Ready, Set, Charge, California!

A Guide to EV-Ready Communities

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Disclaimer

The Association of Bay Area Governments (ABAG), EV Communities Alliance, the Bay Area Climate Collaborative, LightMoves Consulting, and Clean Fuel Connection prepared these guidelines with funding received from the Reformulated Gas (RFG) Settlement Fund to guide California jurisdictions in the development of EV ready communities, and to provide a consistent framework for the deployment of electric vehicle (EV) infrastructure.

These guidelines have been prepared at a time when EV-related laws, regulations, and industry practices are undergoing rapid change. As a result, California local governments and the organizations that serve them must strive to continuously update their knowledge regarding industry, consumer, utility, and state and federal government expectations and requirements for the deployment of EV infrastructure. These guidelines are intended to assist public agencies throughout California to advance community EV readiness. However, they do not represent a definitive legal framework for the installation of public and private charging infrastructure.

Neither the sponsoring organizations of the *Ready, Set, Charge, Guidelines*, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed within this document. Local agencies may or may not adopt similar methods of EV infrastructure installation and operations. The views and opinions of authors expressed herein do not necessarily state or reflect those of the organizations who developed the document.

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Section 1 Introduction

Historians of the future are likely to look back on 2011-12 as "tipping point" years – the moment in time when mass-market electric vehicles (EVs) first began to overturn the century-long dominance of oil and the internal combustion engine. Throughout the United States, and throughout the globe, EVs are increasingly recognized as a core strategy for achieving energy security, reducing greenhouse gases, improving air quality, and limiting the long-term cost of personal mobility. Communities in California have the opportunity to make their mark in this pioneering phase of the "EV era" – and these Guidelines will help your California community become "EV ready."

1.1 Document Purpose

The Purpose of These Guidelines: The *Ready, Set, Charge, California! - Guide to EV-Ready Communities* is intended to support both the quantitative national EV goals announced by President Obama (deployment of 1 million EVs by 2015, which corresponds to ~200,000 EVs in California) -- and the qualitative state goals articulated by the California PEV Collaborative. The PEV Collaborative goals (for the year 2020) include the following:

1. Consumer experiences with PEVs are overwhelmingly positive
2. Ownership costs of PEVs are competitive with conventional vehicles
3. PEV charging integrates smoothly into an increasingly clean, efficient reliable, and safe electricity grid
4. PEVs advance energy security, air quality, climate change, and public health goals
5. Early strategic action creates jobs and economic benefits in California
6. The PEV market moves beyond early adopters to mainstream consumers

The Audience for These Guidelines: To achieve these goals, the *Ready, Set, Charge, California Guidelines* will address the full spectrum of EV-related issues from the perspective of regional and local policy-makers, industry and community leaders, and on-the-ground practitioners in the fields of transportation and community planning, climate and sustainability, energy systems and utility operations, buildings and facilities, parking and traffic, public works, and fleet management. All these disciplines and more will need to be engaged at both the senior management and staff level if California is truly to become a global EV leader.

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This guide will cover a broad spectrum of EV readiness issues, including high-level policies to encourage EV deployment at the regional level, and local issues regarding EV infrastructure deployment, including siting, signage, and access issues.

1.2 Introduction to EVs

While it is too early to predict how quickly California consumers will embrace the Electric Vehicle. With so much depending on the cost of gasoline, the overall state of the economy, and the pace of technology development– it is clear that there is much that regional organizations, counties, cities, and business and community leaders can do by *working together* to accelerate the mass adoption of EVs. The key to this process of acceleration can be found in the concept of the "EV ecosystem."

1.2.1 Overview of EV Ecosystems

The basic idea behind the "EV ecosystem" is that – unlike other vehicles – EV purchase decisions will not be made only on the basis of how much a particular EV model costs, how it looks, and how it performs. Rather, EV purchase decisions will also be significantly influenced by the answer to this question: "Is my community, my region, and my state truly "EV-ready?" To answer that question, consumers will be looking at issues such as:

- How many EV chargers are there in the public domain?
- How easy are they to use?
- How fast do they charge?
- How much do they cost?
- Is it easy to get a residential EV charger installed in my garage?
- How will I charge if live in an apartment or condominium?
- Will I get any kind of driving privileges by driving an EV – such as cheaper parking, toll discounts, or HOV lane access?
- Is my community actively celebrating the environmental and economic benefits of EVs – am I part of the "next big thing"?

Thus, the "EV ecosystem" is much more than just electric cars and chargers – it includes EV-friendly policies, incentives, and communications that inform the total EV customer experience.

1.2.2 Core EV Technologies

Electric Vehicles (EVs) consist of two principal variations. Pure "all-electric" Battery Electric Vehicles (BEVs) are exclusively powered by electric motors, while Plug-in Hybrid Electric Vehicles (PHEVs) combine a plug-in electric motor and a gas-powered motor or engine. Accordingly, BEVs and PHEVs have very different performance parameters, both within and between their respective automotive categories. For example, the 2011 GM Volt PHEV has an estimated all-electric range

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of 40 miles before the gas engine takes over, while the upcoming Toyota Prius PHEV is likely to have an all-electric range of ~12 miles. In the BEV category, the entry-level Nissan Leaf has an electric range of 70-100 miles, while the high-end Tesla Roadster has an all-electric range of more than 200 miles.

EVs also include low speed vehicles or neighborhood electric vehicles (NEVs), which are small, lightweight vehicles limited to roads with posted speed limits of 25 miles per hour or less, such as college and corporate campuses, downtown shopping areas, or retirement communities.

Vehicle range for BEVs varies significantly depending on driving conditions. Factors include speed, traffic, payload, rates of acceleration, hills, temperature, and use of heating and air conditioning equipment will significantly impact driving range. For example, the range of the Nissan Leaf BEV is nominally defined as 100 miles, but driver reports indicate that real-world mileage can be as low as 50 miles with unfavorable conditions (stop and go driving in extreme heat, for example) or as high as 135 miles, with steady freeway driving at moderate speeds. Higher-capacity batteries of up to 300 miles are expected to enter the market in late 2012 with the release of the Tesla Model S. However, these batteries will likely be relatively costly. In the 2015-2020 period, new battery architectures may permit batteries in the 300-500 mile range, while costs per kWh are expected to decline steadily.

The limited all-electric range of BEVs can create "range anxiety" – concern regarding the vehicle's capability to get users where they need to go. In response to range limits, vehicle manufacturers are working on a number of strategies. For shorter-range BEVs, some manufacturers are intentionally targeting the second-car owner in a household. Others (such as Peugeot) are bundling rental services for conventional vehicles, so that transportation is sold as a service, with gas-powered SUVs available for long-distance trips with the family. In some international markets, the EV services company known as Better Place is working to market "swappable" batteries enabling BEV owners to switch out depleted batteries for fully charged batteries in just two or three minutes. The San Francisco Bay Area's Metropolitan Transportation Commission (MTC) is developing a pilot test for "battery-switch" taxis to demonstrate this technology for possible mass deployment in California.

Another key response to the range anxiety challenge is widespread deployment of Fast Chargers – which can "fuel up" a nearly depleted Nissan Leaf battery in approximately 20 minutes (or provide almost 50 miles of additional range in approximately 10 minutes.) In the Bay Area, communities are working to deploy more than 100 Fast Chargers throughout the region to ensure BEV owners that a Fast Charger will always be available anywhere in the nine-county region.

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1.2.3 Significance of EVs for environmental, economic and community benefit

As local leaders engage the challenge of EV-ready community development, it will quickly become clear that this will be a long-term effort with significant costs *and* opportunities. To provide a context for informed investment decision-making, it is critical to understand what is at stake in the EV transition. The most obvious benefit of EVs is dramatically reduced emissions. Taking into account the emissions caused in the production, transport, and utilization of gasoline vs. California's electrical power, the emissions of EVs are estimated by the California Air Resources Board to be in the range of 78% lower[1] than the average internal combustion engine vehicle, and substantially less than even the cleanest regular hybrids.

The emissions advantage of EVs in turn translates into both reduced greenhouse gases – the principal catalyst of global warming – and the reduction in the "criteria pollutants" that are responsible for thousands of premature deaths in California, and the serious epidemic of asthma.[2] In addition, the reduction of foreign oil consumption facilitated by EV adoption will boost American energy independence, enhance national security, and increase job creation.

The long-range outlook for oil indicates that *exportable* supplies are under intense pressure due to growing demand within key exporting countries, declining productivity of existing oil fields, and a growing gap between newly discovered resources and rising demand in China, India, and other rapidly industrializing countries. These trends are likely to cause the price of gasoline to continue to rise over the long term. Within California, consumers, business, and government are spending nearly *$60 billion annually*[3] on imported gasoline, much of which is imported from potentially unstable regimes in the Middle East. Mass adoption of EVs will help to "re-localize" these fuel investments, with significant "multiplier" effects as consumers reinvest their "gas money" in our local economies.

1.2.4 Market Adoption

There is a broad array of factors that will significantly influence mass EV adoption. Gas prices, technology developments, and macro-economic conditions are among the most important variables, and these are largely outside the control of local authorities. However, many other market drivers can be influenced by local and regional action through policies and incentives. By aligning regional initiatives with state and national efforts, local stakeholders can help set and achieve their own regional goals for EV adoption.

The forecasts below[4] are rough estimates of EV penetration, based on a wide range of future scenarios. The low-range estimates assume that EVs will continue to

[1] CARB citation
[2] Citation
[3] Citation
[4] Citation

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command a significant initial price premium, that governments will limit subsidies, and that gas price increases will be moderate. The mid-level scenario assumes ongoing incentives for purchase of vehicles and charging. The high penetration scenario assumes significant consumer interest, rapid EV cost reductions, significant government subsidies, and a major increase in gasoline prices.

Scenario	Annual Sales		Vehicle Population	
	no.	percent	no.	percent
low	115,000	8.8%	560,000	2.3%
moderate	250,000	19.2%	1,250,000	5.1%
high	500,000	38.5%	2,500,000	10.2%

1.3 EV Policy

At this early stage in the electrification of transportation, it is not clear what kind of entity – if any *single* entity – will be "in charge" of EV charging infrastructure in local California communities, or who will drive the full range of EV ecosystem policies. However, regions that wish to accelerate EV adoption are well advised to take a pro-active approach to stakeholder role clarification and strategic policy alignment, as discussed below.

1.3.1 Stakeholder Roles

Many local leaders throughout California are discovering that EV-friendly policies are best deployed on a region-wide basis to achieve the positive customer experience that is so important in these early days of the "EV era." The importance of the regional approach is readily apparent in the case of charger deployment. If market forces alone dictate the EV charger siting process, then the "EV ecosystem" may suffer from over-building in some areas, and the absence of critically needed infrastructure in others. The key to addressing these potential imbalances lies in the development of an effective multi-stakeholder coalition to help guide EV ecosystem development on a region-wide basis.

Metro areas that seek to establish a leadership position have begun to establish cross-sector EV councils. These include the San Diego EV Project, SoCal EV, the San Francisco Bay Area EV Strategic Council, and the Monterey Bay EV Alliance, among others. Some of these regions, notably San Diego and the Bay Area, have been successful in attracting substantial funds from outside the region (primarily state and federal grants) – which in turn are leveraging substantial local public and private resources.

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In the Bay Area, participants in the EV Strategic Council have characterized their collaboration as a "venture lab" to develop "game-changing" innovations most likely to foster mass EV adoption. In keeping with this vision, most of the work of the Council is to be carried out in ad hoc project teams focused on pro-EV policies, aggregate purchasing, EV charger network development, and other areas.

1.3.2 EV policy coordination and alignment

The multiplicity of EV-related funding sources, and the autonomy of key actors, poses challenges for EV ecosystem strategy alignment. With little prior experience to guide policy makers, many stakeholders are grappling with tough questions regarding resource allocation, charging technology; installation streamlining; local incentives, and much more. What is clear is that a *combination* of pro-EV strategies, linked to strong outreach and messaging, is most likely to shift the EV adoption curve and strengthen the economic and energy security of California communities. In Section 2 below, we will discuss the diversity of EV ecosystem strategies, and the many roles that local governments can play in their advancement.

Once EV strategies are adopted at the senior leadership level, regional and local agencies – including transportation and air quality agencies, counties and cities, and private and nonprofit partners -- will need to work together to advance them. Within cities and counties, this will likely involve the establishment of an EV Working Group that brings together staff from planning and building departments (to address EV-friendly building and zoning codes, for example), public works (to address electrical infrastructure, signage, parking facilities, etc.), transportation agencies (to address siting of infrastructure, access to relevant funds, etc.), and sustainability and climate-related staff (to ensure that accelerated EV adoption strategies are included in climate action plans.)

Comment: *Appendix X includes a listing of leading regional EV initiatives domestically and internationally. These range from ubiquitous EV car sharing networks (Paris), to reduced congestion and parking charges for EVs in center cities (London), to massive EV bike and scooter deployments (Beijing). Local leaders may find that a review of these initiatives can inspire local experimentation and "outside the box" thinking.*

Comment [WU1]: Still being developed

Section 2 EV-Ready Community Policies, Actions, and Incentives

Across the United States, local governments have evolved a broad array of EV-friendly policies, actions, and incentives suitable for incorporation into General Plans and Climate Action Plans. Incorporation of program-level guidance in support of widespread EV adoption is a crucial initial step for local governments, which will help establish the policy framework for subsequent adoption of implementing ordinances.

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2.1 EV-Friendly Policy Best Practices

There is an ever-expanding menu of EV-readiness policies, actions, and incentives available to local governments. The following examples are meant to be illustrative rather than comprehensive. This summary includes programmatic guidance at the level of both internal and community-wide programs, policies, and incentives.

Internal Programs, Policies and Incentives

Fleets: Government agencies are discovering the environmental, fiscal, and community relations benefits of utilizing alternative fuel vehicles (AFVs), especially EVs. Many agencies have set targets for fleet conversions, and have adopted "clean vehicle" policies that guide the decision-making process on all new vehicle acquisitions or conversions of existing vehicles to electric operation. Policy support for public charging stations that accommodate fleet use and installation of solar systems at fleet parking facilities are highly visible ways to communicate local government commitment to reducing greenhouse gas emissions and increasing use of renewable energy.

Recommendation: Public agency administrations should shape and introduce public policy for local elected officials to adopt calling for public fleets to be powered by EVs and sustainable alternative fuels.

Example Policy: Achieve a 100% alternative fuel vehicle public fleet by 2025.

Example Action: Replace 10% of the agency's public vehicle fleet with alternative fuel vehicles annually. For vehicles not ready for replacement, develop a program for conversion to plug-in operation and partial alternative fuels, such as hybrid conversions to PHEVs, or use of bio-diesel as an alternative to diesel.

Renewable Energy: Local agencies across America are also installing renewable energy facilities, such as solar PV, wind generators, and waste-to-energy systems. Linking the installation of renewable energy applications to those locations where electric vehicles will be parked for long periods of time will further reduce the carbon footprint of EVs. For example, in its Climate Action Plan, the City of Fremont has assessed the potential for solar carports at its police station[5].

Recommendation: Public agency administrations should introduce public policy for local officials to adopt that will result in the construction of renewable energy systems on public sites where electric fueled fleet vehicles are parked, such as solar carports and roof top solar panels on garages.

[5]Fremont Climate Action Plan Part M5: http://www.fremont.gov/DocumentView.aspx?DID=4163

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Example Policy: Install renewable solar systems at fleet parking facilities where the greatest number of electric vehicles will be parked.

Example Action: Install a 1MW solar system at a municipal corporation yard.

Capital Improvement Programs: EV readiness should be a part of every project design review process. To accelerate EV readiness, local governments should consider changing design guidelines, standard drawings, specifications and details for qualifying public works infrastructure projects, which will allow for lower cost readiness improvements, such as conduit placement, junction box installations, and electric panel sizing. Berkeley California's plan to work with Bay Area Rapid Transport (BART) to plan for and provide electric charging infrastructure at new and existing stations is an example of planning for EV readiness[6].

