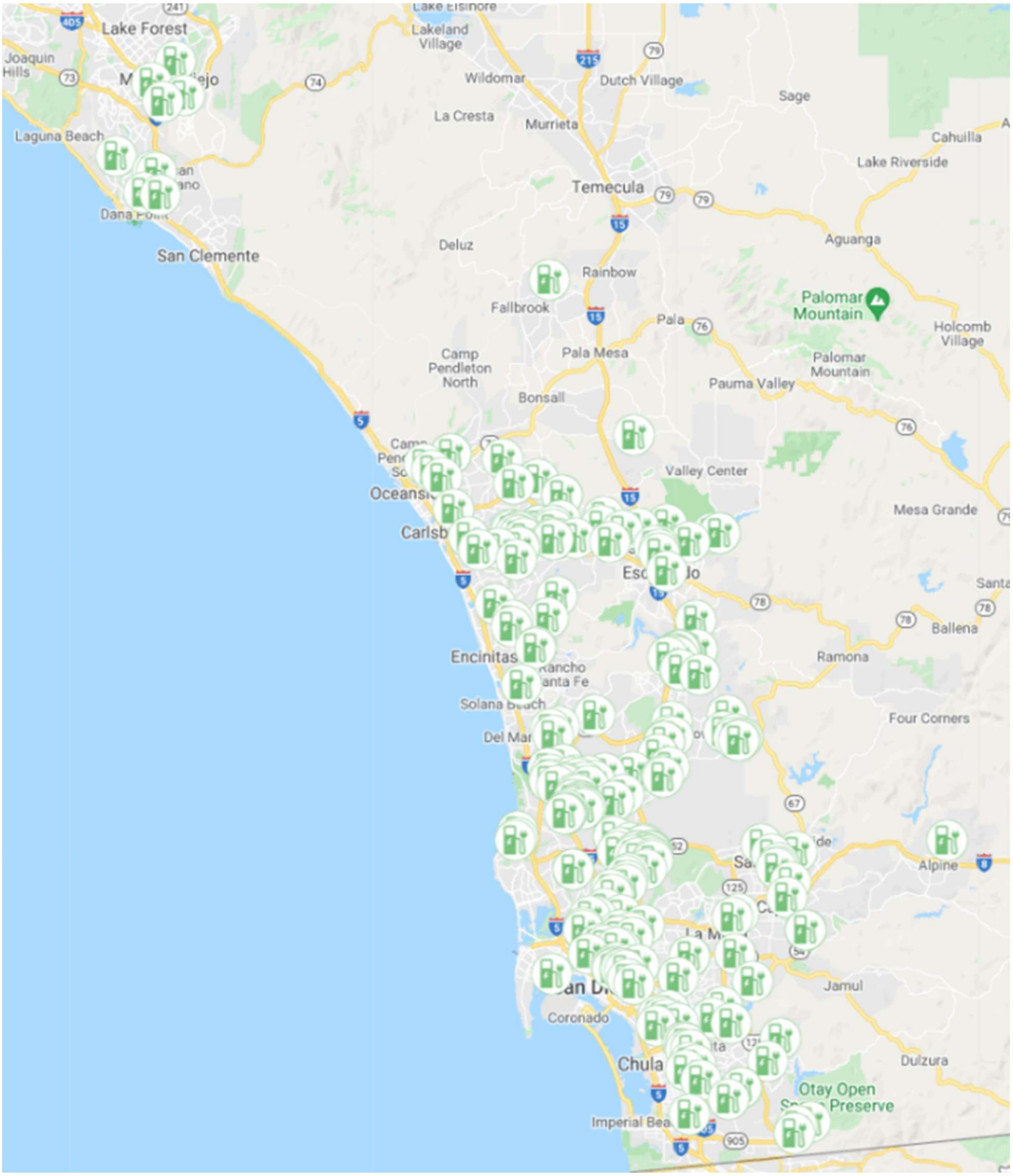

Figure 1. PYD Charging Installations

Spatial Analysis

To evaluate spatial coverage and identify potential opportunities to reduce gaps in EV charging infrastructure, the team identified publicly owned parcels without access to public Level 2 charging within a walkable distance (deemed a quarter mile, for the purposes of this report) and without DC fast charging within a distanced considered to be a conveniently short drive (deemed 2.5 miles). [2]

Overall, the results show many publicly owned parcels in areas without nearby charging. These parcels should be considered for publicly accessible charging installations if they offer public parking. Appendix A provides more detailed maps of these areas. We outline suitability in terms of dwell time by venue types later in this report; however, charging suitability should be evaluated on a site-by-site basis. We include additional key considerations and use profiles later in this report.

Figure 2, below, illustrates the large number of publicly owned parcels without Level 2 charging within a quarter mile across the San Diego region.

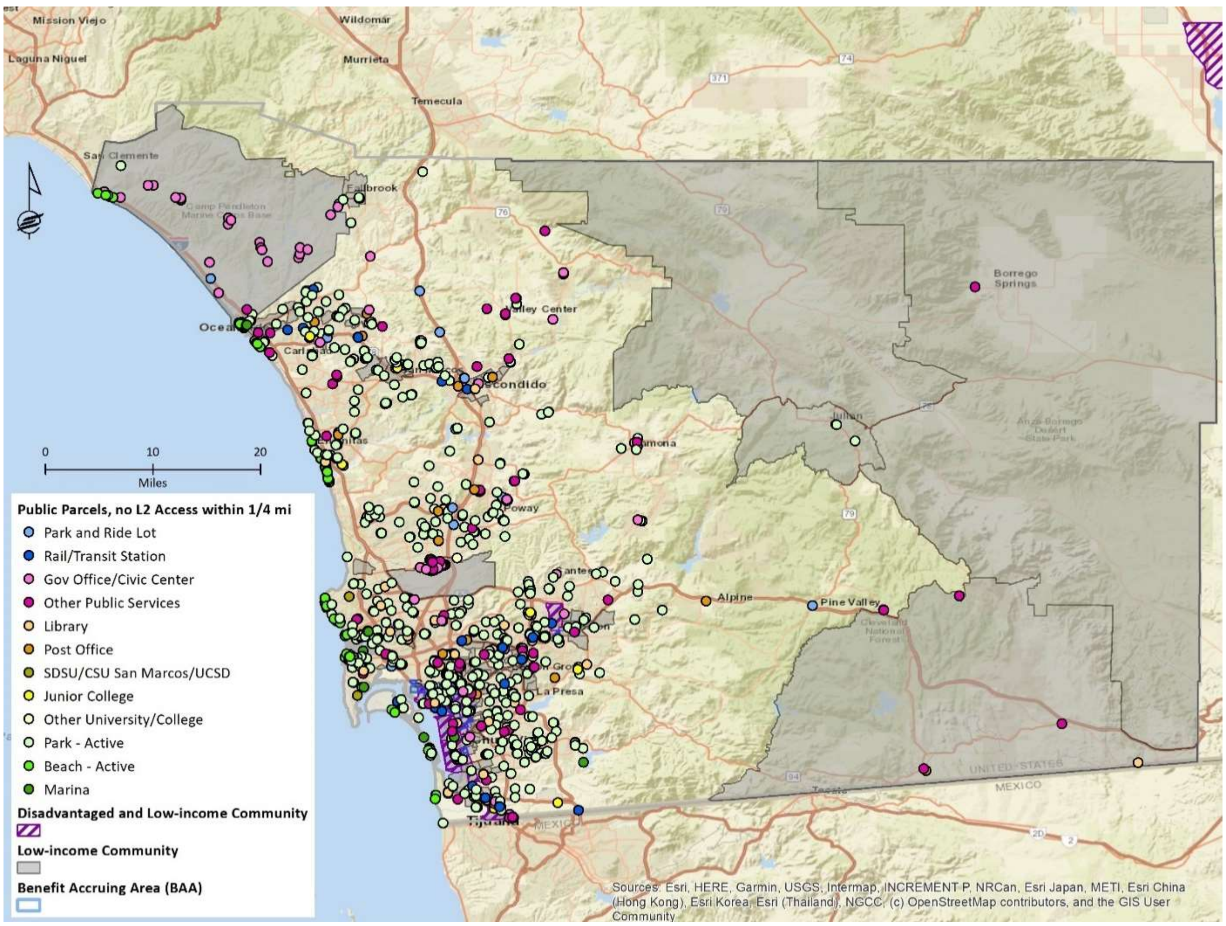

Figure 2: Publicly Owned Parcels with No Public Level 2 Charging within 0.25 Miles

[2] .25 and 2.5 miles were previously used for listing alternative fuel stations in e *San Diego Regional Alternative Fuel Readiness Plan* (2016) https://www.sandag.org/uploads/projectid/projectid_487_23916.pdf

The analysis did not include public parcels with less accessible land such as habitat preserves since the demand for charging is lower in more rural settings. As a result, fewer potential sites were identified in the eastern portion of the County. Additionally, some urban parks and government building complexes are made up of multiple parcels, so multiple points may represent the same general site.

Figure 3, below, shows publicly owned parcels without DC fast charging within a 2.5-mile radius. The more urban areas show almost complete charging coverage through publicly accessible DCFC. For this reason, there is a lack of identified parcels in the urban coastal part of the County, including the areas near San Diego Bay identified as DACs. However, demand is likely to increase as the EV market grows in these areas, especially where high volumes of visitors (e.g., tourists) with short dwell times are expected. Although the current deployment of stations offers spatial coverage more charging ports will be needed to serve increasing numbers of vehicles.

The map also shows certain rural areas and corridors where charging may still be needed, especially in the unincorporated East County. For instance, the Interstate 8 corridor currently lacks DC fast charging past El Cajon. A publicly owned parcel could offer one of the few opportunities to fill a critical charging gap supporting travel to and from Imperial County and points east, as there are limited privately owned sites suitable for development in this stretch.