Recommendation: Local agency engineering and planning staffs should modernize their standard plans, details and specifications for public infrastructure projects to accommodate future energy-related improvements, including the installation of EV charging stations.

Example Policy: Encourage the installation of low cost EV Readiness infrastructure as a component of Capital Improvement Projects.

Example Action: Update design guidelines, standard drawings, specifications and details for qualifying public works infrastructure projects to facilitate the installation of EV readiness infrastructure.

Example Action: Install a second electrical conduit in trenches with street light conduits on blocks where EV charging stations are planned to be installed.

Franchise Agreements with Utilities: Cities and counties have franchise agreements with utility companies, which allow right of entry into public rights-of-way. Local public works and planning staffs should advise electrical utility companies where new public charging systems are being planned so that upgraded energy storage, local distributed generation, facility energy management solutions, or electrical supply infrastructure can be incorporated into utility service plans.

Recommendation: Local agency public works staff should initiate procedures or franchise agreement amendments to accommodate planned EV infrastructure installations.

[6] Berkeley General Plan, Transportation Element. Policy T-2.B.2
http://www.ci.berkeley.ca.us/contentdisplay.aspx?id=498

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Example Policy: Encourage utility companies to incorporate energy supply infrastructure and system improvements into their utility services plans.

Example Action: At a public agency parking lot planned for extensive EV charging facilities, public works officials collaborate with local utility companies to accommodate renewable energy and energy storage back-up systems on agency property.

Taxi Regulations: Vehicles in taxi fleets accumulate mileage at a very high rate, generally in excess of 50,000 miles annually[7]. Oversight of taxi regulations are provided by local and state agencies to ensure that the vehicles are in clean, safe, and customer friendly operating conditions. Permitting agencies, often cities or counties, can adopt policies to expand their regulatory powers and permitting rules to create incentives for taxi companies and private owners to purchase plug-in hybrid electric or all electric vehicles.

An assortment of incentives can be provided to taxi companies to encourage purchase of EVs. These range from lowered permitting costs, inspection changes, preferred route and zone selection, airport and destination center access, and staging area advantages. For example, the City of San Francisco permits certain AFV taxi drivers one "front of the line" trip per driver, per shift as an incentive to use alternative fuel vehicles. In another example, drivers of AFV taxis in San Jose get additional service opportunities at the San Jose International Airport.

Recommendation: Local agencies responsible for permitting and regulatory oversight of taxis should develop a suite of incentives for companies that choose to buy and operate electric vehicles.

Example Policy: Encourage the use of EVs in taxi fleets.

Example Action: The City shall offer incentives to taxi fleets who utilize EVs, including passenger pick-up priority.

Community-wide Programs, Policies and Incentives

Charging Station Siting Plans: In many of the metropolitan regions where grant funds for EV charging equipment have been awarded, stakeholder teams have been formed to develop regional charger siting plans. These take into account a range of relevant factors. For example, the recently completed *Puget Sound Regional Siting Analysis* addresses site visibility and exposure, EV driving ranges, locations with high hybrid/EV ownership or interest, high volume destinations, dwell time, and

[7] http://www.greencar.com/articles/natural-gas-vehicles-burn-cleaner-cheaper.php/

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parking supply[8]. The importance of these siting plans cannot be underestimated at this stage of EV market development. Driving an EV at the dawn of the EV era is the equivalent to driving a gasoline-powered car in the early 20th century – when drivers had no assurance regarding local gas availability.

As a "force multiplier" for EV charger deployment, ample directional signage should be included to inform motorists of the location and type of charging equipment. In some localities, some initial signage already exists. In the 1990's, hundreds of street and freeway signs were installed in Southern California to direct drivers to EV charging stations.

All charging station siting plans must take into account the impact of on-peak daytime charging on the utility grid and the cost to operate plug-in vehicles. For example, public and workplace charging should be priced to encourage charging in the morning or evening based on the local utility rate structures.

Recommendation: Working through a regional planning agency, local agencies and other stakeholders should create 3- to 5-year short range public charging station siting plans. Information on every public charging station should be shared and easily disseminated through social media.

Example Policy: Encourage the development of Regional Siting Plans for EV infrastructure.

Example Action: Develop a City-wide public EV Charging Station Siting Plan by 2015 in coordination with County and regional EV Siting Plan development.

Parking and Charging Incentives: A range of parking incentives has been established in some jurisdictions for low-emission vehicles. As hybrid vehicles have now become fairly common place, agencies should consider shifting from hybrid to PEV incentives. In particular, incentives may be needed to accelerate EV charger deployment in public parking areas. On-street parking spaces in urban cores normally are priced higher than off-street facilities to encourage shorter term use, and improve customer access to fronting businesses. The same type of pricing structure could apply to on-street charging and off-street charging facilities. For example, the City of San Jose's Clean Air Vehicle Parking Program allows free parking for qualifying vehicles at city owned garages, regional parks and on street spaces in the downtown core[9].

[8] Puget Sound Regional Council, Regional Station Siting Analysis.
http://psrc.org/assets/4144/Station_siting_July2010.pdf
[9] http://www.sjdowntownparking.com/clean_air.html

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Recommendation: Local agencies should adopt policies and enabling ordinances that allow for charging or parking incentives for electric vehicles, and to regulate their use, as well as establish penalties for the misuse of charging station equipment.

Example Policy: Incentivize the use of electric vehicles by providing incentives for zero-emission vehicles including free or reduced priced parking, and minimal charging fees.

Example Action: Adopt an enabling ordinance authorizing free parking for electric vehicles within the established days and hours of operation in the downtown core by January 01, 2012 and to expire in two years unless extended by an action of the elected body.

Minimum Parking Requirements: Local regulations can be established to reduce parking requirements for private development when substantial numbers of EV charging stations are installed. This concept could be expanded upon significantly in downtown core areas or near job centers where new housing developments could rely on both car-sharing programs and on sharing of workplace parking facilities for nighttime and weekend use. Developers making arrangements for EV car-share parking on-site could receive even greater reductions in required parking.

Recommendation: Local agencies should explore a range of incentives that result in reduced parking requirements where significant investments for EV charging stations and/or EV car-sharing agreements are being implemented.

Example Policy: Incentivize the installation of EV charging infrastructure in new developments through reduced parking requirements for development projects providing EV charging stations.

Example Action: Reduce on-site parking requirements for new developments by five percent for every ten EV charging stations provided.

Section 3 Model Development Regulations and Guidance

The automotive industry, EV supply equipment (EVSE) manufacturers, and government agencies have been working together to establish common standards for communications, connections, and electrical systems for EV chargers. This is resulting in a uniform approach to charging connections, centered on the "J1772" universal connector standard. However, there is a need for corresponding harmonization of EV charger installation, permitting, and inspection procedures, so that ease of charger deployment will match the ease of use. The following section of these guidelines offers recommended definitions, zoning and building code amendments, and policy guidance related to permitting, signage, and accessibility.

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3.1 Definitions

As local jurisdictions adopt ordinances, codes, standards, and regulations, every effort should be made to utilize standard definitions, and to update them regularly. To assist in the deployment of standard terms, these Guidelines provide definitions in three categories:

- Battery Charging and Supply Equipment
- Vehicles
- Other

Battery Charging and Supply Equipment

Accessible Card-Reading Device: a battery charging station that meets the accessibility requirements of Chapter 11C of the California Building Code.

> ***Comment:*** *The card-reading controls on a battery charging station that contains charging supply equipment for two or more vehicles simultaneously, and meets the accessibility requirements of Chapter 11C of the California Building Code for each vehicle will qualify as an accessible card-reading device for each vehicle.*

Battery Charging Station: an electrical component assembly or cluster of component assemblies designed specifically to charge batteries within electric vehicles.

> ***Comment:*** *Battery charging stations include Level 1, Level 2, and DC Fast Charge (sometimes called Level 3) charging stations (see charging levels). Battery charging stations are also commonly referred to as chargers and charging stations.*

Battery Swap Station: a fully automated facility that will enable an electric vehicle with a swappable battery pack to enter a drive lane and exchange the depleted battery with a fully charged battery through an automated process.

> ***Comment:*** *Other terms used are battery switch stations, battery exchange stations.*

Charging: Charging occurs when the connector from the battery charging station is inserted into the electric vehicle inlet and electrical power is being transferred for the purpose of recharging the batteries on board the electric vehicle.

> ***Comment:*** *Electricity may or may not be transferred at all times during the act of charging. As vehicle to grid (V2G) advancements occur, electricity may flow from the vehicle batteries back to the grid or facility. Another type of charging is through inductive means, where charging uses the*

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electromagnetic field and there is no physical connection between the charging device and the battery. For the purposes of these guidelines, it is presumed that charging occurs via a direct connection (conductive charging) between the charging station and the electric vehicle inlet.

Charging Levels: standardized indicators of electrical force, or voltage, at which an electric vehicle's battery is recharged.

> ***Comment:*** *It is important to note that only the terms "Level 1" and "Level 2" are consistently used between industry and consumers. The use of "Level 3" is not consistently used at this time. Once Level 3 terms are defined, local governments should adopt amendments to adopted definitions.*

Connector: is a device that, by insertion into an electric vehicle inlet establishes an electrical connection to the electric vehicle for the purpose of charging and information exchange. This device is part of the electric vehicle coupler. *(Electric Vehicle Connector, California Electric Code, Article 625)*

Coupler: a device that mates an electric vehicle inlet and electric vehicle connector set. *(Electric Vehicle Coupler, California Electric Code, Article 625)*

Electric Vehicle Charging Station: a public or private parking space that is served by battery charging station equipment that has as its primary purpose the transfer of electric energy (by conductive or inductive means) to a battery or other energy storage device in an electric vehicle.

> ***Comment:*** *This definition combines the parking and battery charging characteristics into one definition as these features are functionally related.*

Electric Vehicle Charging Station — public: an EV charging station that is publicly owned and publicly available (e.g., Park & Ride parking, public library parking lot, on-street parking) *or* which is privately owned but publicly available (e.g., shopping center parking lot).

Electric Vehicle Charging Station — Restricted: an electric vehicle charging station that is publicly owned and has restricted access (e.g., fleet parking for designated vehicles) or privately owned and has restricted access (e.g., single-family home, designated employee parking).

> ***Comment:*** *This definition is provided to clarify that not all "public" parking, signage and accessibility requirements will apply to "restricted" EV Charging Stations.*

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Electric Vehicle Infrastructure (EVI): structures, machinery, and equipment necessary and integral to support an electric vehicle, including, but not limited to charging stations and battery exchange stations.

> ***Comment:*** *Per this definition, this term is broader than Electric Vehicle Supply Equipment (EVSE) which refers to the charging equipment, cord and connector on the premises.*

Electric Vehicle Supply Equipment (EVSE): the conductors, including the ungrounded, grounded, and equipment grounding conductors and the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle. *(California Electric Code, Article 625)*

Inlet: the device on the EV into which the electric vehicle connector is inserted for charging and information exchange. This device is part of the electric vehicle coupler. For the purposes of this code, the electric vehicle inlet is considered to be part of the electric vehicle and not part of the electric vehicle supply equipment (EVSE). *(Electric Vehicle Inlet, California Electric Code, Article 625)*

Vehicles

Battery Electric Vehicle (BEV): any vehicle that operates exclusively on electrical energy from an off-board source that is stored in the vehicle's batteries, and produces zero tailpipe emissions or pollution when stationary or operating.

> ***Comment:*** *Definition is a subcategory of electric vehicles (see "Electric Vehicle).*

Clean Air Vehicle Sticker: California law allows use of High Occupancy Vehicle (HOV) lanes with only one occupant when the vehicle displays Clean Air Vehicle Stickers. A list of qualifying vehicles is provided on the California Environmental Protection Agency's (EPA) Air Resources Board website.

> ***Comment:*** *Evidence of Automatic Vehicle Identification System (FasTrak) must be submitted with HOV sticker application in order to obtain stickers for Clean Vehicles registered in Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, or Sonoma counties.*

Clean Vehicle: any clean fuel vehicle identified by the State of California as qualifying for the California Clean Vehicle Incentives program. Effective January, 2011 there are two types of vehicles that qualify: Zero Emission Vehicles (ZEV) and Plug-in Hybrid Electric Vehicles (PHEV) that qualify as Enhanced Advanced Technology, Partial Zero Emission Vehicles (AT PZEV).

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Comment: *California law allows single-occupant use of HOV lanes by qualifying clean alternative fuel vehicles. A list of qualifying vehicles is provided on the California EPA's Air Resources Board website. Use of these lanes with only one occupant requires a Clean Air Vehicle Sticker issued by the California Department of Motor Vehicles (DMV).*

Electric Motorcycle: is a battery electric vehicle having a seat or saddle for the use of the rider, designed to travel on not more than three wheels in contact with the ground, and is powered by an electric motor and produces zero emissions or pollution when stationary or operating.

Comment: *In California, 3-wheel zero emission vehicles are classified as "motorcycles".*

Electric Vehicle (EV): any motor vehicle registered to operate on California public roadways and operates, either partially or exclusively, on electrical energy from the grid, or an off-board source, that is stored on-board for motive purpose. "Electric vehicle" includes: (1) a battery electric vehicle; (2) a zero emission vehicle (ZEV); (3) a plug-in hybrid electric vehicle; (4) and a neighborhood electric vehicle (NEV)

Comment: *This definition provides for inclusion of a variety of electric vehicles, and is designed for regulatory purposes, so that factors such as signage are not required to call out detailed differences among BEVs, ZEVs, PHEVs, and NEVs. Note that extended range electric vehicles (EREV) are not separately defined but are included in the definitional components for PHEV (i.e., an EREV is driven initially in all-electric mode by electricity from its battery, and is then driven in hybrid mode by electricity generated from a gasoline motor).*

Extended Range Electric Vehicle (EREV): see definition of Plug-in hybrid electric vehicle (PHEV)

Hybrid Electric Vehicle (HEV): is a type of hybrid vehicle which combines a conventional internal combustion (ICE) propulsion system with an electric propulsion system. The presence of the electric drive motor is intended to achieve better fuel economy than a conventional ICE.

Comment: *A Hybrid Electric Vehicle does not plug into an off-board electrical source.*

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Motorized Bicycle: a device that has fully operative pedals for propulsion by human power and has an electric motor that has a power output of not more than 1,000 watts and is incapable of propelling the device at a speed of more than 20 miles per hour on ground level. (California Vehicle Code Section 406)

> ***Comment:*** *A "moped" is a form of motorized bicycle and is capable of propelling the device at a maximum speed of not more than 30 miles per hour on level ground. For the purposes of these guidelines all motorized bicycles will be distinct from "electric vehicle" to enable local governments, by ordinance, to treat parking, operation and charging locations for them separately.*

Motorized Electric Scooter: any two-wheeled device that has handlebars, has a floorboard that is designed to be stood upon when riding, and is powered by an electric motor and produces zero emissions or pollution when stationary or operating. (CVC section 407.5 Motorized Scooters)

> ***Comment:*** *These vehicles are defined as being distinct from "electric vehicle" to enable local governments by ordinance, to treat parking, operation and charging locations for them separately, if that regulation is not in conflict with CVC section 21225.*

Motorized Quadricycle and Motorized Tricycle: a "motorized quadricycle" is a four-wheeled device, and a "motorized tricycle" is a three-wheeled device, designed to carry not more than two persons, including the driver, and having either an electric motor or a motor with an automatic transmission developing less than two gross brake horsepower and capable of propelling the device at a maximum speed of not more than 30 miles per hour on level ground. The device shall be utilized only by a person who by reason of physical disability is otherwise unable to move about as a pedestrian or by a senior citizen as defined in Section 13000. (California Vehicle Code Section 407)

> ***Comment:*** *For the purposes of these guidelines, motorized quadricycles and motorized tricycles will be distinct from "electric vehicle" to enable local governments, by ordinance, to treat parking, operation and charging locations for them separately.*

Neighborhood Electric Vehicle (NEV): an electrically powered, four-wheeled self-propelled low-speed vehicle whose speed attainable in one mile is more than 20 miles per hour and not more than 25 miles on a paved level surface and has a gross vehicle weight of less than 3,000 pounds. (California Vehicle Code Section 385.5)

> ***Comment:*** *Definition of a subcategory of electric vehicles (see "Electric Vehicle").*

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Non-Electric Vehicle: any motor vehicle that does not meet the definition of "electric vehicle."

Plug-In Hybrid Electric Vehicle (PHEV): an electric vehicle that (1) contains an internal combustion engine and also allows power to be delivered to drive wheels by an electric motor; (2) charges its battery primarily by connecting to the grid or other off-board electrical source; (3) may additionally be able to sustain battery charge using an on-board internal-combustion-driven generator; and (4) has the ability to travel powered by electricity.

> ***Comment:*** *Definition of a subcategory of electric vehicles (see "Electric Vehicle"). Note that extended range electric vehicles (EREV) are not separately defined but are included in the definitional components for PHEV (i.e., runs on electricity from its battery, and then it runs on electricity it creates from gas).*

Zero Emission Vehicle (ZEV): any vehicle driven only by an electric motor that is powered by advanced technology batteries (BEV) or a hydrogen fuel cell, and produces zero tailpipe emissions or pollution when stationary or operating.

Other

Accessible Electric Vehicle Charging Station is an electric vehicle charging station where the battery charging station equipment is approachable and usable by persons with disabilities in compliance with the California Building Code (Title 24).

> ***Comment:*** *This definition applies to Public Buildings, Public Accommodations, Commercial Buildings and Publicly Funded Housing.*

Accessible Parking Required: means each lot or parking structure where parking is provided for the public as clients, guests or employees, shall provide accessible parking as required by the California Building Code (Title 24).

> ***Comment:*** *For the purposes of these guidelines an "accessible electric vehicle charging station is distinct from an "accessible parking space".*

Accessible Parking Space: a parking space where accessible parking is designated for vehicles displaying a Disabled Person (DP) placard or DP license plates. (California Building Code Title 24)

Clean Air Vehicle Parking Space: any posted and/or marked parking space that identifies the use to be exclusively for the parking of a clean fuel vehicle as defined by the California Air Resources Board.

> ***Comment:*** *This term provides for a space(s) to be designated as a "Clean Air Vehicle" space for qualifying fuel-efficient vehicles and carpool/ van*

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pool vehicles consistent with the California Green Building Standards (CALGreen) Code; or potentially as an incentive by a public agency or private company for qualifying clean fuel vehicles as defined by the California Air Resources Board or local ordinance.

Electric Vehicle Parking Space: any posted parking space that identifies the use to be exclusively for the parking of an electric vehicle.

> ***Comment:*** *This term provides the potential for a space to be designated, perhaps as an incentive by a public agency or private company for electric vehicles even if charging equipment is not provided.*

Internal Combustion Engine Vehicle (ICE): a vehicle with an engine that burns fuel within itself as a means of developing power.

> ***Comment:*** *Although the term internal combustion engine covers all types of reciprocating and rotary engines, it is typically used with reference to two stroke or four-stroke gasoline and diesel engines, and is the source of power for conventional vehicles.*

Level Accessible Area: an area which is minimally30 inches by 48 inches level and clear. This area shall be provided within 10 inches in plan view of the face of the accessible card-reading controls and shall be unobstructed by any features, except pump nozzles and hoses, with the long side of this space parallel to and centered [plus or minus 9 inches] with the face of the card-reading controls.

> ***Comment:*** *The slope of the level accessible area shall not be more than 2-percent in front of the battery charging station, however the slope may extend to 5-percent where the authority having jurisdiction determines that, due to unusual site conditions, the 2-percent slope is not obtainable. For the purpose of this definition the electrical cord and connector may overlap the level accessible area.*

"Path of Travel" is a continuous, unobstructed way of pedestrian passage by means of which the level accessible area from the vehicle to the base of the accessible battery charging station, with or without card-reading controls to the inlet on the vehicle. It shall include the clearance requirements stated in CBC, Chapter 11B and the ADA for wheelchair passage widths, and relationships of maneuvering clearances to wheelchair spaces.

> ***Comment:*** *The minimum clear width or single wheelchair passage shall be 32 inches at a point and 36 inches continuously. CBC Chapter 11B, Section 1118B.1.*

Point of Service: the battery charging station from which the charging service is provided.

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Van Accessible Parking Space: an accessible parking space sized for a van.

> ***Comment:*** *According to the California Building Code, one in every eight accessible parking spaces, but not less than one, shall be served by a loading and unloading access aisle 96 inches (2438 mm) wide minimum placed on the side opposite the driver's side when the vehicle is going forward into the parking space and shall be designated van accessible, as required by Section 1129B.4 of the California Building Code.*

3.2 Zoning

The following section of these guidelines provides sample zoning code provisions for the placement of EV infrastructure in various land-use designations. This section includes a sample table for "Allowed Uses" in typical zoning districts. Examples of zoning ordinance amendments are included from cities and counties throughout the U.S. and Canada, as well as recommendations regarding how these amendments can be incorporated into local agencies' zoning ordinances.

3.2.1 Sample Zoning Code Provisions

Electric Vehicle Infrastructure—Allowed Uses

Purpose
This Chapter provides model regulations and guidance for when a jurisdiction chooses to regulate where, what type and how many electric vehicle charging stations will be permitted in different land uses.

Definitions: (See Section 3.1 Definitions)

Zoning District Tables
Electric Vehicle Infrastructure (EVI) -- in the form of charging stations of various electrical levels -- are permitted in zoning districts as identified in Table 1. The first column lists the name of each zoning district, the second, third and fourth columns indicate the type of EVI. For each zoning district, the table identifies the type of infrastructure permitted and the process by which it is permitted. A "P" represents that the EVI is a permitted use in the corresponding zone. A column left blank indicates that type of EVI is not permitted in that district.

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Zoning District	Level 1 and Level 2 Charging Station	Level 3 Charging Station[2]	Battery Exchange Station
Low Density Residential	P[1]	P[1]	
High-Density Residential	P[1]	P[1,3]	
Mixed-Use	P	P or P[3]	
Commercial	P	P	P
Industrial	P	P	P
Institutional	P	P	P
Recreational	P[1]	P[1]	

Zoning Districts and Allowed Electric Vehicle Infrastructure

[1]Allowed only as an accessory to a principal outright permitted use
[2]The term "Level 3" is used interchangeably with Fast Charge and Rapid Charge (See Section 3.1 Definitions)
[3]Local jurisdictions may to choose to allow Level 3 charging stations as an outright permitted use or to adopt development standards applicable to high-density residential, mixed-use residential or other zoning districts.

Design and Installation Criteria

A. **Size.** Electric vehicle charging stations may be the same size as standard parking spaces. The installation of a charging station shall not shorten the electric vehicle charging station to below minimum local zoning requirements for off-street parking spaces.

B. **Signage**.

1. Each electric vehicle charging station shall include guide signage identifying the space as an "electric vehicle charging station".
2. If time limits or vehicle removal provisions are to be enforced, regulatory signage including parking restrictions, hours and days of operations, towing and contact information shall be installed immediately adjacent to, and visible from the electric vehicle charging station. (See Section 3.6 Signage)

C. **Accessibility**. Where charging station equipment is provided within an adjacent pedestrian circulation area, such as a sidewalk or accessible "path of travel" to the building entrance, the charging station shall be located so as not to interfere with minimum pedestrian clearance widths as defined in Chapter 11B of the California Building Code. Cords and connector equipment shall not extend across the path of travel within sidewalks or walkways. (See Section 3.5.2 ADA and Reasonable Accommodations)

D. **Number of Accessible Electric Vehicle Charging Stations.** At each parking site, the first two charging stations must be accessible (a charging station

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that can simultaneously charge two or more EVs would qualify to meet this requirement)

E. **Lighting.** Where charging station equipment is installed, lighting levels should be compliant with local codes. Higher lighting levels will improve visibility of cords, charging equipment and vehicle inlets.

F. **Maintenance.** Charging station equipment shall contain a phone number or other contact information for reporting malfunctioning equipment, other problems or to seek information.

3.2.2 Sample Zoning Ordinance Amendments

Zoning ordinance amendments can be utilized as an effective mechanism to incentivize the installation of EV charging stations. Specific examples are provided below.

EV Charging Stations Count Towards Minimum Parking Requirements: Electric vehicles serve the same purpose of any other vehicle, except they do not use liquid fuel. Electric vehicle charging stations should be included in the calculation for minimum required parking spaces pursuant to established zoning ordinances.

Recommendation: Public agencies should adopt zoning code amendments that authorize the inclusion of an EV Charging Stations in the calculation of minimum required parking.

Sample Code Language: Electric Vehicle Charging Station—Allowed as Required Spaces. Electric Vehicle charging station spaces shall be allowed to be used in the computation of required off-street parking spaces as provided under (site code section, refer to section 2.1 for guidance), provided: that the electric vehicle charging station(s) is accessory to the primary use of the property[10].

Charging stations required for new development: When significant new developments or redevelopments occur, communities should require the provision of charging stations.

Recommendation: Local agencies should adopt ordinance language requiring the installation of electric vehicle charging stations when significant develop or redevelopment occurs.

Sample Code Language: Required facilities[11]

A. Beginning (insert date), development for each of the land uses identified in Table 1 of subsection B of this section shall be required to provide

[10] *http://www.codepublishing.com/WA/Seatac/html/Seatac15/seatac1540.html#15.40.*
[11] *City of Mountlake Terrace, Washington (Ordinance 2553, Adopted November 01, 2010)*

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electric vehicle infrastructure as shown in the table. For purposes of Table 1, electric vehicle charging stations shall be provided when the development is 10,000 square feet or more and one of the following occurs:

1. A new building or a new off-street parking facility is developed;
2. An addition or improvement to an existing building is made that meets a certain threshold, pursuant to (insert relevant code section); or
3. The parking capacity of an existing building, site, or parking facility is increased by more than 50%.

B. The first column in Table 1 shows the type of land use for which electric vehicle charging stations shall be provided, pursuant to this section. The second column shows the minimum percentage of the facility's parking spaces that shall provide a connection to electric vehicle charging stations.

Land Use Type	Percentage of Parking Spaces
Multi-household residential	10%
Lodging	3%
Retail, eating and drinking establishment	1%
Office, medical	3%
Industrial	1%
Institutional, Municipal	3%
Recreational/Entertainment/Cultural	1%
Other	3%

Required number of electric vehicle charging stations

C. Design for Expansion. To allow for additional electric vehicle parking in the future, beginning [insert date], all development that meets the criteria of subsection A of this section shall be designed to allow for double the amount of electric vehicle parking shown in Table 1.

1. Site design must provide electrical, associated ventilation, accessible parking, and wiring connection to transformer to support the additional potential future electric vehicle charging stations.

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EV Charging Stations Required for Large Parking Lots: Local agencies should encourage, incentivize or require existing large public parking facilities to provide electric vehicle charging stations.

Recommendation: Local agencies should adopt zoning amendments that require the provision of EVSE in large existing parking facilities.

Sample Code Language: All public, private, and government parking facilities that are available for use by the general public and have at least one hundred parking spaces shall designate one per cent of the parking spaces exclusively for electric vehicles by [insert date], provided that at least one of the parking spaces designated for EVs is located near the building entrance and is equipped with an EV charging unit. Spaces shall be designated, clearly marked, and the exclusive designation enforced. Owners of multiple parking lots within the jurisdiction may designate and electrify fewer parking spaces than required in one or more of their owned properties as long as the scheduled requirement is met for the total number of aggregate spaces on all of their owned properties. The electric vehicle charging units shall meet recognized standards, including SAE J1772 of the Society of Automotive Engineers[12].

EV Charging Stations Required, Multi-family: Most EV charging will occur at night. Multi-family developments should provide facilities for residents to charge EVs, with provisions for EV owners to pay for the cost of the electricity in a manner consistent with the policies of the site owner.

Recommendation: Local agencies should adopt zoning code amendments requiring a percentage of parking spaces in new multi-family projects to include EVSE.

Sample Code Language: Twenty percent of the parking stalls that are for use by owners or occupiers of dwelling units in a multifamily building that includes three or more dwelling units, or in the multi-family component of a mixed use building that includes three or more dwelling units must include a receptacle to accommodate use by electric vehicle charging equipment[13].

3.3 Vehicles and Traffic

This section provides sample regulations to discourage non-electric vehicles from occupying charging stations, and to regulate chargers' time of operation. These regulations apply only at charging stations intended for public use in public parking facilities or on public roads.

[12] *Hawaii State Statutes, Part IV, Section 291-71. Adopted 2009, Effective upon adoption.*
[13] *Vancouver, British Columbia, Building By-law No. 9419, § 13.2.1 Electric Vehicle Charging, Section 13.2.1.1. Parking Stalls (Adopted July 9, 2009, Effective April 20, 2011*

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Purpose
This Chapter provides model regulations on the noticing and enforcement of parking related to EV charging stations in any off street parking facility owned or operated by a public agency or at any on-street parking space designated as an electric vehicle charging station.

Definitions: (See Section 3.1 for applicable definitions)

Electric Vehicle Charging Stations reserved
The Director is authorized to designate parking spaces in any off-street parking facility owned or operated by the public agency, or any on-street parking space as being exclusively for the charging of electric vehicles.

A. Director. The "Director" means the head of the local jurisdiction department responsible for administering the off-street and on-street parking programs.

B. Charging. For the purposes of this Chapter, "charging" means any parked EV connected to the charging station. (See Section 2.1 for definition of "charging")

Noticing
The Director shall have the exclusive power and duty to place and maintain or cause to be placed and maintained signs at each electric vehicle charging station. Each electric vehicle charging station shall include guide signage identifying the space as an "electric vehicle charging station". To reserve the space for the exclusive use of charging electric vehicles, to regulate time limits on charging, or to remove unauthorized vehicles, regulatory signage including parking restrictions, hours and days of operations, towing and contact information shall be installed immediately adjacent to and visible from the EV charging station. (See Section 3.6 for applicable signs)

Markings
The Director is authorized, on the basis of necessity to allocate electric vehicle charging stations by space markings. When such markings have been placed, only one electric vehicle shall occupy such space, and no person shall park except within the boundaries of the space defined.

Prohibitions
When signage is utilized that indicates that a space is reserved as an electric vehicle charging station, no person shall park or stand any non-electric vehicle in such space. Any non-electric vehicle is subject to fine or removal.

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Violations and Penalties

A. Violations of the Chapter shall be punishable as infractions. The amount of fine shall not exceed the fine prescribed in the rate of fines resolution or ordinance.

B. Any person who has parked or left a vehicle standing at an electric vehicle charging station is subject to having the vehicle removed by any peace officer or other person designated by the Police chief or designated law official in the manner and subject to the requirements of the California Vehicle Code.

3.4 Streets, sidewalks, and public places

This section of the guidelines provides sample municipal code language for installation, operation and enforcement of charging infrastructure intended for public use on public roadways or in public parking facilities. Section 3.1 of the guidelines contains definitions, and Section 3.6 contains guidance on signage installations. Applicable information from both of these sections can be inserted into code chapters as determined appropriate by local agencies.

3.4.1 On-Street Electric Vehicle Charging Stations

Purpose
This Chapter provides model regulations and guidance on the installation, operation and enforcement of electric vehicle charging stations intended for public use on public roadways.