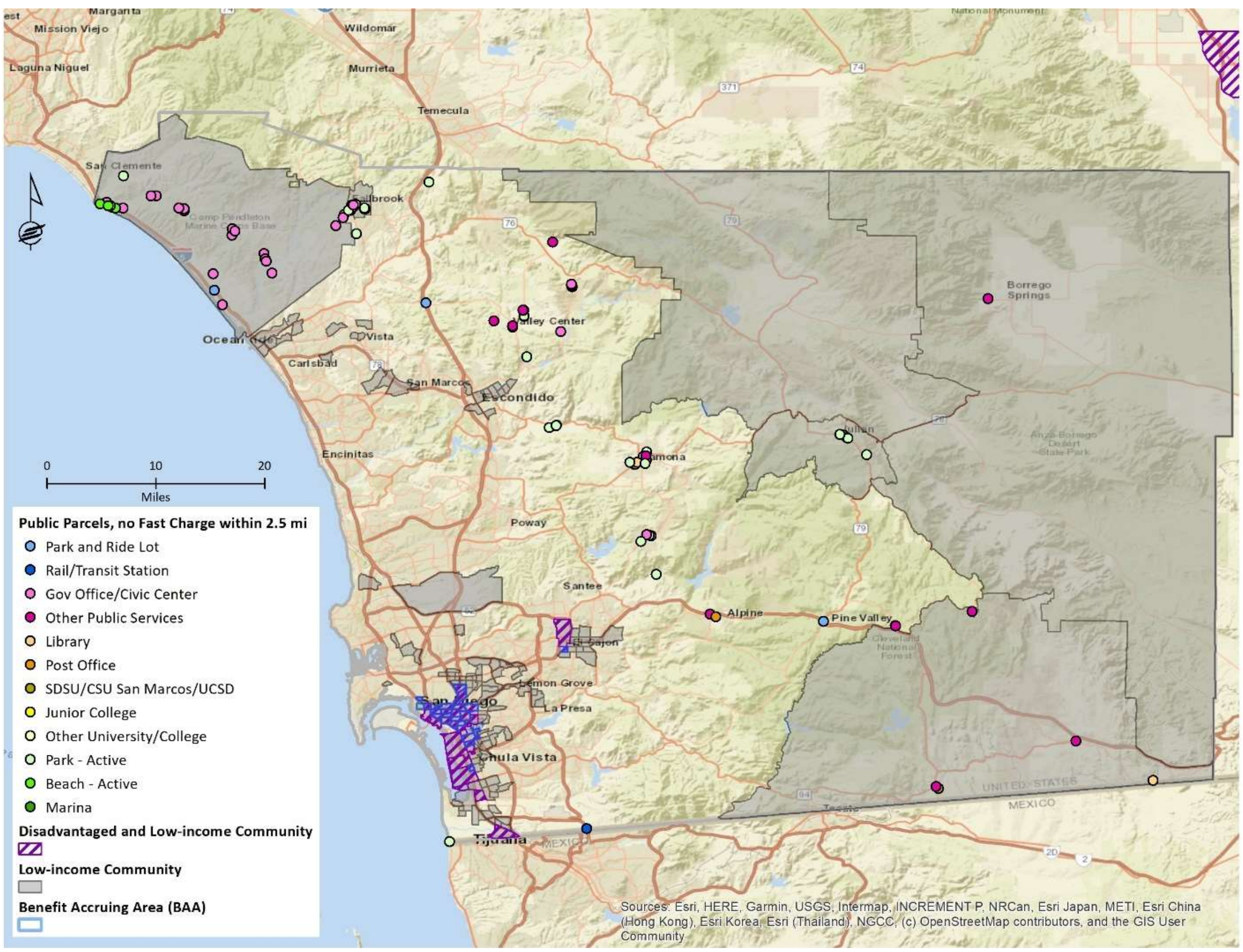

Figure 3: Publicly Owned Parcels with No Public DCFC within 2.5 Miles

Table 2, below, shows the total number of public parcels where EV charging could potentially be sited to fill charging gaps. Again, this count of parcels reflects the uses shown on the map and exclude certain public parcels such as national forest or habitat preserve land.

Table 2: Public Parcel Counts

Total Parcels	Total Parcels without Level 2 Access	Parcels in LIC without Level 2 Access	Parcels in both LIC and DAC without Level 2 Access
2,337	1,122	248	122

Table 2 shows that out of more than 2,337 publicly owned parcels identified, nearly half (1,122) had no publicly accessible Level 2 charging within a quarter mile. Of these, 248 were in LICs, and 122 were in LICs that also fit the state's definition of DACs. Most public sites could have some value as charging locations. However, installing publicly accessible EV chargers at these DAC and LIC sites could be prioritized to meet SANDAG equity goals, as well as take advantage of funding programs with equity criteria.

K-12 schools were excluded from this analysis as schools generally restrict public access to campus for student safety. Military parcels were included and account for 58 of the 248 parcels identified as located in LICs with no Level 2 Access. Although these sites are restricted the broader public, the military represents one of the largest employers in the region, and hosts many military personnel, civilians, and dependents.

The presence of MUDs nearby and the potential to serve those residents that do not have access to charging at home is another potential criterion for prioritizing EV charger locations. The maps in Appendix A include shading to show zones of higher MUD residency.

Park-and-Rides

Transit park-and-ride lots have potential for charging placement. Long dwell times of transit commuters support Level 1 or power-managed Level 2 charging.

Table 3 on the following page provides information about park-and-ride sites in the North County Transit District (NCTD). The highest and best use on some transit parking lots may be as transit-oriented development. EV charging should also be included for tenants of any nearby MUD developments. On October 21st, 2021, the NCTD board adopted a resolution declaring a number of station sites as surplus land, which allows for joint use development to occur at these sites. All forms of charging (L1, L2, and DCFC) can be part of a holistic approach for users with long dwell times (residents and commuters) and short dwell times (ride share and convenience charging drivers). Currently the only NCTD-controlled charging is located onsite at the Oceanside Transit Center, which has a fee structure that has not been optimized for long-term parking by transit riders.

Table 3: NCTD Park-and-Ride Sites

Coaster Station	Charging Nearby	DAC/LIC	Identified for Development
Oceanside Transit Center	Onsite	LIC	Yes
Carlsbad Village	Nearby	LIC	Yes
Carlsbad Poinsettia	No	-	Yes
Encinitas	Nearby	-	No
Solana Beach	No	-	No
Sprinter Station	**Charging Nearby**	**DAC/LIC**	**Identified for Development**
Coast Highway	No	LIC	Yes
Crouch Street	No	-	Yes
El Camino Real	No	-	No
Rancho Del Oro	No	-	Yes
College Boulevard	No	LIC	No
Melrose Drive	No	LIC	Yes
Vista Transit Center	Nearby	LIC	Yes
Civic Center Vista	No	LIC	Yes
Buena Creek	No	LIC	No
Palomar College	No	LIC	Yes
San Marcos Civic Center	No	LIC	No
Cal State San Marcos	Nearby	-	No
Nordahl Road	No	LIC	No
Escondido Transit Center	No	LIC	Yes

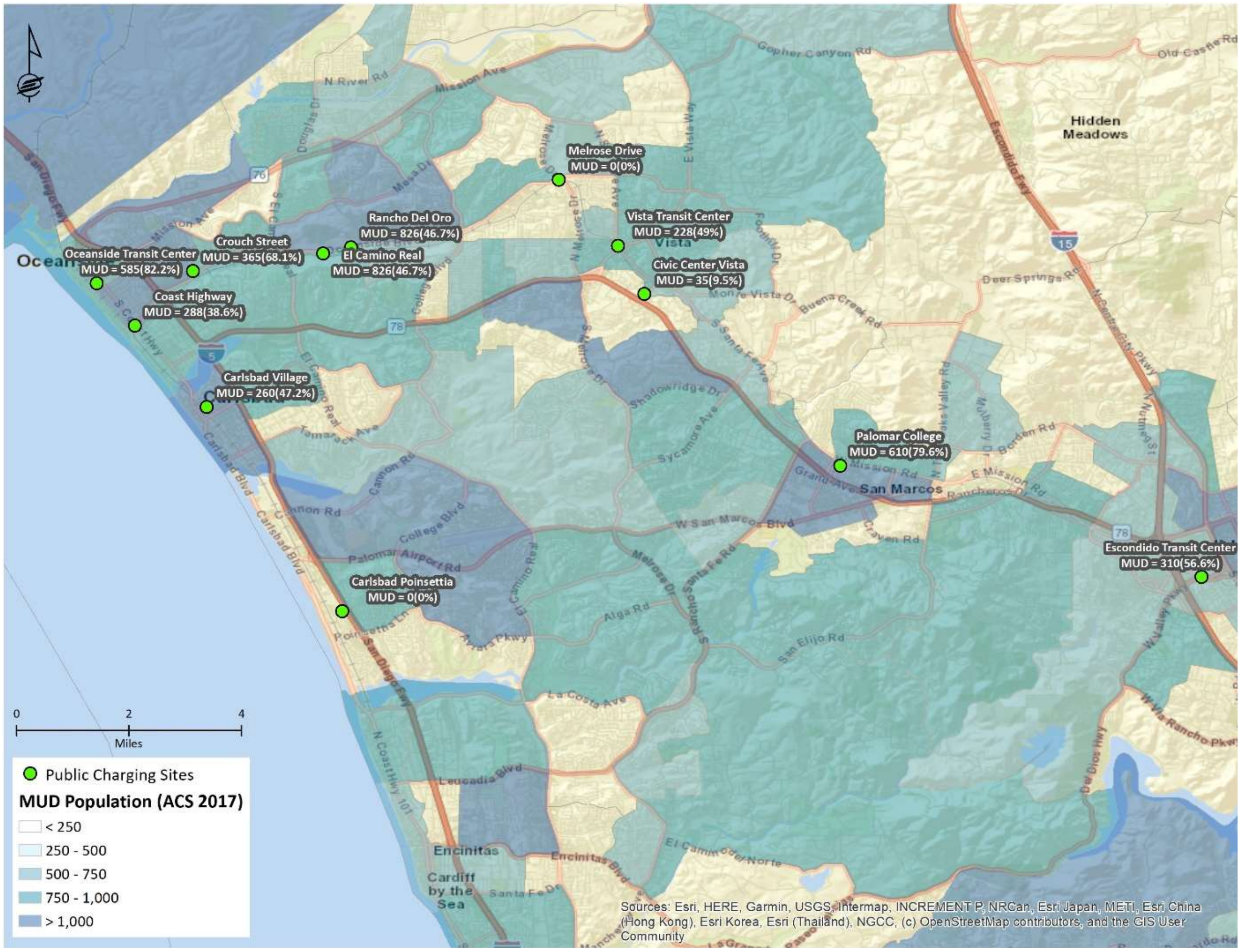

Figure 4: Potential NCTD Development Sites

Figure 4, above, shows station/parking sites that may be considered for future development. The table on the following page illustrates that there is a large population of MUD residents nearby each station who could potential be served by EV charging if located at the stations.