Definitions: (See Section 3.1 for applicable definitions)

Permitted Locations
Other than on state highways, any local authority, by ordinance or resolution may designate by the posting of signs adjacent to on-street parking spaces on roadways under the jurisdiction of that authority; that such spaces are for the exclusive purpose of charging electric vehicles. Public parking spaces reserved for the exclusive use of charging electric vehicles shall be referred to as "electric vehicle charging stations". Charging station equipment installed adjacent to electric vehicle charging stations is reserved solely for the charging of electric vehicles.

Design and Installation Criteria

A. Size. An Electric vehicle charging station may be the same size as a standard parking space.
B. Signage.
    a. Each electric vehicle charging station shall include guide signage identifying the space as an "electric vehicle charging station". To

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reserve the space for the exclusive use of charging electric vehicles, to regulate time limits on charging or to remove unauthorized vehicles, regulatory signage including parking restrictions, hours and days of operations, towing and contact information shall be installed immediately adjacent to and visible from the electric vehicle charging station. (See Section 3.6 on Signage).

b. Advance Signage. Installation of signs at important decision points to guide motorists to Electric vehicle charging stations may be provided.

C. Location.
   a. When installing only one EVCS, utilizing the last space on a block face in the direction of travel reduces cord management issues and places the EVCS closer to crosswalks and curb ramps.
   b. An EVCS with a single connector is generally recommended for parallel parking configurations, and should be installed near the front of the electric vehicle charging station based upon the direction of travel.
   c. Charging stations serving perpendicular or angle parking configurations should be centered, or to the left in front of the electric vehicle charging station for single connectors, and placed between two electric vehicle charging stations for dual connectors.

D. Obstructions. When charging station equipment is placed in a sidewalk or walkway adjacent to the on-street charging station, it shall not interfere with minimum pedestrian clearance widths as defined in Chapter 11B of the California Building Code. Cords and connector equipment shall not extend across the path of travel within the sidewalk or walkway.

E. Clearance. When charging station equipment is placed in a sidewalk or walkway adjacent to roadway, it shall have a minimum clearance of 24-inches from the face of the curb.

F. Protection. When charging station equipment is placed in a sidewalk or walkway adjacent to perpendicular or angle on-street electric vehicle charging stations, protective guard posts shall be installed. (California Fire Code Part 9, Title 24)

G. Controls and Equipment.
   1. Charging station card-readers, controls and connector devices shall be no lower than 36-inches or higher than 48-inches from the pedestrian surface.
   2. Retraction devices or a place to hang permanent cords and connectors sufficiently above the pedestrian surface shall be provided.

H. Area Lighting. Well-lit lighting shall exist where charging station equipment is installed to minimize risk of tripping or damage to charging station equipment from vehicle impact.

I. Maintenance. Charging station equipment shall contain a phone number or other contact information for reporting malfunctioning equipment, other problems or to seek information on charging procedures.

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J. Notification. Information on any fees or terms of use shall be clearly visible in day or nighttime conditions.
K. Communications. Charging station equipment shall be equipped with cellular phone service and/or wireless-fidelity (Wi-Fi) communications.

Comment: *The rationale for the requirement for charging station equipment communications or networking requirement is two-fold: 1) For EV driver convenience, it is essential that charging station operational status be communicated via web-based and mobile communication based devices that are now being routinely deployed on EVs and smartphones. Otherwise, EV drivers may find themselves manually "hunting" for available EV chargers, adding to congestion and range anxiety. 2) As EVs are more broadly deployed, utilities and charger owners may need to regulate charging rates during peak hours to better manage grid impacts and prevent over-loading. Communications equipment will help facilitate "smart grid" and charger interactions.*

3.4.2 Off-Street Electric Vehicle Charging Stations

Purpose
This Chapter provides model regulations and guidance addressing electric vehicle charging stations intended for public use in publicly owned parking facilities.

Definitions: (See Section 3.1 for applicable definitions)

Permitted Locations
Any local authority, by ordinance or resolution may designate by the posting of signs adjacent to parking spaces in public parking facilities under the jurisdiction of that authority; that such spaces are for the exclusive purpose of charging electric vehicles. Off-street public parking spaces reserved for the exclusive use of charging electric vehicles shall be referred to as "electric vehicle charging stations". Charging station equipment installed adjacent to electric vehicle charging stations is reserved solely for the charging of electric vehicles.

Design and Installation Criteria
A. Size. Electric vehicle charging stations may be the same size as standard parking spaces. The installation of a charging station shall not shorten the electric vehicle charging station to below minimum local zoning requirements for off-street parking spaces.
B. Signage.
    a. Each electric vehicle charging station shall include guide signage identifying the space as an "electric vehicle charging station".

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b. If time limits or vehicle removal provisions are to be enforced, regulatory signage including parking restrictions, hours and days of operations, towing and contact information shall be installed immediately adjacent to, and visible from the electric vehicle charging station.
c. Advance Signage. Installation of directional signs at important decision points to guide motorists to Electric vehicle charging stations may be provided.
d. See Section 3.6 on Signage

C. Location.
a. An EVCS with a single connector is generally recommended for parallel parking configurations, and should be installed near the front of the electric vehicle charging station based upon the direction of travel.
b. Charging stations serving perpendicular or angle parking configurations should be centered, or to the left in front of the electric vehicle charging station for single connectors, and placed between two electric vehicle charging stations for dual connectors.

D. Accessibility. Where charging station equipment is provided within an adjacent pedestrian circulation area, such as a sidewalk or accessible "path of travel" to the building entrance, the charging station shall be located so as not to interfere with minimum pedestrian clearance widths as defined in Chapter 11B of the California Building Code. Cords and connector equipment shall not extend across the path of travel within sidewalks or walkways. (See Section 3.5.2 on Americans with Disability Act and Reasonable Accommodations)

E. Lighting. Where charging station equipment is installed, lighting levels should be compliant with local codes. Higher lighting levels will improve visibility of cords, charging equipment and vehicle inlets.

F. Maintenance. Charging station equipment shall contain a phone number or other contact information for reporting malfunctioning equipment, other problems or to seek information.

G. Notification. Information on any fees or terms of use, voltage or amperage levels shall be clearly visible in day or nighttime conditions.

H. Communications. Charging station equipment shall be equipped with cellular phone service and/or wireless-fidelity (Wi-Fi) communications.

3.5 Building and Electrical Code Guidance

3.5.1 Guidance for evaluating parking facilities for charging station installations

Before installing charging equipment, property owners and/or operators should first determine if the parking facility is a good candidate site. To assist in this assessment, this section addresses key planning factors in three specific areas: *site*

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location, user base, and parking lot features. To assess the suitability of a privately-owned site, three key questions should guide further planning.

- Does my community have a Charging Station Siting Plan -- or is one being created?
- Does my property meet the long term needs of a particular user base?
- Is there sufficient electricity supply to provide charging services, and if not how feasible will it be to expand the supply?

A. Site Location

Appropriate planning is essential for the successful siting and installation of EV chargers. If a community-wide master plan for EV chargers exists it will help the owner to better understand supply, demand, and the potential aggregate user base. Knowing if charging stations are planned in nearby parking facilities allows an owner to proceed in a strategic, phased approach -- matching the site characteristics and user demand to the level of investment. Additional key siting considerations include:

- Ability to economically obtain sufficient electrical energy
- Visibility and ease of driving and walking access to the parking facility
- Distance and relationship to other parking facilities and land uses
- Occurrences of flooding or ponding of water on the parking lot
- Availability of cellular phone service and/or Wi-Fi at the site

B. User Base

Parking lots often target multiple categories of user. For instance, a shopping mall would generally target convenient customer parking and long term employee parking. A downtown surface lot owner will often provide short-term hourly parking for shoppers and monthly parking for employees of nearby businesses. When considering the addition of charging equipment on a parking lot, the owner has an opportunity to attract new customers. The operator should look at all possible users, types of equipment, and classes of electric vehicles. Since electrical rates are lower at night than during daytime peak demand periods, operators may want to explore offering nighttime charging services for nearby residents that do not have charging opportunities at their residence.

Key user-base considerations are:

- Hours and days of parking facility operations
- Customers' typical driving distances and frequency of use
- Likely peak use days/times and duration of stay
- Day and night walking conditions and distances to nearby attractions
- Perceptions of site safety
- Method of assessing and collecting charging fees

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- Opportunities for valet parking service and associated impacts on charging equipment and site occupancy

Development of Guiding Principles: Based on local factors and priorities, local jurisdictions may wish to develop and adopt a set of guiding principles for charger location and siting. The following principles have been developed by the County of Marin for use in guiding their charger deployment strategy, and reflect much of the latest thinking from projects across the nation. The Marin principles include primary global principles, secondary global principles, and site-specific principles, defined as follows:

1. Primary Global Principles – Those factors that are of highest importance when deciding on overall sites to locate EV charging stations.
2. Secondary Global Principles – Additional factors of secondary importance to consider when selecting overall locations for EV charging stations.
3. Site Specific Principles – Priority factors to consider when determining the specific location within a general site where the EV charging station(s) will be installed.

Primary Global Principles:

1. **Location:** Select a high-impact, high-visibility location (especially for the first few chargers).
2. **Electricity:** Select a location where Level 2 (240V/40A) electrical supply is or can be made available with relative ease and minimal cost. (See Appendix C for descriptions of EV charger levels.)
3. **Access:** Consider and comply with ADA guidelines for disabled access, and take precautions to ensure that chargers are placed with the user's convenience in mind (avoiding injury from tripping on cords and cables, etc.)
4. **Security:** Select a secure location with adequate lighting to enhance security and provide the customer with a good charging experience.
5. **Signage:** Provide enforcement and other signs that comply with the *Manual on Uniform Traffic Control Devices* (MUTCD) and California Vehicle Codes (CVC), ensuring that signs are high enough, easily visible, and provide clear and accurate information.
6. **Equipment Protection:** EV chargers should be placed where they can be best protected from physical damage by such measures as curbs, wheel stops, setbacks, bumper guards, and concrete-filled steel bollards, while simultaneously taking into consideration ease of access to the charger, mobility of users, and foot traffic in the area.
7. **Fleet Use:** Consider "dual purpose" sites that could also benefit the jurisdiction's fleet vehicles, as well as the general public, where feasible and appropriate.

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Secondary Global Principles:

While the principles above received the highest priority ratings from Marin jurisdictions, many other criteria are also to be considered in the siting of EV chargers, including:

- **Diversity of Intended Users:** EV chargers should (progressively) be located in sites that will appeal to the diversity of EV users (e.g., local residents, visitors and tourists, and fleet drivers)
- **Public Safety:** Chargers should be located in areas with proper ventilation and away from potential hazards including traffic, explosive materials, flammable vapors, liquids and gases, combustible dust or fibers, materials that ignite spontaneously on contact with air, flood-prone areas, and away from areas that might be prone to vandalism.
- **Duration of Use:** Level 2 Charger sites should focus on locations where EV owners will be parked for a significant period of time (e.g., one to three hours). DC Fast Chargers sites should focus on locations where the EV owner will be parked for a relatively short period of time (e.g., 15 minutes).
- **Economics:** The costs of charger installation and potential loss of parking space revenue should be weighed against the benefits of projected revenues, positive publicity, and increased visitor spending in the jurisdiction, as well as the broader societal benefits of spurring the transition to clean, low-carbon transportation.
- **Location Markings:** Indication of parking spaces, striping, driveways, and walkways.
- **Cable Management:** To avoid injury from tripping, cables should not cross sidewalks or pedestrian traffic patterns.
- **Shelter:** When possible, shelter is desirable to protect users from weather when connecting their vehicle to the charger. (However, chargers are designed to be safely operated in exposed locations in the rain, with no danger of electrical shock.)
- **Aesthetics:** Some areas may benefit from the installation of landscaping or screening walls to shield the electrical transformer, panel, or other equipment from the public eye.
- **Solar Power:** Some jurisdictions may choose sites where solar panels can provide energy to power the charging unit.
- **Other EVs:** Locations may be chosen to cater not only to freeway-capable Battery-Electric (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) -- which typically utilize the 240 volt "Level 2" connections for faster charging -- but also to slower-speed Neighborhood EVs (NEVs), electric bicycles, electric scooters, and electric motorcycles which typically utilize a 110 volt electrical connection.

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Site Specific Principles:

- **Accessibility:** EV charger location within a site should comply with ADA access requirements. Specifically, the first two EV chargers installed in any one location should take into consideration requirements in California Building Code Chapter 11C and DSA 97-03.
- **Electrical Supply:** Select a location where it is as inexpensive as possible to provide Level 2 (240V/40A) electrical supply.
- **Benefits vs. Loss of Revenue:** When selecting the specific location of an EV charger at a particular site, a jurisdiction should consider the balance of anticipated benefits (including "EV readiness", revenue potential, and increased patronage of nearby business) versus potentially negative aspects of taking an available parking space (including negative impact on conventional vehicle drivers and lost revenue.)
- **Cord Management:** When determining where to install an EV charger, a location should be selected where cords will not interfere with the path of travel of the user or other pedestrians in the vicinity.
- **Security:** A location should be selected that is secure for users at all times of day and night and relatively secure from vandalism (e.g., in a well-lighted area; and in well-travelled areas.)

3.5.2 Americans with Disabilities Act (ADA) and Reasonable accommodations

The Americans with Disabilities Act (ADA) became federal law in 1990 with the intent to prohibit discrimination of individuals on the basis of disabilities. Title I of the ADA prohibits private employers, state and local governments, employment agencies and labor unions from discriminating against qualified individuals with disabilities in job application procedures, hiring, firing, advancement, compensation, job training, and other terms, conditions, and privileges of employment. The ADA covers employers with 15 or more employees, including state and local governments. An employer is required to make a reasonable accommodation to the known disability of a qualified applicant or employee if it would not impose an "undue hardship" on the operation of the employer's business. Reasonable accommodations are adjustments or modifications provided by an employer to enable people with disabilities to enjoy equal employment opportunities. The Equal Employment Opportunity Commission (EEOC) is the enforcing agency for Title I.

Title II of the ADA addresses State and local government services, and Title III addresses places of public accommodation and commercial facilities. Under titles II and III of the ADA, the Access Board develops and maintains accessibility guidelines for buildings, facilities, and transit vehicles and provides technical assistance and training on these guidelines. The Department of Justice (DOJ) is the enforcing agency for Title II, and the Department of Transportation, along with the DOJ are the enforcing agencies for Title III.

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3.5.2.1 Accessible Electric Vehicle Charging Stations

Since public charging stations offer a service to the general public, the ADA prohibits discrimination of individuals on the basis of disabilities. Accessibility standards specific to public electric vehicle charging stations do not currently exist in California except in some fashion through Chapter 11C of the California Building Code—*Standards for Card Readers at Gasoline Fuel-Dispensing Facilities*[14]. The 11C Standard applies to card readers not only on liquid fuel pumps, but also on charging stations, because it defines electricity as a motor fuel.

There also exists a State of California internal policy 97-03—Interim Disabled Access Guidelines for Electrical Vehicle Charging Stations[15] that was developed in 1997 (last revised 2-10-2005) by the State Department of General Services. The policy is mandated for use on State-owned parking lots, including public schools. The policy states that local agencies are granted latitude to adopt similar methods of administering code requirements. While the policy references the California Building Standards Code, it does not reference the California Electrical Code, Fire Code or Vehicle Code, all of which must be considered when providing safe, accessible and enforceable public charging infrastructure.

The inconsistencies and incompleteness of both the standard for card-reading devices, and the State's internal policy on accessible EV charging stations has led local agencies to develop broad interpretations of the documents. The result has been widespread confusion and inconsistent applications of policy across the state. Until such time that a federal or State legal standard is developed that takes into consideration all necessary codes and modern equipment with varying charging levels, the guidelines below are being made available as a resource for local jurisdictions to use when designing, reviewing, installing and operating electric vehicle supply equipment.