Table 4: MUD Population Near Selected NCTD Stations

Station Name	MUD Population within 2.5-Mile Radius
Carlsbad Poinsettia	4,121
Carlsbad Village	13,191
Civic Center Vista	11,952
Coast Highway	13,583
Crouch Street	18,422
El Camino Real	14,453
Escondido Transit Center	14,876
Melrose Drive	11,962
Oceanside Transit Center	13,583
Palomar College	9,529
Rancho Del Oro	14,276
Vista Transit Center	12,155
NCTD Total	**152,103**

This analysis shows a large MUD population in the vicinity of sites that are identified for future development. NCTD does not currently have a policy for EV charging development at any site but should consider the charging needs of future residents and tenants of any joint development as well as nearby residents in MUDs who could benefit from park and ride charging. This policy could cover all potential users and use cases, including commuters, residents, transportation network companies (TNCs), and NCTD crew change vehicles.

Figure 5 and Table 5 on the following page illustrate the large populations surrounding the recently opened Mid-Coast Trolley stations. The Clairemont station is the only site currently slated for mixed-use development, however there is opportunity to serve transit riders at all sites.

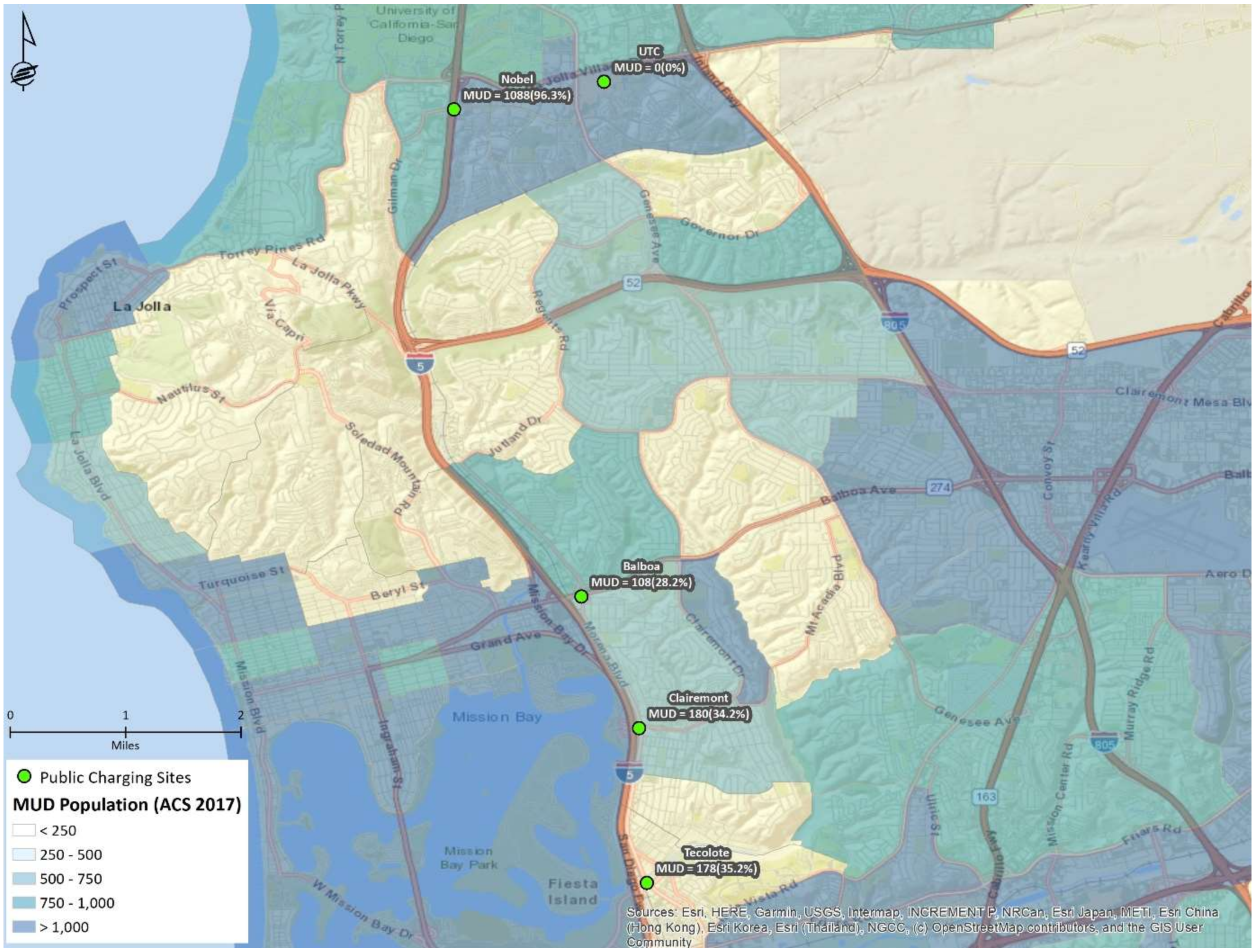

Figure 5: Mid-Coast Trolley Park and Rides

Table 5: MUD Population Near Selected Mid-Coast Trolley Stations

Station Name	MUD Population within 2.5-Mile Radius
Balboa	22,766
Clairemont	24,291
Nobel	19,632
Tecolote	25,671
UTC	21,223
Mid-Coast Total	**113,583**

The Mid-Coast Trolley stations with parking were all designed with the electricity capacity and conduit to support the future charging needs of transit users. Given the larger number of MUD residents within a radius of each station, future charging could be targeted to those commuters who may not have charging at home. The Nobel and UTC stations are also located at major shopping destinations and could also support retail users' charging needs. However, transit riders should be the primary focus of any charging deployments at transit stations. After identifying sites that can address charging needs, agencies will need to devise an operational plan that fits with expected usage given the local context. The following section examines different charging scenarios that could inform future charging deployment and operations at any of these sites.

3. Operational Considerations

Operational Considerations/Business Case Analysis

As learned through the interview process, public agency preference is that EV charging be provided in a manner that is revenue neutral to the agency. For agency-owned stations, this usually means operational costs are covered by user fees. In comparison, third-party operators seek a profit; they must recover more than their operational costs. Electric Vehicle Service Providers (EVSPs) have various business models including offering network and billing services to owners, operating stations on a revenue sharing agreement, or offering full third-party operations, which can be supported through some combination of user fees, partnerships with automakers, and advertising or sponsorship. This section discusses the capital and overhead costs associated with charging infrastructure and presents the operational alternatives that agencies may consider during planning.

Capital Costs

This section looks at the types of infrastructure to be installed. Planners must consider charging speeds and charging types based on the needs of drivers and vehicles being supported. Understanding the several forms of electric vehicle supply equipment (EVSE) charging connectors and associated charging speeds is helpful when considering what to install at any given location. The highest feature, highest cost equipment is seldom needed; there are often more cost-effective options that allow for a quicker payback period for a given level of usage. However higher power and cost units may allow fast charging or load management options that better optimize energy delivery.

	LEVEL 1	LEVEL 2	LEVEL 2+	LEVEL 3 (DCFC)
OVERALL CAPITAL COSTS	$ Least Costly			$$$ More Costly
INFRASTRUCTURE CAPITAL COST CONSIDERATIONS				
EQUIPMENT COST PER PORT	$10-$25	$200-$600	$2,500-$5,000	$10,000-$50,000
CHARGE RANGE	1.2kW: ~40 miles during workday/overnight	3-7kW: 10-25 miles each hour	7-19kW: >25 miles each hour	50kW: ~150 miles each hour
WARRANTY & REPLACEMENT COSTS	Lower warranty & replacement costs	Low-cost replacement instead of warranty	Higher warranty & replacement costs	Highest warranty & replacement costs
PARKING TURNOVER	Minimal to none	Medium need for parking	Higher need for parking turnover	Must have hourly parking turnover
SUPPORTING HARDWARE INSTALLATION	Most likely to use existing hardware	Likely to need installation	More likely to need installation	Most likely to need installation
CARS PER DAY	1-3 cars	3-10 cars	5-20 cars	30 cars

Figure 6: Infrastructure Capital Cost Considerations

Charging Options

LEVEL 1	> 120-volt AC (VAC) charging or "trickle charging" > Every plug-in EV comes with charging cords that can be plugged into a conventional 120-volt wall outlet. > Outlet should be supported by a 20-amp circuit breaker; however, most cords and cars are set for 12 amp draw, which can be supported by 15-amp circuits. > Level 1 can also be provided by a hardwired charging connector, although only a small number of vendors offer L1 units, and networking options are more limited. > The most practical places for Level 1 charging are long-dwell parking scenarios, such as workplaces and residences. > A conservative first phase of charging build-out could provide outlets near parking spaces into which EV drivers plug their own cords. > Wiring rated for higher power may be installed in initial phase for future need or opportunity to upgrade to Level 2.
LEVEL 2 LEVEL 2+	> 208–240 volts and may provide a maximum of 80 amps to a vehicle. Most light duty vehicles today only use 32-40amps, however larger pickups, SUVs and performance vehicles may accommodate higher amperage draws. > Mostly hardwired, although more EVSE models that can be plugged in to a 208- 240v are appearing on the market. > With a range of power and features available – Level 2 can be divided into basic and "Level 2+" options. > The fastest Level 2+ units—and those with more features such as screens, buttons, and communication—are relatively expensive, costing over $2,000 per port. > Networked units offer smart charging controls and may be required as part of utility or grant programs. > Basic units with the fewest features and lowest power are approaching $500 per port. Such low-price points may negate the value of long-term warranties, as such low-cost equipment can be simply replaced. > In the United States, there is at least one model available that can be used as Level 1 or 2 (in Europe, the same cords that come with cars can also use Level 2 voltage). This flexibility may provide an opportunity for site hosts to provide infrastructure at reduced capital costs, as EV drivers can plug in their own cords rather than use site connectors.
LEVEL 3 (DCFC)	> Typically runs on 480 VAC three-phase power, but some charger models can use 208/240 VAC, which can charge at levels as low as 10 kW. > Historically around 50 kW, but more 100+ kW charging is becoming available and preferred for vehicles with larger batteries to reduce charging times. > EVs are not able to maintain the maximum charging speed for the entire charging session. This provides opportunity for load sharing that can reduce the average necessary power per port as the number of simultaneous charging ports increases. > Three current connectors are in use: Tesla, CHAdeMO, and J1772–CCS (Combined Charging System). Examples of charging networks providing all three connectors on the same charger began rolling out in 2020. CHAdeMO is slowly being phased out as most manufacturers are supporting CCS, and new installations should offer mostly CCS ports.