There is one common element in both the 97-03 policy and the Chapter 11C Standard, which is: ***the charging station and its card reading equipment are considered the accessible element (point of service) when regular parking already exists at a site***. This is important since the vast majority of public EV charging stations will be installed in existing public and private parking facilities.

3.5.2.2 Equipment Reach and Approachability

The key challenge facing property owners, engineers, architects, contractors and others is how to place charging equipment near a convenient and sufficient power source, protect the equipment from possible vehicle damage, yet still ensure the

[14]http://publicecodes.citation.com/st/ca/st/b200v10/st_ca_st_b200v10_11c_section.htm
[15] http://www.documents.dgs.ca.gov/dsa/pubs/policies_rev_01-01-11.pdf

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equipment is accessible for persons with disabilities. Below is the primary design requirements articulated in Chapter 11C for accessible fuel-dispensing equipment:

- *At each parking site, card readers serving the first two EVCS must be accessible (a battery charging station that can simultaneously charge two or more EVs would qualify to meet this requirement)*
- *A level accessible area measuring no less than 30-inches by 48-inches (with the long dimension being parallel to and centered in front of the equipment) must exist.*
- *If on a raised curb, the face of the card-reading controls must be within 10 inches in plain view from the face of curb and be no higher than 54-inches from the level accessible area in front of the controls. (It is recommended not to exceed 48-inches in height whenever possible as it is likely the 54-inch requirement will be reduced to 48-inches)Protective posts or other guard devices cannot be closer than 3-feet to the controls and connector handle*
- *In new construction a path of travel (see definitions) no less than 3-feet in width must exist between the level accessible area in front of the charging station and an exterior accessible route of travel to the main building entrance*
- *The electric cord and connector may cross over the level accessible area when inserted in the vehicle charging inlet*

The figure below of a gas dispenser with two hoses, protected by guard posts provides an illustration of the front of the controls where the gas hose and card-readers are situated (note the recessed curb beneath the controls).

Example of an accessible fuel dispenser

The figures and accompanying *comments* that follow provide guidance for accessible electric vehicle charging stations in various parking lot configurations. The examples are based upon a review of conventional parking lot designs, ADA design

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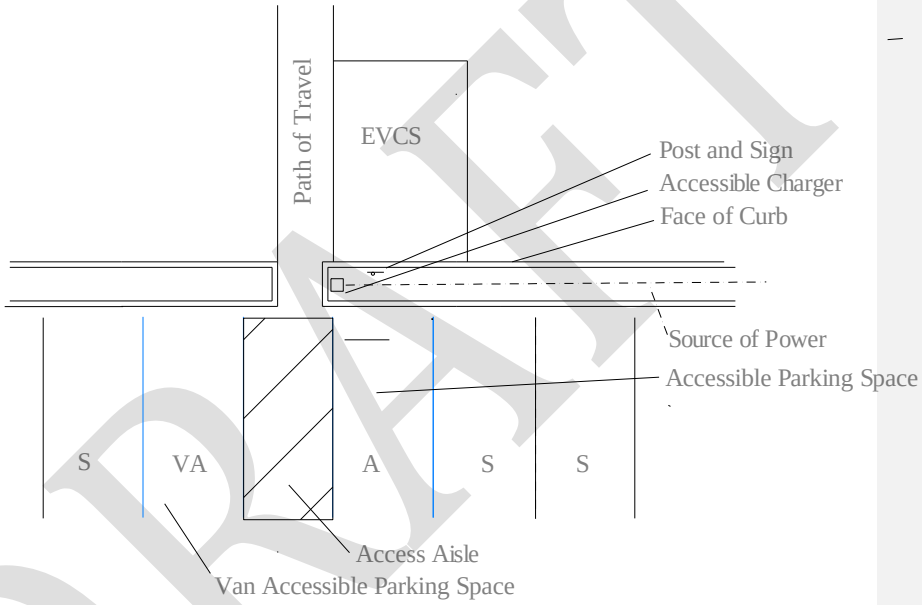
standards and requirements for reasonable accommodations, Chapter 11C of the CBC and the State's internal Policy 97-03. If a local jurisdiction in California finds that compliance with accessibility and building standards would make the specific work of the project affected by the building standard unfeasible due to one or more factors cited under "unreasonable hardships" (see definitions) section of the State Building Code, the details of the hardship shall be recorded and entered in the files of the enforcing agency.



Installation of First Charging Station

Comment: *This example illustrates how placement of dual port charging station can accommodate an accessible EVCS on one side of an island, as well an accessible parking space on the opposite side. Any vehicle displaying a Disabled Person (DP) placard or DP license plate may occupy the accessible parking space including an electric vehicle that could utilize the accessible charger. Signs identifying the accessible parking space as an "electric vehicle charging station" would be added to the existing ADA signage. The accessible charging station must meet the reach, height, clearance and slope requirements of accessible fuel-dispensing equipment (Chapter 11C, CBC).*

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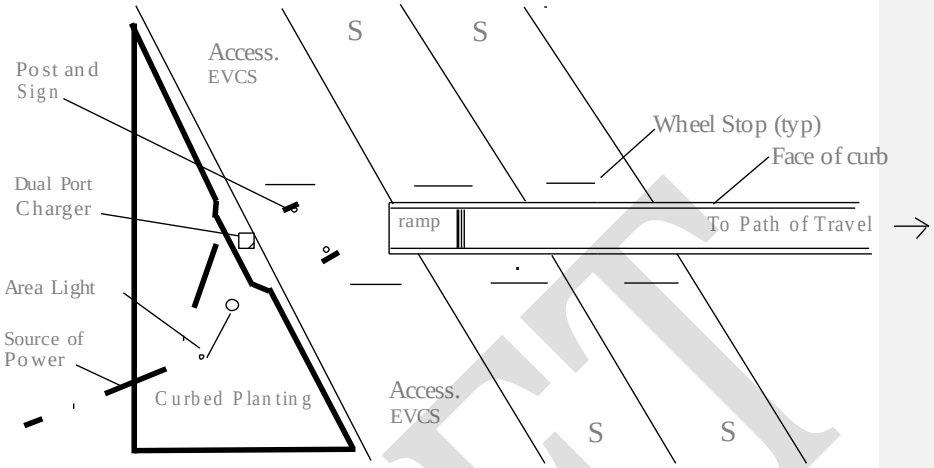

Example of Dual Charging Station serving two EVCS

Comment: *This example takes advantage of a planted island at the end of a parking bay, where a dual port charging station is installed in a recessed section behind the curb line. The two accessible EVCS are a minimum of 12 feet wide (9' for parking and 3' for maneuverability), and have an unobstructed route from any side of the vehicle to the charger and to the ramp leading to the path of travel. Because the charging station is installed at the same elevation as the parking lot surface, guard posts containing signage are installed to protect the equipment and keep the ramp clear.*

3.5.3 Model Building Code Amendments for EV Readiness

The following section of the guidelines offers examples of building code amendments pertaining to EV charger installations, and energy/storage management systems that local agencies should consider aligning the goals of sustainable transportation, energy efficient buildings, and reduced emissions. Building ordinance amendments can be utilized as an effective mechanism to require or incentivize the installation of EV charging stations. Specific examples are provided from existing codes in the U.S. and Canada, followed by recommendations on how these changes can be implemented in California communities.

Require sufficient floor area and electrical infrastructure for EVs

In new multi-family, commercial or industrial developments larger than 10,000 square feet, all conduits leading to the electrical room including service conduits, and the electrical room should be appropriately sized to accommodate future electrical equipment necessary for electric vehicle charging stations.

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Recommendation: Properly size all electrical supply infrastructure, the electrical room floor area, and equipment to accommodate the charging of electric vehicles.

Example Code Language: The electrical room in a multi-family building, or in the multi-family component of a mixed use building that in either case includes three or more dwelling units, must include sufficient space for the future installation of electrical equipment necessary to provide a receptacle to accommodate use by electric charging equipment for 100% of the parking stalls that are for use by owners or occupiers of the building or of the residential component of the building[16].

Single Family Residential EV Readiness

Most EV charging will occur at night at homes when vehicles are parked for long periods of time and when electric utility rates are often the lowest. Every new home buyer should be afforded the opportunity to put in low cost improvements for production of renewable solar energy or for the charging of electric vehicles.

Recommendation: All new residential units should include basic infrastructure, such as conduits, junction boxes, wall space, electrical panel and circuitry capacity to accommodate future upgrades for solar systems and/or EV charging.

Example Code Language:

A. All new residential units shall include electrical conduit specifically designed to allow the later installation of a photovoltaic (PV) system which utilizes solar energy as a means to provide electricity. No building permit shall be issued unless the requirements of this section and the jurisdiction's Pre-Wiring Installation Requirements are incorporated into the approved building plans. The provisions of this chapter can be modified or waived when it can be satisfactorily demonstrated to the Building Official that the requirements of this section are impractical due to shading, building orientation, construction constraints or configuration of the parcel[17].
B. All new residential units shall include electrical conduit, terminal boxes and electrical panel capacity specifically designed to accommodate the future installation of a plug-in electric vehicle (PEV) charging station with a minimum 240V/40 amp dedicated circuit. No building permit shall be issued unless the requirements of this section are met and incorporated into the approved building plans. The provisions of this chapter can be modified or waived when it can be satisfactorily demonstrated to the Building Official

[16] *Vancouver, British Columbia, Building By-law No. 9419, § 13.2.1 Electric Vehicle Charging, Section 13.2.1.2. Electrical Room*
[17] *City of Chula Vista, Ca. Ord. 3173 § 1, 2010; Ord. 3121 § 1, 2009 15.24.065 Photovoltaic pre-wiring.*

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that the requirements of this section are impractical due to zoning, occupancy type, vehicle use, or construction constraints.

Energy Storage and Management in Large Developments

To accommodate future growth of EVs in the marketplace, more electrical energy will be needed to simultaneously charge vehicles. In large new developments or in significant redevelopments, sufficient space for electrical infrastructure should be installed to accommodate future on-site energy generation, energy storage, and energy management systems, which have the potential to reduce or eliminate the need for local utility infrastructure improvements.

Recommendation: Parking areas and building facilities shall be designed to double or triple the number of charging stations initially required, with no resulting need to upgrade the infrastructure of the local utility company. When major improvements are being made to existing developments or new construction projects with significant parking requirements, smart on-site energy systems shall be installed before utility upgrades are required.

Example Code Language:

A. Section 3.1.1 Design for Energy Management. Effective [date], when a development of [insert square feet] or more occurs, the facility shall include electrical conduit and panels and/or subpanels specifically designed to allow the installation of an energy storage and/or renewable energy generation system. These systems shall moderate the facility's peak energy consumption and improve energy efficiency. The provisions of this chapter can be modified or waived when it can be satisfactorily demonstrated to the Building Official that the requirements of this section are impractical due to shading, building orientation, construction constraints or configuration of the parcel.

B. Section 3.1.2 Design for Expansion. Effective [date] when the parking capacity of an existing building or site with a minimum of 50 existing parking spaces is increased by more than 50%, the facility shall be equipped with additional electric vehicle chargers to 10% of the total of newly added spaces. Energy storage, generation, and management systems that can accommodate all or part of this upgrade at reduced cost, as compared to utility infrastructure upgrades, are required before utility infrastructure improvements are made. The provisions of this chapter can be modified or waived when it can be satisfactorily demonstrated to the Building Official that the requirements of this section are impractical due to shading, building orientation, construction constraints or configuration of the parcel.

C. Section 3.1.3 Design for Expansion. In order to allow for additional electric vehicle charging in the future as the market for such vehicles grows, beginning

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[date], all development that meets the criteria of this chapter shall be designed to accommodate double the number of initial charger installations while minimizing electric utility infrastructure upgrades. Energy storage, generation, and management systems that can accommodate all or part of this future upgrade at reduced cost, as compared to utility infrastructure upgrades, are required before utility company improvements are made. The provisions of this chapter can be modified or waived when it can be satisfactorily demonstrated to the Building Official that the requirements of this section are impractical due to shading, building orientation, construction constraints or configuration of the parcel.

3.6 Signage

This Section provides guidance for local agencies choosing to post signs to notify of, or regulate the use of electric vehicle charging stations intended for public use. Local and State agencies posting guidance or regulatory signs on public roadways, must do so in conformance with the current edition of the California Manual on Uniform Traffic Control Devices (CA MUTCD). Sign sizes, shapes and colors vary based upon the type of message, whether an international symbol exists, and the type of roadway where the sign is to be used. Local authorities may use additional or alternative signs, not approved in the CA MUTCD in public parking facilities.

General Service Signs

General service signs that are currently contained in the MUTCD and CA-MUTCD are intended to provide general guidance to the charging station and should be installed at a suitable distance in advance of the turn-off or intersecting roadway, or at the charging station and should be considered for use when meeting the qualifying criteria in chapter 2F of the CA MUTCD. The color format for general service signs is as follows:

Letters	Symbols	Arrows	Borders	Background
White	White	White	White	Blue

Below are the General Service Signs with recommended sizes currently approved in the CA MUTCD. The G66-21 (CA) sign was added to the CA MUTCD to be used on conventional roads. It should also be used in public parking facilities at all decision points and at the electric vehicle charging station. The D9-11b sign can be combined with either the G66-21 (CA) or the D9-11bP.

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G66-21 (CA)

Parking Facility 12" x 12"
Parking Facility 18" x 18"
Conventional Road 24" x 24"

D9-11bP

Freeway 30" x 24"
Expressway 30" x 24"
Conventional Road 24" x 18"

D9-11b

Freeway 30" x 30"
Expressway 30" x 30"
Conventional Road 24" x 24"

Below are the typical types of advance turn and directional arrows used with the electric vehicle charging signs:

Comment: *The above sections are modeled after the Sonoma County Electric Vehicle Infrastructure Guidelines Report and the Puget Sound Regional Council EVI Deployment Guidelines Report.*

Guidance: On April 1, 2011, the Federal Highway Administration (FHWA) issued an Interim Approval for use of an alternate D9-11b sign to the States of Oregon and Washington (see figure below). The FHWA considered the substitution of the electrical cord in place of the gas hose and nozzel as a more appropriate representation of a battery charging station. The use of this sign as an alternate to the D9-11b will be granted to other states or public agencies that submit a request to FHWA. When, and if an official rule making occurs and the sign is included in the MUTCD, then it can be used as a permanent sign on public roadways by any agency in the United States. The same dimensions of the D9-11b apply to the alternate sign.

D9-11b (Alternate)

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Regulatory Signs

Regulatory signs are required for enforcing the time duration and days that electric vehicles are permitted to park and/or charge at public charging stations. Qualifying electric vehicles should be defined in local codes, and their charging status addressed (plugged in and charging, not charging, disconnected, etc.) Currently, no regulatory signs exist for electric vehicle charging purposes in either the California MUTCD or the federal MUTCD. However, signs have been developed for testing in Oregon and Washington, and it is recommended that those signs be utilized in California until such time as California adopts standard signs. New signs can be added to the MUTCD or California MUTCD through the "experimentation" process which is described in each manual.

Regulatory signs are generally prohibitive or permissive, and there are certain color designations for each. Green/white regulatory parking signs are considered permissive signs and are intended to provide motorists with the allowable time and days to park. Red/black/white regulatory parking signs are prohibitive and are intended to advise motorists of an action that shall not be taken.

To be lawful, each of the above signs should be no smaller than 12"W x 18"H and placed immediately adjacent to the electric vehicle charging station at heights as prescribed in the CA MUTCD. The sign on the right would allow for the parking of an electric vehicle without being plugged in (it could be used as an incentive in parking spaces where charging station equipment does not exist) whereas the sign in the center would require the electric vehicle to be plugged in and charging (see definition for "charging"). Both of the prohibitive signs above are intended to make it unlawful for any non-electric vehicle to occupy the space. If a permissive sign is used in combination with a prohibitive sign it shall be installed below or to the right of the prohibitive sign.

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Local authorities or property owners, after notifying the police or sheriff's department, may cause the removal of an unauthorized vehicle from an electric vehicle charging station, if appropriate language is adopted in the agencies' municipal code. The process for posting and notification is described in the California Vehicle Code (CVC) Section 22511, and recommended ordinance language to authorize the enforcement of these signs is included in section 2.3 of this document.

Section 4 Installation Streamlining for Residential EV Chargers

The role of the local permitting authority for EVSE installation is to protect public safety by ensuring that electrical work is done properly and all applicable codes are met. The code that applies to EVSE is the National Electrical Code, in particular Article 625, which deals with charging station installations. EV supply equipment represents a significant increase in residential load, ranging from half of a typical household's usage to three times the usage in some areas of California[18]. In fact, many older homes may not have the necessary spare capacity in their existing electrical panel for the new EVSE. These homes may require substantial additional work at significant cost to the customer. Costs can vary dramatically depending on the condition of the existing wiring, panel upgrades, and conduit runs. Installation costs can vary from as little as $200 if all conduits are in place and ample panel capacity exists, to $10,000 or more if extensive replacement of equipment is required.

Any electrical work, including the addition of a 110V or 220V outlet, requires an electrical permit from the local building department and a subsequent inspection to verify that work has been completed in compliance with the approved permit. Obtaining a permit generally requires the completion of an application describing the work to be completed and payment of a permit fee.

A recent survey by the UCLA Anderson School LUSK Center entitled *Realizing the Potential of the Los Angeles Electric Vehicle Market,* confirmed the importance of streamlined permitting in the purchase of electric vehicles. Among the Study's recommendations:

> *Survey results indicate that expedited permitting is very important to Early and Mid-Adopters in Los Angeles. Permitting demands should be addressed within the same day.*[19]

[18] Citation

[19] *UCLA Anderson School of Management, Luskin Center for Innovation, Realizing the Potential of the Los Angeles Electric Vehicle Market, May 2011*

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The creation of standardized procedures across multiple jurisdictions will allow EVSE installation partners to train installers how to meet a more consistent set of requirements. To facilitate standardized procedures, building official associations have provided recommended best practices to accommodate PEV buyers in a consistent and expeditious manner. There are two key components to this effort: 1) reviewing and streamlining local procedures, and; 2) outreach to and collaboration with utilities, electricians, automakers, and consumer organizations to ensure that overall installation times and "handoffs" are made as rapidly and seamlessly as possible.

4.1 Permitting and Inspection Best Practices

A number of the efforts around the State to streamline EVSE permitting and installations are summarized below, with key documents relevant to these effort included in the appendix of this document, or available on-line (web sites provided in footnotes).

- **The City of Los Angeles** has committed to a 7-day approval process[20] for installation of EVSE, providing the customer's electrical system can support the charging requirement. In addition, Los Angeles has an on-line permitting process which greatly expedites residential permits.
- **The County of Los Angeles' Public Works Department** together with GM, Nissan, Southern California Edison, and a large number of affiliated city building departments have drafted a simple checklist for permitting and inspection to provide consistency throughout the greater Los Angeles area. The Southern California Chapter of International Code Council will be training its membership using the checklist developed in conjunction with the County of Los Angeles. The chapter is also planning to create a training video to assist other jurisdictions effectively utilize the checklist. The checklist will also be shared with local electricians so that they can be prepared to meet the requirements. The checklist is included in appendix 8.6 of this document.
- **The Tri-County Uniform Code Council** representing building departments in the greater Bay Area has adopted uniform guidelines for both residential and commercial EVSE permits that provide guidance for the 55 jurisdictions in the South Bay region of the Bay Area. These guidelines are included in appendices 8.7 and 8.8, respectively, of this document.

Based upon the successful work being done in other communities to streamline EVSE permitting, installations and inspections, the following recommendations are offered to facilitate streamlined permitting and inspections for residential EVSEs on a statewide basis.

[20] http://ladbs.org/LADBSWeb/e-permit.jsf

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Reducing the time required to obtain an EVSE Permit
Current permitting processes for residential EVSEs can be time intensive and result in serious inconvenience, increased costs for the customer, and may result in EVSEs being installed without the legally mandated electrical permit. Reducing the time required to obtain a permit to install an EVSE will improve the customer experience and increase the likelihood that customers will apply for and receive required permits.

Recommendation #1 - Implement on-line permitting: To reduce the number of time-consuming visits to government offices, cities and counties should consider allowing homeowners and licensed contractors to submit EV charger permit applications on-line.

Recommendation #2 - Implement over the counter permitting: Local jurisdictions should implement an over-the counter permit issuance process for single-family residential EVSEs.

Recommendation #3 - Provide outreach and education on EVSE requirements: Local governments should provide information on their web sites about what is needed to apply for an EVSE permit on line and train personnel to provide accurate and timely information.

Recommendation #4 - Prioritize EVSE permitting: To promote public adoption of EVs, cities and counties should consider processing EV charger permit applications on a priority basis. For example, San Francisco allows for prioritization of some permits, but requires permit applicants to trigger the expedited process by requesting prioritization; ideally, prioritization of permit processing for EV chargers would be automatic.[21] The County of Los Angeles also prioritizes EVSE permitting above other building permits.

Recommendation #5 - Establish blanket permits for multiple EVSEs**:** Jurisdictions should provide "blanket permits" allowing for multiple EVSE installations under one permit.

Recommendation #6 (for state action) - Universal permit applications: The State of California should spearhead an effort to develop and utilize one standard permit application throughout the state a using a standard set of requirements similar to those listed in the checklist issued by the Tri-County Uniform Code Council, and included in appendix 8.6 of this document.

[21] Friends of the Earth, *A Survey of Bay Area Permitting Procedures for Electric Vehicle Charging Infrastructure*, 2010.

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Recommendation #7 - Establish low costs for permitting EVSEs: Cost is currently a barrier to both the purchase of an electric vehicle, as well as the purchase and installation of the associated charging infrastructure. Reducing the cost of permitting will help ensure a more positive EV customer experience. (Currently, fees reportedly vary from as little as $20 to over $200.)

Recommendation #8 - Establish flat fees for simple installations[22]: Currently, many jurisdictions set permit fees based on a percentage of the overall cost of the project. This imposes additional computational steps required for applicants, and inflates permit costs for more complex jobs. Cities and counties should adopt flat fees to simplify customer interactions.

Recommendation #9 - Waive plan requirements for simple installation: Cities and counties that currently require plans for simple residential electric vehicle charger installations should waive this policy as it complicates and slows the permitting process. At least two counties – Contra Costa and Santa Clara – do not currently require plans for single-family residential permits.

Reducing the need for electrical upgrades

Recommendation #10 - Allow a 30 amp dryer circuit to be used for installation: This approach will require the installation of a mechanical device to only allow the dryer or the charger to operate at one time, thereby avoiding the need for an upgraded panel in certain installations.

Recommendation #11 - Allow the use of a load limiting device: A load limiting device allows the total load to exceed capacity, but automatically turns off selected circuits if usage reaches 80 percent of capacity.

Reducing the number of required inspections[23]

Applying for a permit and waiting for an inspector can be time-intensive. As many as three separate visits by the installer may be required to apply for the permit, perform the work, and complete the inspection. In addition, a fourth visit by the installer will be necessary if the utility requires a separate inspection. A variety of steps can be taken by localities to reduce these time demands.

Recommendation #12 - Allow self-certification for simple installations: To speed simple installations that do not require an electrical system upgrade, cities and counties should consider adopting a process whereby registered, licensed electricians can self-certify that they have installed equipment according to code.

[22] Friends of the Earth, *A Survey of Bay Area Permitting Procedures for Electric Vehicle Charging Infrastructure*, 2010.

[23] Friends of the Earth, *A Survey of Bay Area Permitting Procedures for Electric Vehicle Charging Infrastructure*, 2010.

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New York City is already utilizing a similar self-certification process, and British Columbia, Canada may soon adopt a self-certification model as well.

Recommendation #13 - Condense compliance review inspections for complex installations[24]: Since multiple home inspections can cause time lags in the installation process, cities and counties that require interim inspections of upgraded electrical equipment should simply hold one final inspection that includes compliance review of the electrical upgrade as well as the charger installation. Currently, home site visits can include an electrician's initial on-site assessment of a home's capacity load, the electrician's upgrade of electrical systems, the local government inspection of the equipment upgrade, the electrician's installation of charger infrastructure, and the final inspection of the charger installation. Having recognized the time delays involved in such visits, officials in New York are by revising city code to allow for just one inspection at the end of project installation.

Reduce the time associated with completing required inspections

Recommendation #14 - Establish 24-hour inspection request systems[25]: Cities and counties should consider establishing on-line or 24-hour voicemail systems through which EV permit applicants can schedule inspections. Although a number of Bay Area cities and counties already have such systems in place, others offer only restricted daytime hours for scheduling.

Recommendation #15 - Provide shorter inspection windows: Establish 2-hour windows for site inspections, to limit customer wait time. This has been effectively implement in Los Angeles.

Recommendation #16 - Unify building and utility inspection: In the City of Santa Clara, building and utility inspections are unified (due in part to the existence of a municipal utility). Cities with close relationships with their utility may be able to integrate these functions.

Streamline permit review, issuance, and inspections

Recommendation #17 - Develop and deploy an EVSE plan review checklist: Develop and utilize an *EVSE Plan Review Checklist*[26], which at a minimum should include the following required elements for approval of a permit:

[24] Friends of the Earth, *A Survey of Bay Area Permitting Procedures for Electric Vehicle Charging Infrastructure*, 2010.
[25] Friends of the Earth, *A Survey of Bay Area Permitting Procedures for Electric Vehicle Charging Infrastructure*, 2010.
[26] LA County Working Group

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- Provision of a site plan illustrating project location and identifying the proposed location of the Electric Vehicle Supply Equipment
- Demonstration of physical protection of Electric Vehicle Supply Equipment. (CEC 110.27)
- Provide electrical load calculations of existing and/or proposed electrical system, including EVSE model number and full load amperage; and
- Provide electrical single line diagram of proposed work.

Multi-family Dwelling Unit (MDU) Charger Installations

Installations of EVSE at multi-family dwelling units (MDU) require more detailed information than a residential permit application. Typical application packages consist of engineered drawings that include a site plan showing the location of the building and the property, a layout showing the location of the electrical work to be done, and specifications for the equipment. Additional details including locations of safety bollards, dimensions of a concrete pad for the base, and striping details or signage to be provided. Applications are reviewed by building, planning, and utility staff, which can require a wait of several days to several weeks, according to local jurisdiction staffing.

Multi-unit development installations typically involve an electrical room with a high voltage main electrical panel, subpanels, transformers, and other equipment. Plan check review may involve sign-off from a city engineer, planning and/or building departments and the city or county fire marshal. While it is unlikely that these steps will be eliminated, cities can help streamline the approval process by taking of the following actions:

Recommendation #18 - Adopt and publicize building codes for MDUs: Local agencies should adopt building codes amendments that address EV charger design and safety standards. For example, cities may require all installations to have protective bollards. [SAMPLE LANGUAGE NEEDED.]

Recommendation #19 - Publish submittal requirements for EVSE projects: Local agencies should develop and distribute handouts containing the requirements for EVSE installation. In addition, subsequent outreach and education should occur targeting the general public and contractors to facilitate complete application submittals.

Recommendation #20 - Develop written procedures for early contact with local utilities: Working cooperatively, local agencies and utilities should develop procedures to regarding customer inspection and service needs.

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Recommendation #21: Fast track approval of EVSE projects. In addition to fast-tracking EV permits, inspection approvals should be fast-tracked, i.e., prioritized above more complex and time-consuming building inspections.

Section 5 Charging Station Installation Strategies

5.1 Equipment

The number of companies manufacturing electric vehicle charging equipment is in the dozens and growing rapidly (see List in Appendix xx). Unlike the competing designs that characterized the EV industry in the 1990s, virtually all plug-in vehicle charging equipment manufactured today comes with a connector that meets Society of Automotive Engineers (SAE) Standard J 1772. The adoption of a universal connector standard for 110v and 208/240 volt charging was a major industry breakthrough that ensures that virtually all vehicles will be able to use all EVSE, regardless of brand name.

Comment [WU2]: Currently being developed

Charging equipment is categorized by voltage and amperage which translates to speed of battery recharging. Typically, the faster the charging, the more complex (and costly) the equipment and the installation is. A major change from the pioneering days of plug-in vehicles is inclusion of the charging components on the vehicle rather than in the external charging equipment. The equipment that drivers plug into at home or at commercial locations includes various features and communication protocols to ensure safety. A final connector standard for DC Fast Charging is still being developed and is expected to be approved in 2012.

A handful of manufacturers are already installing equipment in homes, businesses, and public garages, but many more are expected to begin selling in the near future. Equipment manufacturers have added various features to differentiate their

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equipment from the products of their competitors. Some units are simple, low-cost units that still meet safety requirements and codes. Others include advanced features such as subscription packages, websites for tracking charger locations and availability, credit card or debit card billing systems, and even a reservations system!

Until recently, it was assumed that due to the higher voltage associated with charging equipment, safety required that the 240 volt "Level 2" units be permanently connected or "hardwired" so they could not readily be moved from place to place. A re-examination of the applicable electrical codes resulted in test lab approval of charging products that can be attached to a wall or other structure and plugged in to a special receptacle. The goal of these manufacturers is to make the installation of charging equipment similar to the installation of familiar appliances such as refrigerators, electric stoves and clothes dryers.

Comment [J3]: This is very important. Is there an official name or I.D. for this receptacle?

5.2 Electrical Requirements

As shown in Table xx below, typical residential charging equipment is either 120V (Level 1) or 208/240V (Level 2). Nearly all vehicles come with a standard 110V cord that can plug into any wall outlet. As shown in Section, xx, the complete charge time for Level 1 can be lengthy, ranging from 6 hours for a 50 percent charge of a Volt to 38 hours to fully recharge a Tesla. Despite the longer charge time, most homes can accommodate a 120V charger and this may be a low cost solution for individuals who have limited electricity.

Level	Configuration
AC L1:120V AC single phase	Configuration current 12, 16A
	Configuration power 1.44, 1.92kW
AC L2:240V AC single phase	
	Rated Current ≤ 80A
	Rated Power ≤ 19.2kW

Higher amps and voltage translate to faster charging. To illustrate, the GM Voltec charger draws 16 amps of current, while the charger for the Tesla sports car draws 80 amps. A home with the 100 amp panel typical of mid-century houses may not be able to accommodate the more powerful chargers. Most vehicles available on the market today charge at 3.3 kilowatts per hour at 208 or 240 volts. At this rate, a Volt will charge in 5 hours and a Nissan Leaf in a little over 7 hours. Most Level 2 chargers can
accommodate 6.6 or 7.2 kilowatts of power, even though the battery may be programmed to draw less. Some industry groups are assessing the potential for even faster home charging; these standards have not yet been finalized.

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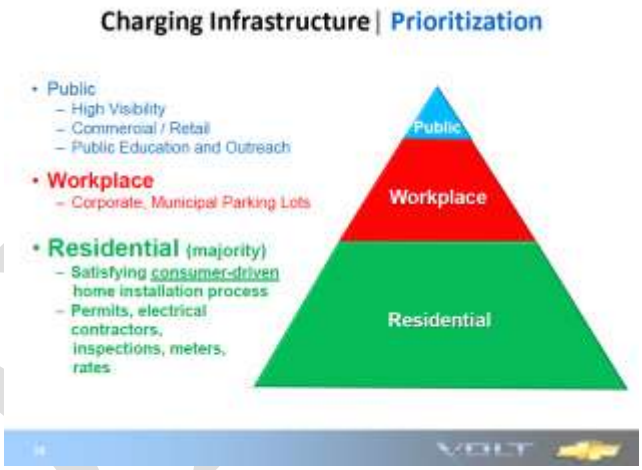
For public or workplace charging, designers should include a 120v, 20 amp circuits for each Level 1 charging outlet and 208/240 40 amp circuits for each Level 2 charging unit.