Electrical Management Strategies

Power sharing and load management are methods to reduce total electrical capacity necessary for a given installation (and, therefore, costs related to hardware). These approaches can also be used to increase the number of charging ports at existing installations without expanding the capacity provided by the utility or the service panels. The simplest forms can exist between two charging ports, while the most innovative consider real-time power demand from other loads on the site (e.g. lighting or air conditioning), opportunities to use renewable energy (e.g. incentivizing mid-day charging for solar sourcing), and even pricing signals. Some hardware and networks include these features at no cost while others charge additional fees.

Networking may be used to provide controlled station access, billing, and load management. This usually represents additional hardware costs, as well as monthly fees. Related costs can be mitigated by simplifying load management measures and, on a per-port basis, reducing the number of ports installed. For example, public parking layouts can offer higher physical charging access, with each cord reaching at least two parking spaces, so fewer ports are needed. Additional considerations are charging reliability (minimizing competition for popular parking areas) and incentivized parking turnover (such as increasing costs for vehicles that remain connected once charging is complete).

Overhead Costs

One general consideration for keeping overhead costs down (thereby maximizing revenue) is that overhead cost per port (and location) decreases as use increases. Other overhead costs that must be considered include the conditions presented by the EVSP, including the network, warranty, transaction, and revenue share.

Figure 7, below, shows approximate cost ranges for these factors. The sophistication of charging hardware and software often drives the cost of the system. Charging strategies that allow the use of lower-overhead installations should be considered. Some of the simplest installations may have no ongoing maintenance, transaction, or network costs. Alternatively, some EVSPs offer turn-key opportunities where they are responsible for these costs.

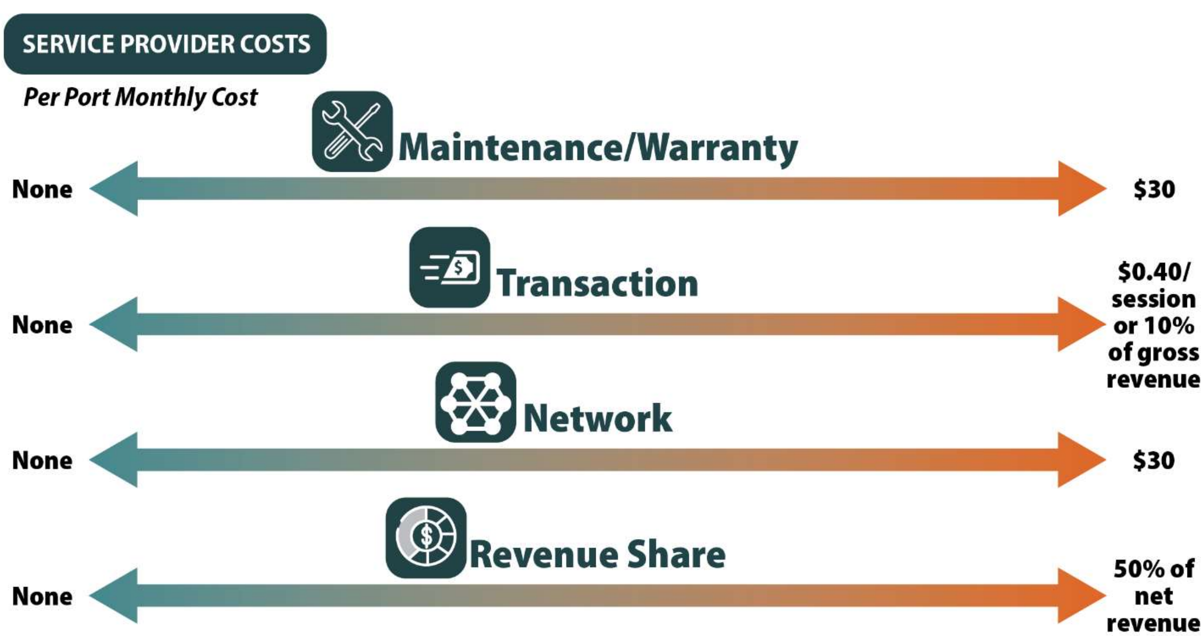

Figure 7: Overhead Operational Cost Considerations

Fuel Costs

Utility Electricity Costs

Agencies planning charging should consider utility rates and options for managing electricity costs, as well as alternatives that place this responsibility on the EVSP. SDG&E currently offers at least five residential and commercial tariffs relevant to EV charging. Some rates offer high- and low-power versions. Using the lower-power options can reduce fixed costs and overcome electric capacity constraints. Creating scenarios to provide the lowest-cost electricity is important, both to be competitive in the growing public charging domain and to provide incentives for drivers to choose and drive EVs.

Figure 8 shows several electricity rates that are relevant to EV charging. The two residential rates are examples of relatively low-price energy, representing competition with public charging. SDG&E pricing provides a comparison: the utility owns and operates four public sites that currently retail $0.23–$0.45/kWh, plus a 6% service fee.[3] This represents some of the least-cost public charging available, and yet, the price is significantly higher than the rates people with at-home charging access typically pay. Some of the commercial rates are optimized for high-power and high usage sites.

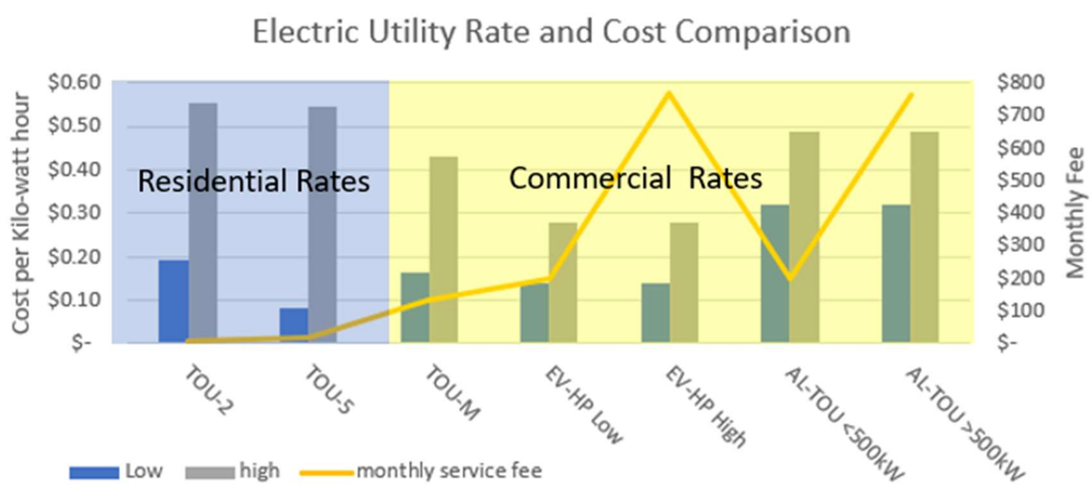

Figure 8: Utility Tariff Electricity Costs

As noted in Figure 8 above, higher usage translates to higher revenue; more transactions compensate for rates with higher monthly fixed charges, including demand charges. At the same time, the operator may need to charge high retail charging fees to recover various overhead costs. Utility costs for the customer of record (property owner, vendor, etc.) are often $0.15–$0.50/kWh, and other influences, such as demand charges and critical peak pricing, can add further costs. Higher retail costs can discourage overall utilization if drivers have access to lower-cost energy at home or elsewhere. These two factors—the need for high utilization and the need to recoup costs—constitute a sometimes-challenging balance.

Drivers in the San Diego region average around 25 miles per day. The associated charging can be achieved on Level 1 during a typical workday or overnight. At Level 2, one to two hours will cover a single day of driving, and a longer day of charging may suffice for a full week of driving. For drivers with large-battery EVs who do not have reliable charging at home or work, the DC fast charging experience is similar to visiting a gas station. Though DCFC provides the easy conditions that allow nearly anyone to drive an EV, this charging approach often supplies the highest-priced energy, a deterrent to long-term EV ownership.

[3] 1928 S Moreno St Oceanside, CA https://www.plugshare.com/location/222997 (more up-to-date pricing on Chargepoint website)

Electricity vs. Gasoline

Table 6 compares driving costs for gasoline-powered vehicles and EVs assuming three variables: fuel economy, monthly distance traveled, and varying electricity costs. Most notably, even traveling in a relatively common 25-mile-per-gallon car is competitive against using high-cost electricity. Even at high gasoline costs of $4 per gallon, modern cars that can attain as much as 50 miles per gallon offer significant competition to EVs.