5.3 Design and Installation

One of the many benefits of driving a plug-in vehicle is the ability to refuel at home, at work, and at play. While 80 percent of charging is expected to take place at home[27], workplace and public charging will play a key role in encouraging consumers to purchase plug-in vehicles.

The figure below[28] below illustrates the anticipated charging pyramid. Designs must be flexible to accommodate the anticipated growth in the number of plug-in vehicles as well as changes in usage of infrastructure as drivers become acclimated to the PEVs and more adventurous in extending their driving range.



5.4 Charging Infrastructure Design Criteria

The buzzword for buying or selling real estate has always "location, location, location." The same can be said for installing charging infrastructure. Location is always the primary factor driving installation cost, although it is supplemented by other factors such as total electrical capacity and other electrical loads.

[27] Citation
[28] Citation

Residential Installation Design
Residential installations are driven by a few key factors:

- The location of the garage or other charging location in relationship to the electrical meter and panel
- The ability of the existing electrical panel to handle the additional charging load which is in turn tied to the age and size of the house and the other electrical loads
- Local utility options for reduced EV charging rates and metering requirements for those rates

Recommendation #22, Training: Provide training and consistent procedures to local plan-checkers and building officials. Training curricula should address where and how equipment can be mounted, clearances around windows or other electrical equipment, protection of equipment from damage by the vehicle and emergency disconnects. Develop a checklist for building inspectors on what to look for in approval a charging equipment installation. (see Sample in Appendix xx from the County of Los Angeles and International Code Council Southern California Chapter). Homeowners also need assistance in making prudent decisions about whether their home has the electrical capacity to accommodate charging equipment, and training must address these general issues.

Recommendation #23, Provide an installation process checklist for homeowners: This checklist (sample provided in appendix x) should include simple "how-to" information for consumers to determine if they can safely accommodate charging equipment. Consumers should be advised that installation costs vary widely and that key variables include:

- The distance between the electrical panel and the garage EVSE location
- The size and loading of the existing panel
- Whether conduit can be mounted to the exterior of the structure or must be buried in a trench or run through walls, basements or attics
- Local utility costs and requirements for installation of a second meter.

Multi-Family Dwelling Units

Multi-family dwelling units, whether rentals, condominiums, townhomes or cooperatives, pose unique challenges when installing charging infrastructure. These include:

- Limited parking: In most multi-family complexes, especially older ones, parking spaces are at a premium and there may not be free spaces to install charging stations.

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- Assigned or deeded parking: It is difficult to predict which units may require chargers. In some cases, it may not be practical to switch assigned parking spaces to accommodate EV drivers.
- Distance between utility meters, parking spaces and unit electrical panels: A new 208/240 EV charging circuit requires connection between the charger location and the tenant's/owner's electrical panel. In multi-family dwelling units, the electrical panel may be in the residential unit and located hundreds or even thousands of feet from the parking area. This can impose significant cost barriers.
- Inability to take advantage of off-peak charging rates: Off-peak EV charging rates may require a new meter and utility service. Most multi-family units have meters that are clustered together in a central location. There may not be space to add another meter. In addition, the new electrical panel for the EVSE might need to be installed hundreds of feet away in the individual residential unit.
- Limited electrical capacity: Older buildings typically have limited electrical capacity. Level 2 chargers typically require a minimum of a 40 amp circuit (with the exception of the Voltec charger which requires a 20 amp circuit). Older apartments or condominium units may have only a 60 amp service or less. Upgrading electrical capacity may be very costly and may also trigger requirements to bring the property up to today's building codes.

As in single family residences, costs for MDU installations are largely determined by existing electrical capacity and distance from the electrical panel to the parking space. Cost mitigation strategies can include placement of charging equipment in guest parking spaces or other common areas. Selection of a charging unit with a billing system will ensure that PEV drivers pay-as-they-go and do not place a financial burden on non-PEV drivers.

Property management groups and/or HOAs should in turn adopt policies to install charging stations in common areas serviced by the same master meter that covers other services such as sprinklers, perimeter lighting, and electric gates. A reservation system or first-come-first-served system could be implemented and users would be billed for their share of the cost. Rates can be established for RFID or credit card payment to the property management group and/or HOA to cover electricity costs and maintenance.

<u>Recommendation #24: Pro-actively outreach to HOA's and property managers</u>: Local or regional government entities, in cooperation with utilities and regional EV consortia should outreach to homeowners' associations (HOAs) and property management groups to communicate solutions for multi-family dwelling units. Legislation pending in California would require that HOAs and other property

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management groups accommodate the needs of residents for charging infrastructure.

Drivers without Garages: A significant percentage of drivers do not have a garage or assigned parking space[29]. This is particularly true in dense urban areas such as San Francisco, and areas of Los Angeles, San Jose, and Santa Monica. These drivers typically park on public streets or in public garages. In some areas, residential street parking is governed by permits issued by the local jurisdiction. Accommodating plug-in drivers without garages requires innovative solutions including: curbside charging (possibly by permit only); installations in nearby public parking structures; and more ubiquitous deployment of Fast Chargers in locations convenient to both employment and residential centers.

Recommendation #25: Develop charging solutions for garage less EV drivers: Potential solutions include providing public charging in the public right-or-way or in public garages. Charging network access fee structures can be developed to help recoup capital costs, maintenance, and electricity costs.

Commercial Installation Design

Charger siting strategies for commercial installations typically involve trade-offs between highly visible locations which can showcase the host site's commitment to the environment vs. lower-visibility locations that may be less costly and less prone to pre-emptive occupancy by internal combustion engine vehicles (also known as "ICE-ing"). As a rule of thumb, distance equals cost, so the longer the conduit run, whether horizontal or vertical, the higher the cost. In general, indoor locations tend to have better access to power than outdoor sites, but outdoor sites may have better cellular reception for units that are wirelessly networked.

The availability of sufficient existing 208 or 240 volt power at the site is a key cost factor. The parking lots and garages of large corporate campuses and retail locations may have sufficient capacity only for the parking lot lights that were installed when the facility was built. Installation of EVSE may require trenching hundreds of feet back to the main electrical room and major electrical upgrade work that can sometimes build into the tens of thousands of dollars, depending on local conditions.

Installation of EVSE in new construction is far more cost efficient than retrofitting existing buildings or facilities. A number of green building guidelines encourage architects and engineers to include charging infrastructures in their building designs. The best known of these are the California Green Building Code (CalGreen),

[29] Need Citation. Can we find state-wide estimate

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and the Leadership in Energy and Environmental Design (LEED) standards developed by the U.S. Green Building Council.

The U.S. Green Building Council rates new and existing commercial and residential construction based on the inclusion of energy saving features and the use of energy efficient construction techniques. Installing an EVSE can earn the following points toward LEED Basic, Silver, Gold, and Platinum certifications**:**

- Any size commercial building and any multi-family residence over 4 stories that installs one or more chargers qualifies for up to 3 points under the New Construction (NC) program or between 3 and 15 points under the Existing Building (EB) program.

- Single family homes and multi-family residences under 4 stories that are new or under major renovation qualify for 1 credit under "Innovative Design" criteria.

The 2010 California Green Building Standards Code which went into effect January 1, 2011 also includes EV charging as a voluntary measure. Voluntary Tier 1 of the Code requires that 10 percent of the spaces be wired with a 120 circuit and a 208 or 240 volt grounded AC outlets or conduit and panel capacity installed for future outlets. Voluntary Tier 2 of the Code requires that 12 percent of the spaces be so configured. The State of California is currently reviewing these requirements to determine if they should be made mandatory.

Some local jurisdictions have created their own EV charging requirements. For example, the City of Los Angeles adopted Section 99.04.106.6. requiring:

Comment [WU4]: Perhaps we should move this into section 3.5.3, Building and Electrical Code Guidance

- One 208/240 v 40 amp, grounded AC outlet for each dwelling unit; or
- Panel capacity and conduit for the future installation of a 208/240 v 40 amp, grounded AC outlet for each dwelling unit.

For residential dwellings with a common parking area, the code requires:

- A minimum of 5% of the total number of parking spaces be equipped with 208/240 v 40 amp, grounded AC outlets; or
- Panel capacity and conduit for future installation of electrical outlets equal to the simultaneous charging of 5% of parking spaces; or
- Additional service capacity, space for future meters and conduit for future installation of electrical outlets equal to the simultaneous charging of 5% of parking spaces.

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5.5 Investment and Revenue Sharing Models

Most equipment and installations are currently subsidized through a variety of grants from the federal government, state government, and regional air districts. Federal tax credits of 30% are still currently available under the Alternative Fuel Vehicle Refueling Property Credit provisions of the IRS code[30], although these will require renewal after 2011.

A number of manufacturers are adding features to their equipment that allow sites to collect a fee for the use of the charger. These chargers may also have internet capability for collecting and viewing data on usage, fees collected, and even greenhouse gas reductions.

As the market grows, other financial models include leasing and subscription based models are starting to emerge. The energy services company known as NRG is currently investigating the deployment of their charger program in California – currently deployed in Houston and other metro markets under the E-Go brand. This program provides low-cost residential charger installations to customers who sign up to access their large-scale public charger networks based on three-year "cell phone style" access packages that range form $49 to $79 dollars a month, with electricity usage included in the higher cost packages. There may be state utility commission restrictions on the ability of NRG or others to offer these charge network subscription packages until CPUC rule-making is further clarified. In the meantime, some local governments and public utilities may be able to develop creative approaches along these lines.

Section 6 Utility Considerations

Many utilities are playing a key role in the installation of charging infrastructure, and all utilities are involved in the provision of power to the infrastructure after it is installed. Utilities in California are divided into municipal and investor owned groups. Municipal utilities (or "munis") are governed by state law and a local district board or City Council. Investor owned utilities are private corporations governed by their Boards of Directors and regulated by the California Public Utilities Commission (CPUC). The CPUC has been investigating issues related to the implementation of electric vehicle charging for approximately two years and has issued decisions and draft decisions on several key points. These decisions will affect what investor owned utilities can and cannot do in the EVSE arena. Municipal utilities, while not subject to CPUC regulation, may be required by legislation to implement policies similar to those required of the investor owned utilities.

[30] Citation Needed

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Local Agency/Utility Coordination

Utilities have been working closely with local governments and automakers to prepare for the potential grid impact of plug-in vehicles. Among the most critical elements has been a campaign to ensure that the utility is notified of the residential EVSE location when an EV is purchased. Such notification enable utilities to evaluate the impact on the electrical grid and plan necessary upgrades. As a result of negotiations with the utilities, automakers currently selling plug-in vehicles are asking PEV buyers to "opt-in" to the notification policy, allowing their home addresses to be shared with the utility. Access to data from the Department of Motor Vehicles is also being explored. Another notification method being discussed is through a check box on electrical permit applications.

Recommendation #26: Provide utility notification of charger installations: As part of a standardized permitting application and checklist, include a check box for EVSE installation and a notice that this information is being shared with the local utility. Since permit information is public record, this is a simple way to notify utilities of the chargers being installed in their territory.

Many major cities have already reached agreements with utilities to link this information to utilities. Other approaches currently being explored include a statewide reporting mechanism being discussed by the California PEV Collaborative and California Energy Commission.

6.1 Electricity Rate Information and Sub Metering

Many California utilities offer special rates to encourage EV use and to establish incentives for EV owners to recharge at night and in "off-peak" hours when the utility has surplus distribution capacity, and cleaner renewable electricity is more widely available. Since wind generally blows more strongly at night, EVs are particularly well-suited to balance available supply of wind by charging primarily at night. EV charging is a good match for "time-of-use" rates because most EV users (including fleet and residential customers) find it most convenient to charge overnight. Moreover, for EV users seeking to get the lowest possible rates, adopting a special EV "time of use" rate is crucial. This provides a more-cost effective options for most residential customers, who are currently subject to what is known as a "tiered" rate structure.

How Tiered Rates Work

The specific rate design and rate amount varies for each California utility. However, the PG&E rate structure is typical and will be discussed here for illustrative purposes. In the first or lowest-cost tier, as of mid-year 2011, customers pay 12 cents per kWh for the first 294 kilowatt hours (kWh). That rate rises to 14 cents/kWh for the next 88 kWhs used, all the way up to 39 cents for amounts over 589 kWh. According to the

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Department of Energy, the average California household uses 580 kWh each month. Thus, if an EV customer adds an EV load to their home rate, they could "bump" much of their total household use into the highest rate, which is more than three times the lowest rate.

Special Utility EV Rate

To address the problem of tiered rate structures that would otherwise penalize EV owners, some utilities offer special "sub-metering" programs that enable EVs to be billed on an additional sub-meter, installed as an adjunct to an existing meter. The specifics on these programs vary by utility. The following websites provide information on relevant programs for the major metro investor-owned utilities in the state. Customers of smaller utilities should consult their local utility website or call the customer information center.

PG&E	http://www.pge.com/about/environment/pge/electricvehicles/fuelrates/index.shtml
SoCal Edison	http://www.sce.com/PowerandEnvironment/PEV/rate-charging-options.htm
San Diego Gas & Electric	http://www.sdge.com/environment/cleantransportation/evRates.shtml
SMUD	http://www.smud.org/en/community-environment/evs/Pages/PEV-Rates.aspx

Whole-house "Time of Use" Rates vs. EV Charger Sub-Metering

For many utilities, there are two options available to homeowners seeking to use lower EV "time of use" rates. The first option is to place the entire house—including the EV charger—into the special EV rate, which varies significantly depending on when power is utilized. For example, in PG&E territory, the "Experimental Time-of-Use Low Emission Vehicle rate" known as Schedule E-9, provides electricity at night in the 5-6 cents per kWh range; whereas the peak period rate is in the range of 28 cents per kWh. PG&E customers should be aware that use of the E-9 rate *is mandatory for customers currently on a residential electric rate who plan on refueling an EV on their premises*. The Southern California Edison rate plan provides off-peak EV charging at a rate of 11 cents/kWh for charging between 9 pm and noon, and 22 cents/kWh for day-time charging in the winter, and 28 cents in the summer.

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Installing an EV Sub-meter

An alternative to whole-house time-of-use rates is to meter EV charging separately from the rest of the house. In many cases, this provides the least expensive overall rate option for consumers because it may not impose new time-of-use rate structures on regular (non-EV-related) uses of electricity within the home. To accommodate this option, a second meter panel or a special "dual-meter adapter" is required. The adapter may not work in all residential installations. To assess specific conditions in a customer's home, the customer will likely have to pay a licensed electrician to perform an assessment. Depending on the evaluation results, the utility may install a second meter conforming to local jurisdiction and utility requirements, including local permitting and inspection guidelines. Once an electrician confirms that your electrical panel can accommodate a second meter, some utilities will install the second meter at no charge, while others may impose some fees.

Commercial charging and demand response programs

Many commercial customers participate in utility programs that include both time-of-use rates and so-called "demand charges" if electricity utilization exceeds a certain threshold within a peak period of electricity demand. To ensure that demand charges are limited, many chargers are equipped with communications equipment that enable the charger to "ramp down" its charging rate (or even temporarily halt charging) in response to signals from the utility or from energy management system software deployed at a nearby facility. Where cars are parked all day, these time-limited periods of engagement in "demand response events" are not likely to be noticeable to the EV owner, or problematic in any way.

Many sophisticated building energy management systems also enable corporate or facility energy managers to balance a variety of loads within a large facility to ensure that demand charges are minimized even if there are several chargers being accommodated on a single campus or property. To manage this kind of "smart charging" from the EV owner's perspective, many companies are working on software that will enable EV owners to specify how much driving range they need from a given charging session, so that demand response events can be tailored to specific parameters defined by the EV user. For additional information on smart charging capabilities of EV chargers, please see Appendix _ for a list of charging companies and their contact information.