Table 6. Comparing Electric and Gasoline Fuel Costs for Drivers
(assumes 750 miles driven monthly)

Vehicle Type	Cost	Required Fuel / kWh	Costs per Month	Time for Fueling / Charging
EV (3 miles/kWh)	$0.10/kWh - $0.55/kWh	8 kWh daily 250 kWh monthly	$20 - $150	> 2-3 hours/day > 75 hours/month with L2 Charging > 1 hour/week, 5 hours/month with DCFC
Conventional Fuel (25 MPG)	$4/gallon	30 gallons/month	$120	> ~3 10-minute fuel-ups per month
Conventional Fuel (50 MPG)	$4/gallon	15 gallons/month	$60	> ~1 10-minute fuel-up per month

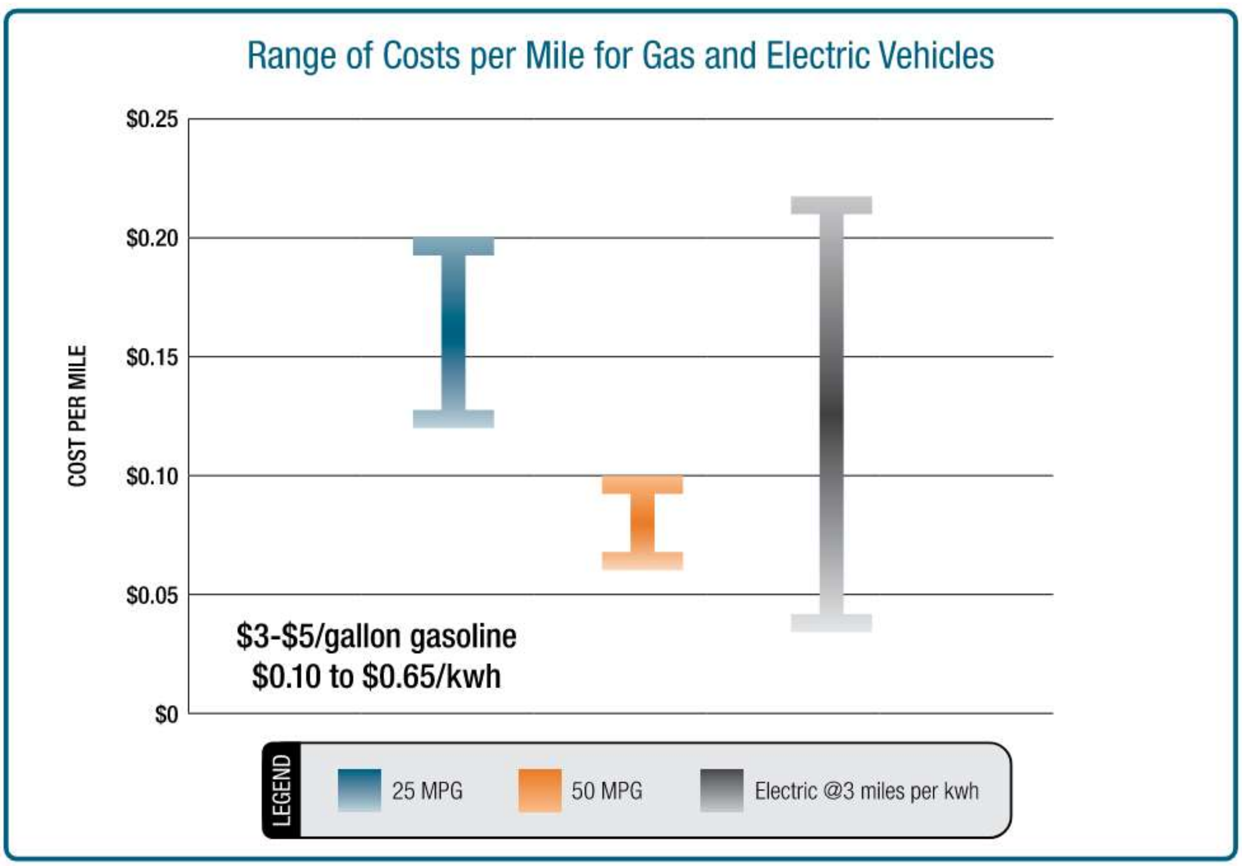

Figure 9: Range of Per-Mile Costs for EV and Gas Vehicles

Time-Based Electricity Pricing

The least-cost energy is often available late at night and on weekends, while late afternoon and early evening are when energy costs are highest. This is highly beneficial for venues able to support residential charging demand (overnight). Venues that can provide morning and early afternoon charging also have good access to low-cost energy, including renewables. As solar penetration increases, the hours between 10am-2pm will be the lowest carbon and lowest cost electricity for much of the year. Smart controls and pricing can help direct more charging to this time.

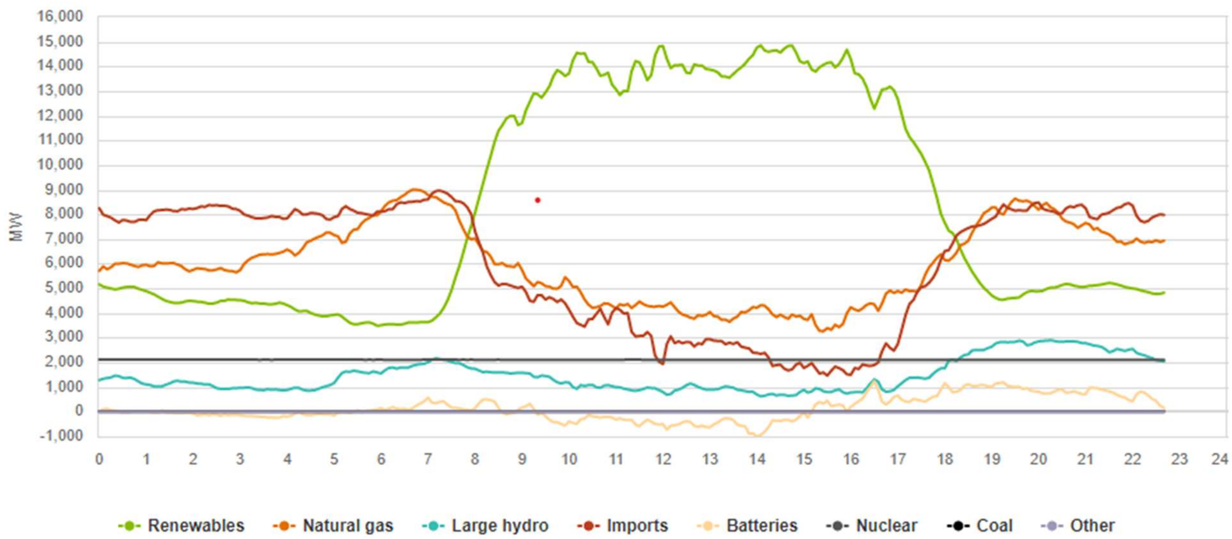

Figure 10: Electricity Supply by Time

Benefits of Greater Access

A strong business case results from maximizing the number of hours of energy consumption on a given charging port. This is possible by making charging accessible to as many types of customers as possible while encouraging charging cord and parking space turnover. The perspective in Figure 10, below, represents opportunities to ensure success of investments and at the same time influence the region's choice of vehicle fuels at various venue types.

Several of the venue types seen below in Figure 10 depict useful examples for this report. Public buildings represent employee workplace charging (long dwell time, Level 1) and, in some cases, public charging for visitors (short dwell time, Level 2). Transit depots also represent workplace-like charging. Public spaces such as parks would serve short-dwell-time visitors. Each venue is potentially suitable for DCFC. While increasing numbers of EVs are equipped to use DCFC, roughly half the vehicle population cannot. DCFC also tend to have higher retail rates. For these reasons, a holistic approach to placement of DCFC, Level 1, and Level 2 is a worthwhile goal.

Each venue, in ideal circumstances, can support nearby residential charging from MUDs. In terms of providing charging, MUDs are documented as the most difficult venue type. However, MUDs represent a significant part of the local population and are frequently home to underserved communities, so increasing MUD charging access not only supports energy equity but also improves infrastructure utilization, thereby lowering costs.

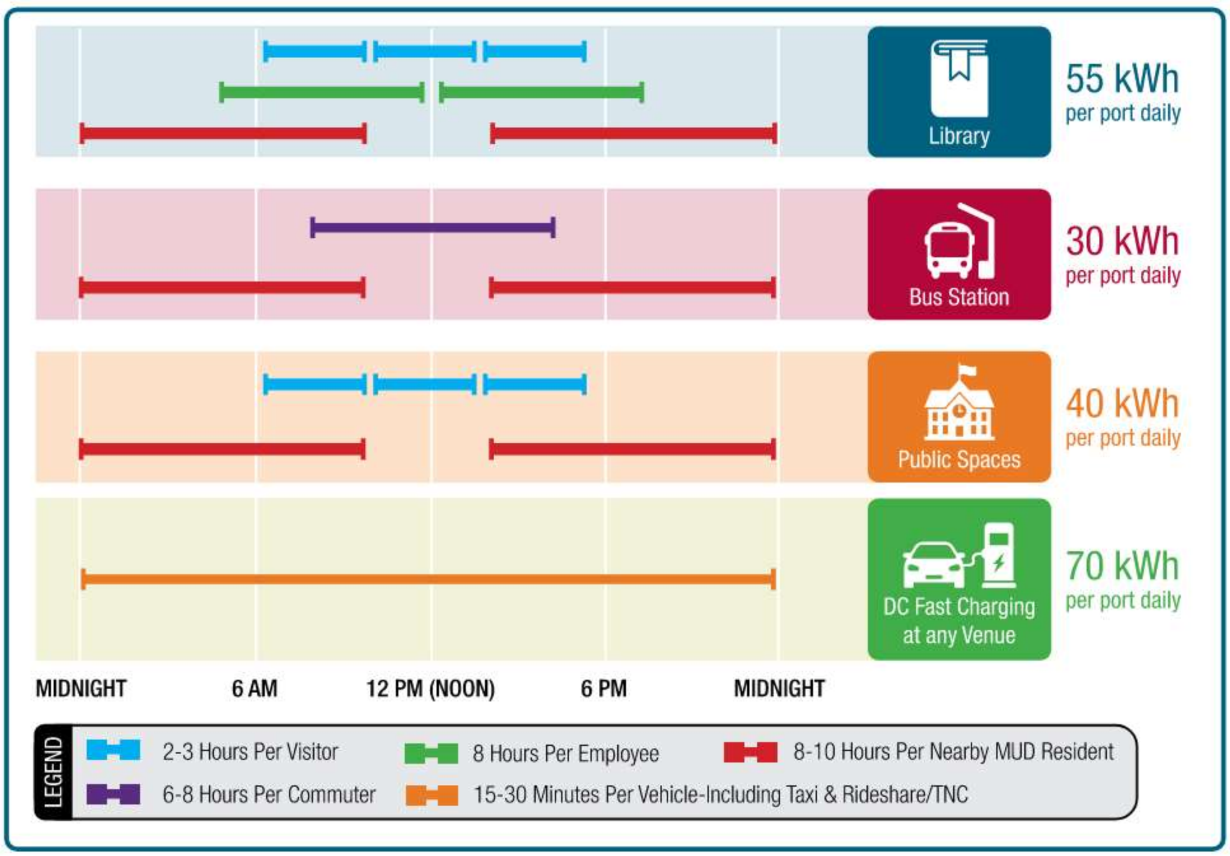

Figure 11: EV Charging Venue Types and Utilization Potential

Charger Utilization Expectations and Assumptions

Figure 11, below, depicts a financial model based on varying the retail rate of electricity provided to EV drivers while keeping all other variables constant. In this context is it is important to note that drivers are less likely to consume energy at higher prices. Although higher retail costs represent more gross and net revenue, they also discourage customer usage and therefore viability of an installation.

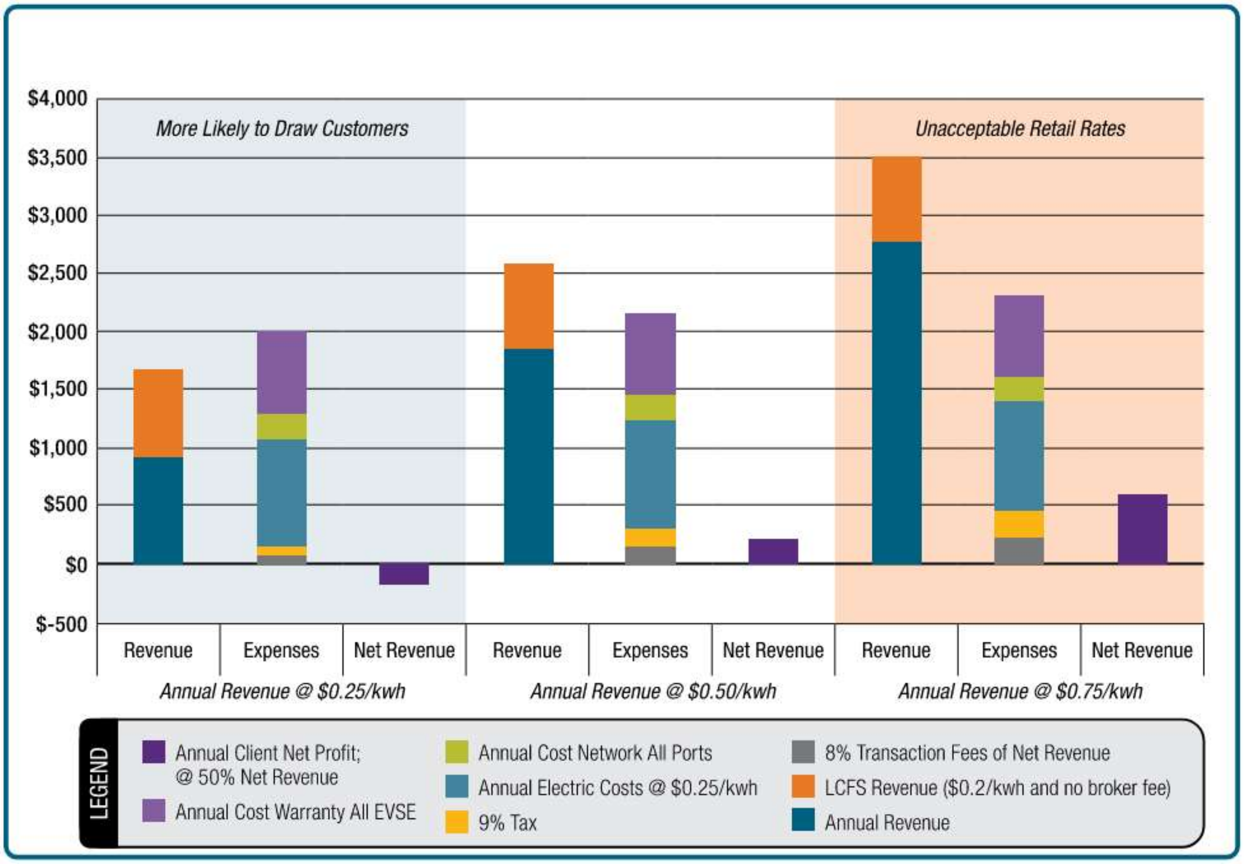

Figure 12: Net Revenue Variance by Retail Price to EV Driver

Figure 12, below, examines gross and net revenues by varying the utility cost of energy while maintaining all other variables. More net revenue is possible at lower utility costs which present more opportunity for profit margin without discouraging customers due to high prices. As least-cost energy is available late at night, venues supporting residential charging may have the best opportunity for revenue positive operations. Software based charging-load management in addition to driver-based marketing can help target least-cost energy at night and in the mornings.

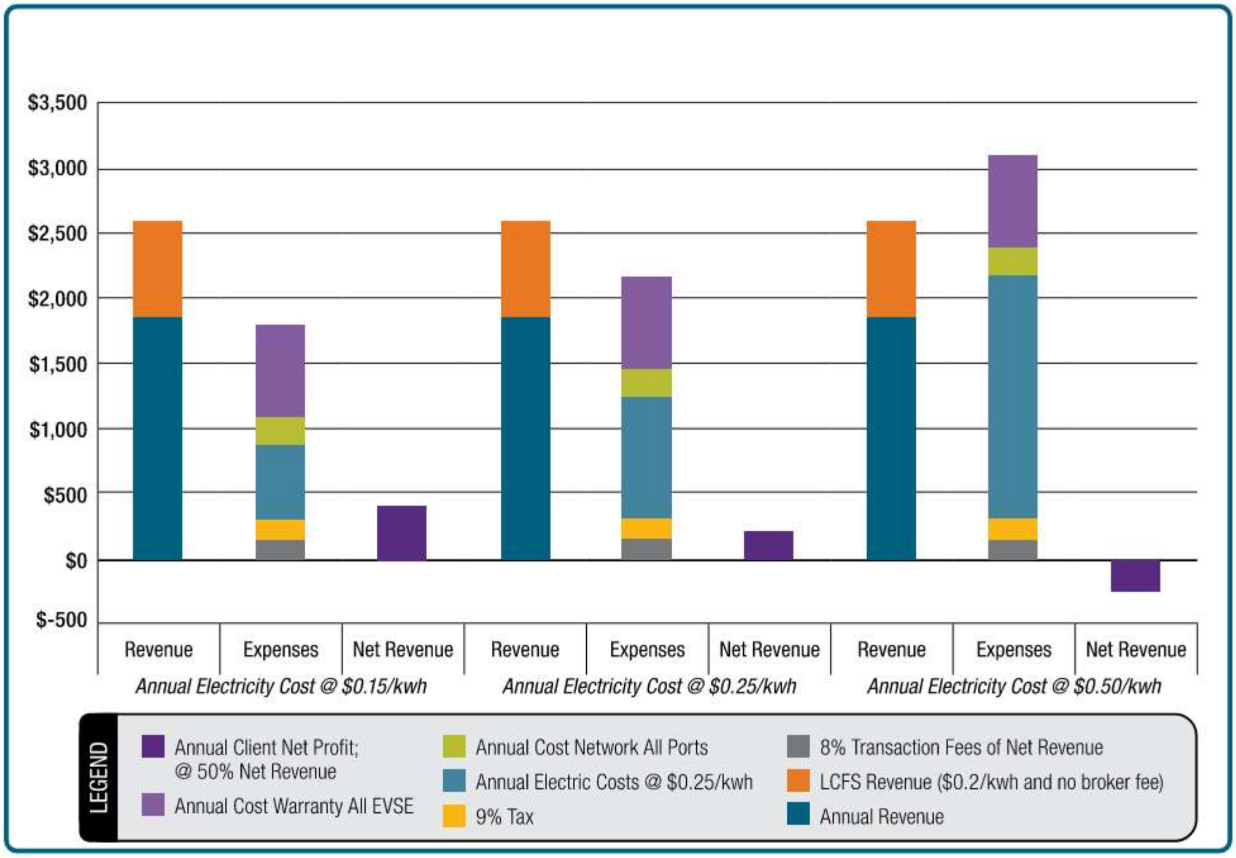

Figure 13: Net Revenue Variance by Utility Tariff Energy Cost per Kilowatt-Hour

The revenue scenario shown in Figure 12, above, is based on an optimistic assumption of daily energy use. Agencies should support parking layouts that allow two or more parking spots per charging cord to induce cord turnover and utilization without the need to move vehicles after completing charging. This is an effort to achieve enough charging to exceed fixed costs. Further detail on parking-charging strategy will be discussed in subsequent tasks.

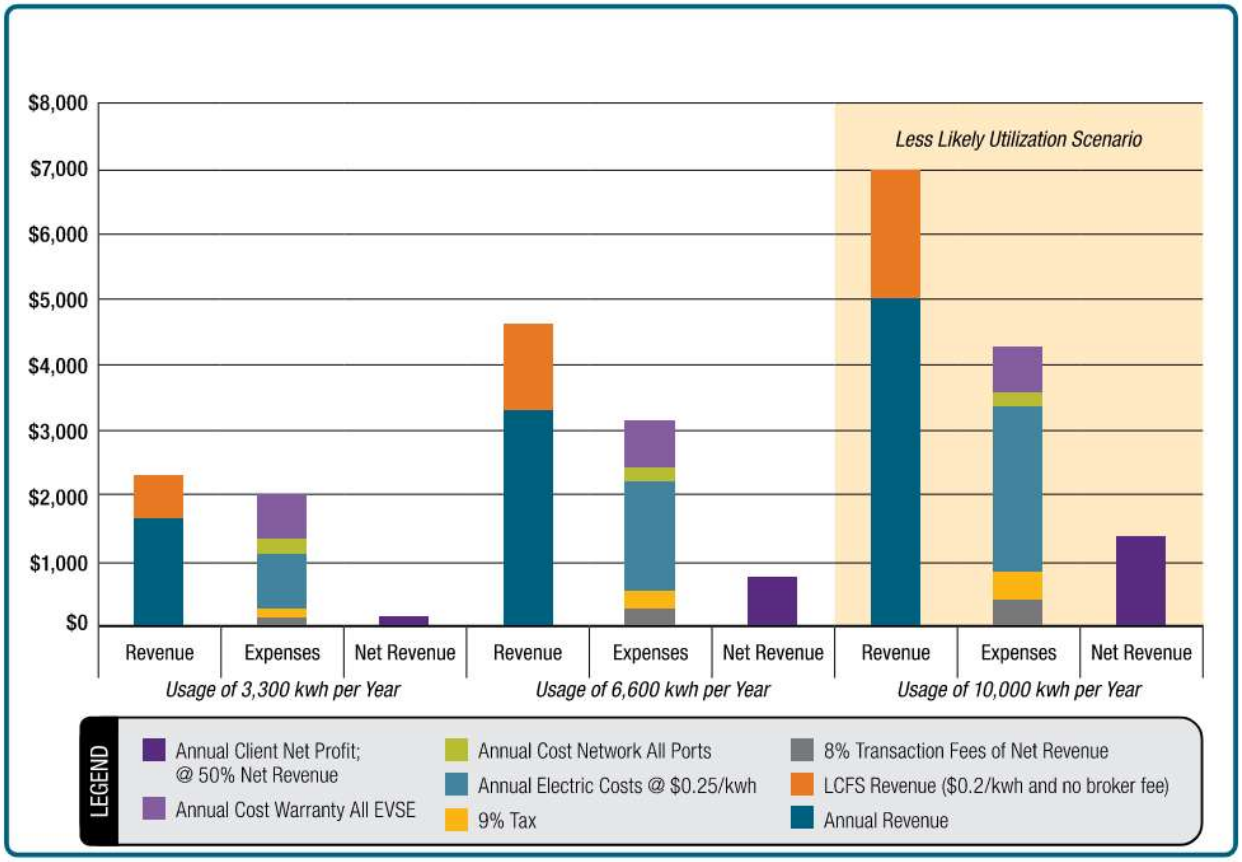

Figure 14: Net Revenue Variance by Annual Energy Consumption per Port

Figure 13, above, examines the potential per-port net-profit (after all expenses including EVSP fees are deducted from revenue) by varying annual energy consumption per port. The lowest usage scenario represents a single, 1.5-hour charging session per day which results in near neutral revenue. However, not all public sites currently receive this minimal level of usage.

Programs, Public Funding, Benefits, Capital Planning and Services

California has only had modern plug-in electric vehicles on the road for a just over a decade. As this market continues to develop there will there be related programs that effect the economics and operational consideration of charging. Some of the existing state and regional EV charging programs are listed below.

The Low Carbon Fuel Standard (LCFS) is a California regulation requiring fuel disruptors to lower the carbon content of all transportation fuels sold in California. It offers an opportunity for entities putting electricity into vehicles to monetize the carbon reduction this represents. Entities can opt into the program and generate LCFS credits for many vehicle classes including off-road equipment. Credits can be sold on the open market and help influence a given installation's positive business case.

California Electric Vehicle Infrastructure Project (CALeVIP) provides varying regional funding for infrastructure based on Level 2 or DCFC charging and venue types. More than $17 million was provided in the initial round of program funding. SANDAG and the San Diego County Air Pollution Control district partnered to bring this California Energy Commission program to the San Diego region as the San Diego County Incentive Project A total of $21.7 million will be provided for the first 3 years of the program, with $16 million coming from CEC.

SDG&E recently has begun their **Emergency Load Reduction Program (ELRP)** that includes electric vehicle charging infrastructure. The program provides incentives which pay out for energy avoided as compared to normal on high-load days. Some EVSPs are developing systems that take advantage of this program. Allowing flexibly controlled charging accounting for renewable energy, can also support the increased LCFS credits.

SDG&E is beginning their **Power Your Drive 2.0 Program** (PYD 2.0) to provide charging at workplaces and MUDs. Construction costs up to and in some cases including the Level 2 charging station are covered by the utility as well as the design costs. This requires a new dedicated utility account which depending on the host organization's goals, should be considered.

Upcoming capital projects by local municipalities are opportunities to incorporate EV charging make-ready at lower cost than as stand-alone work. This can help minimize redundant work, such as through trenching through paved areas and prepare for future increases in EV demand with make-ready preparation.

Existing Public Procurement Contracts

Once an agency has considered its charging needs, it will need to procure equipment or a vendor that can meet those needs. The project team reviewed and analyzed existing Sourcewell[4] and California Department of General Services[5] public contracts for EV charging. The goal of this task was to ascertain typical technical specifications and contracting terms to aid in the development of an EV service provider bench solicitation that could be used by public agencies in the region.

The project team reviewed approximately 18 active and expired contracts. Fourteen contracts are current, with expiration dates between July 2022 and July 2025 and 4 expired in 2017 or 2018. A matrix of data culled from these contracts, along with the associated contracting documents, is included under appendix B.

AC Level 2 chargers and DC fast chargers (DCFCs, sometimes known as Level 3 chargers) are the most common charger types available through the contracts; only one current contract includes AC Level 1 chargers. Of the expired contracts, two covered AC Level 1 and Level 2 chargers and two covered only Level 2. From this, it appears that there is a trend away from Level 1 chargers, though whether this stems from supply-side (fewer vendors offering Level 1 chargers) or demand-side (those seeking Level 1 simply installing 120 VAC electrical outlets) decisions and preferences is difficult to parse with the available information. Level 1 charging may reduce the cost of capital to get a site operational as the hardware is included with each new electric vehicle and the low power minimizes the size of electrical equipment such as transformers. Their slow charging may create higher asset utilization in terms of the percentage of time plugged-in where active charging is taking place. Their application is best for longer dwell parking like workplaces or transit park and rides, as well as overnight, which could support nearby MUD.

[4] Sourcewell is a Minnesota government agency serving public agencies nationwide. It holds hundreds of cooperative contracts in a wide range of sectors from administrative services to fleets. The organization conducts competitive solicitations and then allows members to purchase from these contracts through local dealers.

[5] The California Department of General Services (DGS) acts as the business manager for the state. Their Leveraged Procurement Agreements (LPAs) allow state agencies, counties, cities, education departments, and other government entities to purchase directly from suppliers using existing contracts and agreements.

Of the 14 current contracts, six require equipment to be networked, three (the DGS contracts) require equipment to be network-ready, and five allow either networked or non-networked equipment. All use and require Open Charge Point Protocol [6] (OCPP). While all contracts include 1-to-3-year warranty terms, none of the Sourcewell contracts include details on maintenance requirements beyond outlining the process vendors use to respond to maintenance requests. In contrast, the DGS contracts do require one maintenance service during the first year of the warranty period and stipulate that the vendor is required to repair equipment damaged by external causes.

Vendors offer a broad range of discounts below MSRP via the Sourcewell and DGS contracts. The discounts ranged from 0–50% with an average of approximately 11%. Some vendors offered discounts based on the volume purchased, and one offered free project consultations and software integration as part of their agreement. The vendors pay the contracting agency—Sourcewell or DGS—1-3% of the sales revenue they obtain through the contract; the average is 1.5%. Some agencies report receiving lower prices through their own competitive procurement; however, potential savings should be weighed against the expense of running an individual procurement.

Sourcewell requires the vendor to assign an Account Representative to streamline communications. The DGS contracts do not specify the need for an Account Representative but do outline several reports that must be submitted on an annual basis providing information on energy consumption, station location and utilization information, and revenue collection, as well as other information that can help information decision making.

Table 7: Comparison of Contract Terms

Contract Type	Number of Contracts Reviewed	Payment to Agency/Municipality	Maintenance and Warranty
Active	14	Average 1.66% of sales	1 –3-year parts and labor warranty
Expired	4	Average 1% of sales	1-year parts and labor warranty
Other	3	Other	Maintenance expected

Public 3rd Party Operator Contracts

The above contracts all represent instances where a public agency is responsible for the procurement of charging equipment and/or network services. In these cases, while there are warranties and maintenance stipulations in place, the agency is ultimately responsible for management and takes ownership of the equipment once installed. The project team also reviewed three existing and upcoming cases in which the supplier will retain ownership of the equipment and will be responsible for its management—Riverside (Tesla), Encinitas (EVgo), and San Francisco Municipal Transportation Agency (to be determined).

The Riverside Tesla Supercharger station is currently operational; the Encinitas stations were discussed at a city council meeting in October 2021 but has not yet commenced; and the SFMTA has not released the awards for the related RFP that closed in October 2021. Further details on these municipal agreements and plans can also be found in the matrix provided in Appendix B.

[6] About Open Charge Alliance, https://www.openchargealliance.org/about-us/about/

The SFMTA RFP made no mention of required charging levels but did require that chargers be available for all connector types. Encinitas required DCFCs be installed, and the Riverside station makes use of the Tesla Superchargers which provides DCFC (but only to Tesla drivers). Since the vendors retain ownership of the equipment, they remain responsible for maintenance and repairs. The SFMTA RFP includes strict requirements for responding to repair requests, and both SFMTA and Riverside require the vendor assign an Account Representative.

In two of the three cases mentioned above, the vendor pays the public agency to install their equipment on public property. It appears that Tesla does not directly pay for use of Riverside's parking spaces but instead contributes through the electricity revenue from the City's municipal utility. Additionally, Riverside views the charging as an economic development action to attract more visitors to their downtown area. Although Tesla Superchargers are not compatible with other brands of EVs, Tesla makes up more than half of the BEV market. Locally, the City of San Marcos hosts Tesla Superchargers under similar terms.

EVgo is contracted to pay the City of Encinitas a flat fee for use of 6 public parking spaces, with a 3% increase annually for the life of the agreement. As outlined in the SFMTA RFP, the vendor will pay a base rent per parking space, with an annual increase, for the first three years of the agreement. In addition to the base rent, beginning in year four the vendor will establish a percentage rent calculated using the previous month's sales; potential vendors included their initial percent rent offer as a part of their proposal to SFMTA.

4. Review Contracting Options

Operational Models

Tables 8, below, review the range of potential operating models that have been deployed by public agencies in the region and evaluates their associated costs, payment processing and their unique benefits and challenges. The operating models below are roughly arranged from where the public agency has the most responsibility to the least responsibility. Rather than selecting a specific operating model, most agencies have been driven by grant and incentive programs terms. A future procurement would allow agencies more opportunity to select an operating model and vendor that works for them.

Table 8: Operational Models

Operational Model	Capital Costs	Network Costs	Payment Processing	Benefits	Challenges
Agency Owner / Operator	Part of City CIPs	Paid by City	Network takes small percentage	Host fully controls pricing	More costly to City unless securing external funds
Agency Owner / EVSP Operator with Revenue Share	Shared	Lower cost to site host	Higher overall % take of revenue by network	Partnership encourages high utilization designs, regular reporting, marketing	Record-keeping transparency Higher electricity cost to end user
Agency Make-Ready / Turn-Key Operator	Site host builds make-ready by grant or Utility funded. EVSP provides equipment.	Limited cost to host	Typically covered by the operator	Host may be able to influence retail prices to encourage EV adoption	Coordination of construction from potentially two entities (to and from the meter). Vendor may be less interested if unable to see hardware charge for network fees
Utility Make-Ready / Agency Operator	Limited to purchase and installation of hardware	Negotiable by host	Negotiable by host	Host has more control	Utility easements and influence over location, minimum ports required.
Utility Owner / Operator	Utility / rate payers	Paid by utility	No influence	Little host responsibility (Cost, etc.) or influence	5-10 year easement, potentially uncompetitive electric pricing compared to gasoline
EVSP Owner / Operator with Public Site Lease	None to site host	None to site host	Expect none to site host	Limited responsibility, low or no cost to site host	5-10 year lease with renewal options, issues with public contracting rules (RFP required, private activity on public land), potentially uncompetitive electric pricing compared to gasoline

Key Considerations and Challenges

Given the complexity of operating EV charging to achieve operational cost recovery, many agencies may consider third-party options. However, public agencies should be careful in selecting a partner and ensure contract terms offer enough safeguards to ensure a good charging experience for the end users, while limiting risk to the agency.

Although third-party operators have been willing to participate when capital costs can be covered by grants (e.g. CALeVIP), settlements (e.g. NRG-EVgo, VW-Electrify America), or utility investment (e.g. PYD), it is not clear that many operators will offer charging when they have to pay the full costs of installation. Third-party operators may also be opposed to taking on the full risk of operations—this is especially true in areas that represent lower income or rural areas where high utilization may not be excepted. Operating charging may be less profitable in these areas but is critical to have widely distributed and available charging to achieve equity goals and mandates.

Many charging station operators will want an agency, at minimum, to cover a monthly networking fee if charging revenue does not exceed fixed costs. The availability of LCFS credits can help make the economics of charging work, especially at higher usage sites, therefore any agreement should clearly demarcate ownership of those credits.

Many jurisdictions installed charging for employees through SDG&E's PYD program. Under PYD, the utility owns the equipment and covers all networking fees. Future SDG&E programs may not have the option for full utility ownership and operation of charging stations per CPUC direction. Public agencies will need to evaluate what level of operations are available and appropriate when participating in these programs.

The utility metering arrangement may also influence the choice of operating model. Installing charging on a meter separate from other loads allows a third-party operator to be the customer of record and receive the bills directly from the utility. A separate meter also gives the customer of record the flexibility to select special EV-only rates or whatever tariff is most ideal given the energy demand. The principal downside to separate metering is it inhibits the ability to integrate EV charging with building energy loads or onsite renewables that can serve both loads.

Whatever the operational model, EV charging needs to be functional both to recover costs and to maintain consumer confidence in charging availability It is also important to ensure funds are reserved or accounted for to cover maintenance beyond the service contract and any costs for removal or replacement of equipment once it is no longer functional.

Table 9: Comparison of Ownership Models

Ownership Model	Benefits	Challenges
Agency Operated	> Agency maintains total control (e.g. can set pricing, parking rules, etc.) > Potential for revenue (e.g. can attempt to lower end user costs instead of making profit)	> More risk, agency is responsible for fixed fees if revenue does not cover > May require expertise/capacity not available in current agency staff.
Third Party	> Places operating risks on vendor > Vendor should be motivated to keep equipment operational > Agency can refer public inquiries/ issues to vendor	> Control is dependent on original contracting language. > Agency may have more limited enforcement options if vendor/equipment is unreliable. > Vendors may not be interested in lower usage sites. > Vendors may want to charge high end user fees.

5. Technical Specifications Supporting Future Procurement

Table 10, below, lists common specifications included in procurements of EV charging equipment and/or services. Procurements have the flexibility to consider multiple situations including one for a turnkey operator and another that covers equipment software and maintenance needs where the public agency is responsible for the charging assets.

Table 10: Specifications for Inclusion in Procurements of EV Charging Equipment and/or Services

	Description	Considerations
Equipment Type	> Plug type & physical hardware Requirements	> J1772 for Level 2 – supports all vehicles on the road today > CSS is the most widely accepted DC standard, however many legacy vehicles are on the road, so sites should include at least 1 Chademo Port. > Tesla Superchargers are only compatible with Tesla Vehicles. > Power level
Billing Standards	> Payment methods and collection process	> Should meet California's open access standards, and accept multi forms of payment > Electric Vehicle Supply Equipment (EVSE) Standards | California Air Resources Board > Consider the processing fees. standalone fee or bundled with other network fees?
Hardware/ Software Standards	> Industry certifications	> NRTL Certification > OCCP compliant hardware and software give more flexibility to change vendors in the future. > OCCP 2+ incorporates ISO15118. This enables vehicle to charger communication for payment and energy management > Open ADR for participation in utility demand response programs
Maintenance and Service Requirements	> Warranty length and services > Uptime requirements	> Parts and labor terms > Performance specifications (in turnkey contract) vs maintenance and service contracted separately > What does the warranty requirements add to the price per kwh vs separate budget for occasional repairs
Lifespan of Infrastructure/ Replacement or Renewals	> Expected operating life of equipment > Regular schedule for replacement	> Underlying electric infrastructure can last decades, but the lifespan of public charging equipment is generally in the 5–10-year range > In a turnkey contract, could specify that equipment be replaced at time of contract renewal or removed at the cost to the provider.
Communications Requirements	> Methods of connectivity for billing, usage data, and diagnostics	> Reliable communications connection is needed > Cellular, Wi-Fi, Ethernet, > Cellular modems do add to ongoing costs.

	Description	Considerations
Reporting Requirements	> Data that network or station operators must make available.	> In both ownership and 3rd party scenarios, networks should provide access to charging data to support management and reporting. > Report for compliance with any grant program terms
Parking/ Charging Layout	> Number and layout of spaces being made available for charging	> Identify specific spaces or general area available for charging. > Support charger placement that allows cord to reach multiple parking spaces. > Accessibility requirements > Lightening and safety considerations

6. Conclusion

Public agencies will play a key role in providing EV charging infrastructure throughout the region in order to meet more than 100,000 shared/public charging ports called for in the *Accelerate to Zero Gap Analysis*. In order to play the key role, these agencies will need to be prepared to consider the following key factors based on the dozen current (or past) contracts assessed.

Key Factors

Siting

- Public Parcels – The region currently has more than 1,100 public parcels without nearby access to public charging.
- LIC and DAC prioritization – Prioritizing EV chargers on public parcels within these communities will help agencies achieve local equity goals and obtain grants to support charger installation.
- Multi-market locations (e.g. transit centers) – EV infrastructure installed at such locations will support regional goals of maximizing electric vehicle miles traveled while reducing overall VMT.

Cost of Deployment (Fixed/Capital) and O&M

- Cost to Agencies
  - Capital Costs for charging can often be covered by grants and/or incorporated into new development or on-going capital improvement programs.
  - Operational costs can be covered by balancing factors such as fee structure (to maximize revenue), parking management (to maximize utilization), and energy management (to minimize utility costs).
- Cost to Users
  - Minimizing overhead costs allows agencies to either operate profitably or offer lower charging fees to be revenue neutral.
  - Offering revenue neutral low charging fees is likely to encourage EV adoption and use, particularly in DAC and LIC locations where low-cost options are less available.

Management of Charger Assets towards Performance

- Staffing for Management/Oversight vs. Direct Operation
  - Agency-owned and operated EV chargers enables more control of the infrastructure though agencies often lack the staff and experience to effectively take advantage of the control.
  - Agencies must carefully consider services and fee structure of their EVSP and ensure contracts consider on-going service, maintenance, and end of life.
- Maintaining Charger Availability to Build and Preserve Consumer Confidence
  - Regardless of the operation model, all EV charging infrastructure must be kept in working order to recover costs and maintain consumer confidence in charging availability.
  - Agencies must reserve funds or account for maintenance costs beyond the service contract and any costs associated with the removal or replacement of equipment once it is no longer functional.

Acronym Reference

- ADR – Automated Demand Response
- AFDC – U.S. Department of Energy's Alternative Fuels Data Center
- BEV – Battery Electric Vehicle
- CALeVIP – California Electric Vehicle Infrastructure Program
- CCS – Combined Charging System
- CEC – California Energy Commission
- CIP – Capital Improvement Program
- CPUC – California Public Utilities Commission
- DAC – Disadvantaged Community
- DC – Direct Current
- DCFC – Direct Current Fast Charging
- DGS – California Department of General Services
- ELRP – Emergency Load Reduction Program
- EV – Electric Vehicle
- EVSE – Electric Vehicle Supply Equipment
- EVSP – Electric Vehicle Service Provider
- kW – Kilowatt
- kWh – Kilowatt Hour
- L1 – Level 1 Charging
- L2 – Level 2 Charging
- LCFS – Low Carbon Fuel Standard
- LIC – Low-Income Community
- MPG – Miles per Gallon
- MUD – Multi-Unit Dwellings
- MWh – Megawatt Hour
- NCTD – North County Transit District
- NRTL – Nationally Recognized Testing Laboratories
- OPCC – Open Charge Point Protocol
- PYD – Power Your Drive
- PYD 1.0 – Power Your Drive 1.0 Program
- PYD 2.0 – Power Your Drive 2.0 Program
- RFP – Request for Proposal
- SANDAG – San Diego Association of Governments
- SUV – Sports Utility Vehicle
- SDG&E – San Diego Gas and Electric
- SFMTA – San Francisco Municipal Transportation Agency
- TNC – Transportation Network Company
- VAC – Volts Alternating Current