As discussed above, utilities throughout the state are offering special rates to encourage EV use and to establish incentives for EV owners to recharge at night and in "off-peak" hours when the utility has surplus distribution capacity, and cleaner renewable electricity is more widely available. The table below summarizes the current offerings of the largest utilities throughout the state.

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Utility	Options	Website/Contact
Southern California Edison	SCE offers customers a choice of a whole house time of use rate or a special residential EV rate. The EV rate requires a second panel, service and utility meter for the EVSE only. SCE also has an on-line calculator and encourages all customers to have a free rate analysis done to help determine the best option for them.	http://www.sce.com/PowerandEnvironment/PEV/rate-charging-options.htm
Los Angeles Department of Water and Power	Los Angeles Department of Water and Power offers a $0 .025 cent per kwh rate reduction for off peak charging. Customers can chose to install a separate meter and service to take advantage of inexpensive off-peak rates plus the EV charging discount. Or customers can choose a time of use rate without a second meter and receive a 500kwh per month discount of $.025 per kwh.	http://www.ladwp.com/ladwp/cms/ladwp002056.jsp
Pacific Gas and Electric	Pacific Gas and Electric Company offers a special discounted rate for Electric Vehicle (EV) customers, the Experimental Time-of-Use Low Emission Vehicle rate (Schedule E-9).	http://www.pge.com/myhome/environment/pge/cleanair/electricdrivevehicles/charging/index.shtml
San Diego Gas and Electric	SDG&E has two residential EV charging rates. The first EV-TOU rate allows customers to take advantage of lower off-peak (night-time) rates and requires a second utility meter and service panel. The second rate EV- TOU-2 puts the entire home on time of use and does not require a second meter and service.	http://www.sdge.com/environment/cleantransportation/evRatesFAQ.shtml
Sacramento Municipal Utility District	An optional discounted electric rate is available for charging PEV. The Residential Time-of-Use Electric Vehicle (**RTEV**) rate offers a $.0243 (winter) to $.0271 (summer) discount per kwh and requires a separate meter and service.	http://www.smud.org/en/community-environment/evs/pages/index.aspx

6.2 Integration of EVs with Renewable Energy and Efficiency Strategies

Many utility industry experts have expressed concern that EVs could create problems for the utility grid if deployed in large numbers. Others have said that EVs can actually help utilities to balance their load across peak and non-peak hours by utilizing car batteries as "distributed storage assets," and help integrate intermittent renewable resources – especially wind and solar – into the grid. The reality is that both views are correct. EVs represent a challenge and a potential asset for grid

operators. It is likely that the gradual pace of EV deployment will give utilities sufficient time to adapt their operations to ensure the most efficient utilization of EVs, and to deploy the "smart charging" and "vehicle-to-grid" controls and communications needed to ensure that EVs are seamlessly integrated into the power system.

The most important issue in EV integration on the grid is ensuring that customers charge at off-peak times. In California, the largest peaks occur in the summertime when air conditioning load is highest, typically in the 2pm to 6pm timeframe. Some utilities have reported that even a single 220 volt EV charger could overload transformers during peak hours, under heavy air conditioning or other loads. This is due to the fact that an EV battery can draw as much power from the grid as the rest of an average household load combined, if the car is charging at full capacity through a 240 volt outlet. (The power draw of an EV is much less of a concern if the vehicle is charging at 110 volts.) To mitigate the effects on transformers and other distribution equipment, utilities are striving to make their grids "smarter" – by installing smart residential chargers and/or smart sub-meters that have software built in to ensure that customer charging within a neighborhood is managed so as not to overload existing transformers.

Comment [WU5]: Consistent reference needed throughout document.

Another option that many commercial and residential customers will find attractive is integrating solar photovoltaic power into their home energy mix. To the extent that solar power can substitute for more expensive grid-tied power, utilizing solar power to directly charge vehicles may be a cost-effective option, with the added benefit of reducing the greenhouse emissions associated specifically with electric driving. In addition, through "vehicle-to-building" (V2B) connections, it will be possible for some future EVs to provide back-up power to homes or offices during a power outage. Finally, as utilities and auto-makers begin to implement full "vehicle-to-grid" (V2G) connections, EV drivers and EV charge station owners will be able to provide a range of "ancillary grid services" in return for payment for use of small amounts of battery capacity by the grid itself.

In the PJM utility system territory in the mid-Atlantic states, for example, a utility-university-industry coalition known as the Mid-Atlantic Grid Interactive Car Consortium[31] has demonstrated that specially equipped EVs can provide "frequency response" energy services to the grid from the vehicle (when plugged into a charging station) by turning on charging to balance excess supply on the grid, and providing energy back to the grid to balance excess load. This service, when aggregated across many vehicles, can be "bid into" energy markets, with payments arranged by an energy aggregation company. According to the MAGICC group, commercial payments now being provided to fleet owners in the MAGICC pilot test area now amount to nearly $2000 per vehicle per year, with very little degradation

[31] Citation needed

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of battery life and no impact on vehicle usability or performance. This level of payment for use of the EV battery could – over the long-term – be a "game changer" for EV economics. However, numerous technical and commercial hurdles need to be resolved to make V2G connections a reality in the near-term. In California, a variety of pilot V2G projects are underway in locations in the Bay Area, at the University of California at Los Angeles, and at UC San Diego. Fleet operators or local governments interested in participating in V2G pilot tests and demonstration programs should contact the EV Communities Alliance[32].

6.3 Fast Charging

Unlike 240 volt Level 2 chargers that take 3 to 8 hours to fully recharge a depleted battery pack, DC Fast Chargers can recharge a battery pack to 80% capacity in approximately 25- 30 minutes. While Fast Charging is unlikely to be installed in homes due to the high cost of equipment and installation (approximately $50,000 – $75,000 installed), some commercial enterprises are viewing fast charging as a business opportunity.

A number of manufacturers are developing fast chargers for release late in 2011. Since no U.S. SAE standard for fast charging connectors currently exists, early units will be fitted with connectors that meet the Japanese Chademo standard. This standard may be adopted by the U.S. or superseded by a new SAE standard by the end of 2012. The Nissan Leaf has fast charge connectivity available as an option and the Mitsubishi "i-miev" is expected to have fast charge as standard equipment.

Fast charging installations raise a number of challenges for property owners and utilities, specifically:

- The power requirements of fast charging—anywhere from 50 kilowatts to over 150 kilowatts at 480 volts may require costly electrical upgrades
- The demand on the utility of instantaneous high voltage may require utility upgrades to existing infrastructure
- The current rate structure can result in high electricity "demand charges."

Despite these challenges, some regions – notably San Diego and the Bay Area, are moving rapidly to deploy large numbers of Fast Chargers, without over 100 Fast Chargers planned for the Bay Area in 2011-2012. In the event that the Fast Charge connector standard changes, vendors promise quick and relatively inexpensive retrofits or adapters to support "legacy standards." The core of the Fast Charge hardware will remain usable for the next generation connector, should it vary from the Chademo standard already adopted by Japanese manufacturers.

[32] www.evcalliance.org

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Section 7: Greening the Fleet

7.1 The EV Role in Greening the Fleet

Public and commercial fleets that include medium and heavy-duty trucks are responsible for a disproportionate share of both greenhouse emissions and fossil fuel consumption. Accordingly, "greening the fleet" is a high-priority for fleet operators in response to California state regulatory mandates (AB 32), and steeply rising gasoline and diesel fuel costs. At the regulatory level, fleet operators are being pressed to reduce both "Category 1 Criteria Pollutants" harmful to human health – which include particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOCs), sulfur oxides (SOX), nitrogen (NOX), and lead (Pb) – as well as "Category 2 – greenhouse gases" – which are causing disruptive changes in the climate system. Historically, "clean fleet" or "green fleet" efforts have focused on fuel and emissions reduction, conventional hybrid vehicles, and natural gas vehicles (NGVs).

What distinguishes green fleet initiatives in the era of electrified transportation is that new plug-in EV models are beginning to appear with significantly improved environmental and operating cost advantages over conventional hybrids and other alternative fuel vehicles, including biofuels and NGVs. Given the increased diversity of available EVs – and their steadily improving price/performance profile relative to conventional vehicles, green fleet programs are increasingly focused specifically on accelerated integration of EVs into the fleet mix. These initiatives also increasingly include analysis and testing of the potential for EV conversions of existing vehicles to reduce fleet operating costs.

While EVs are a logical focus for green fleet programs, the structure of green fleet initiatives can best be stated in terms of over-arching goals, rather than the specific technology choices deployed to achieve those goals. Thus, green fleet programs are typically focused on:

- Enhancing the fleet's impact on the environment and human health
- Reducing costs
- Preparing for future conditions (including potential fuel price spikes or supply disruptions) and regulatory requirements.

7.2 Vehicle technology types and trends

It is important to emphasize that almost any size or type of fleet can be "greened" via the introduction of available and forthcoming BEVs, PHEVs, or conversions. For example, public and private fleet operators have introduced EVs into small fleets of three-wheeled "meter maid" vehicles, specialized utility "bucket truck" fleets,

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medium-duty urban delivery vehicles, taxis, car share fleets, and even off-road "Class 8" port operations (dryage vehicles).

At current prices, EV trucks typically provide fuel cost savings in the range of 75% less than diesel[33]. In addition, EVs offer significant green "halo effect" benefits for customers and other stakeholders who are looking to public agencies and corporations to show meaningful and measurable signs of responsible action on the climate and sustainability agenda.

7.3 Life cycle costing and maintenance/support implications

While the initial purchase price of EV fleet vehicles is typically higher than comparably equipped conventional vehicles, EV buyers do enjoy lower fuel costs, insulation from fossil fuel price shocks, and significantly lower maintenance costs (in the case of BEVs). These advantages are leading many fleet managers to embrace EVs as a core element in their green fleet plans. For BEV fleet vehicles, the maintenance burden is significantly reduced. EV engines have as few as four moving parts compared to more than a thousand parts in an internal combustion engine. Exhaust systems are non-existent, cooling systems radically simplified, and complex clutches and transmissions replaced with simplified units.

Developing a green fleet may require a re-consideration of how capital and operating expenditures are allocated. With fueling costs that can be 75% lower than ICEs[34], yet initial purchase prices that are as much as 50% higher, many fleet managers have pointed out that much or all of the battery expense may need to be re-configured as an operating expense. Batteries are to some degree a "consumable" insofar as they may need to be replaced in the case of a long-lasting fleet vehicle (e.g., at the 8-10 year mark or after 200,000 miles.)

Some vehicle manufacturers are offering to separate the battery from the vehicle and bundle this resource on a separate financing schedule, in some cases with an EV charger subscription contract. These kinds of innovative financing arrangements are likely to proliferate in the coming years, and in some cases place the battery clearly in the operating expense column of the fleet budget. When batteries are de-coupled financially from the vehicle, many of the EVs available today, even in the commercial class, are cost-competitive with ICE purchase prices. Further, with fueling costs typically falling below $1/ gallon equivalent for EVs vs. comparable ICEs, there is a $3+/gallon difference between EV and ICE costs that can be accessed to repay the full battery cost on the "fuel" budget.

[33] Citation needed
[34] Citation needed

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Operating Cost Comparison ICE vs. BEV	**Internal Combustion (ICE)** TYPE: 5 passenger RANGE: 400 mi. with 16 Gallon tank GASOLINE: $3.50 Gallon FUEL COST/TANK: $56.00/ 400 m	**Battery Electric Vehicle (BEV)** TYPE: Nissan LEAF ~ 1kWh = 4 mi. driving distance RANGE: 96 mi. w/ 24kWh battery ELECTRICITY: $0.056 / kWh (off-peak PG&E summer rate with "E9B" Plan)	**Usage Pattern** TERM: 6 Yrs. USAGE: 18,000 mi. / Year TOTAL Mileage: 108,000
Fuel	**Gasoline (ICE)**	**Electric (BEV)**	**Fuel Cost Savings**
Cost (per mile)	**$0.140** Avg. 25 MPG – regular gas Cost per mi.: $56/400 miles = 14 cents/mile	**$0.014** Electricty cost of 5.6 cents per kWh. 1kWh = 4 Mi. of driving distance = 1.4 cents per mile	**10x less**
Lifetime Costs (6 yrs./108k miles)	$15,120	$1,512	**$13,608 savings in 6 Yrs.**
Maintenance	**Gasoline (ICE)**	**Electric (BEV)**	**Maintenance Savings**
Est. routine service and engine wear Lifetime Costs (6 Yrs./ 108K mi)	~$6,000	~$2,000	**$4,000 savings in 6 Yrs.**
Ownership	**Gasoline (ICE)**	**Electric (BEV)**	**Ownership Savings**
Est. Insurance (6 Yrs./108K mi.)	~$6,000	~$5,000	**$1,000 savings in 6 Yrs.**
Est. DMV Smog (6 Yrs./108K mi.)	~$400	~$0	**$400 savings in 6 Yrs.**
TOTALS	~$27,520	~$8,512	**~$19,008/6 Yrs.**

Even with a $10,000 to $15,000 or more price differential between and light-duty BEV and the equivalent ICE vehicle, total life-cycle cost savings based on the heavier usage typical of many fleet vehicles can be compelling. The above example from the California PEV Collaborative[35] uses a conservative $3.50/gallon gasoline cost and still produces a substantial savings over the vehicle life-cycle that more than makes up the difference in initial purchase price.

[35] Need Citation

7.4 Green Fleet Plan Deployment

To work through the specifics of EV fleet greening efforts, a typical planning effort involves these elements:

- Developing a GHG inventory (baseline)
- Developing GHG and fuel efficiency targets
- Analysis of fleet duty cycles and comparison with available electric vehicles with
  regard to range, charging requirements, and operating costs
- Development of a comprehensive green fleet plan that includes goals, milestones, staff responsibilities, commitments from top management, and monitoring and implementation strategies.

Greening the fleet efforts typically involve the integration of several "value streams" and functional areas across an organization, including fleet operations, environmental health, and marketing/communications. At the City of San Jose, for example, the Clean Fleets Team[36] includes representatives from fleet management across a variety of departments, environmental services, finance, the City Manager's Budget Office, and transportation planning and public works (to address charging station issues.) A project lead should have strong knowledge of fleet operations while being both pragmatic and enthusiastic in their communication of the environmental and economic benefits of EV approaches. With a team-based approach, all of the various components of the EV ecosystem – including charging infrastructure, supportive policies, economic analysis, and operational management changes – can be fully integrated into a compelling "value proposition" for decision-makers.

7.5 Commercial EV Technologies and Fleet Charging Challenges

Commercial classes of EV vehicles are evolving rapidly and encompass nearly every class of vehicle. By late 2012, EV models will include examples from every class of vehicle – from high-performance motorcycles (Vectrix, Zero, et. al.) to medium-duty cargo vans (Smith Electric) to heavy duty Class 8 (Navistar), to SUVs, cross-overs, pickups, mini-vans, vans, compacts, sports cars, and luxury cars. Given the rapidly evolving alternative fuel vehicle fleet market, fleet operators are advised to obtain the latest information from organizations such as Plug-in America[37], which tracks all classes of EVs, and CalStart[38], which focuses on medium and heavy-duty options. Commercial ev technologies and fleet charging challenges

[36] Citation Needed
[37] http://www.pluginamerica.org/
[38] www.calstart.org

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Fleet charging challenges

Fleet vehicle charging options span the full range from Level 1, Level 2, and Fast Charge options, depending on vehicle type and specific applications. As with any commercial charging arrangements, fleet managers need to be cognizant of "demand charges" and demand response programs, as well as utility time-of-use rates to select an optimum configuration for their needs. Where light-duty vehicles are likely to be stationary for 12 hours or more, Level 1 charging options may be most appropriate, as these will not require special wiring of EVSE. For vehicles needing the fastest turnaround for demanding applications such as shuttle or taxi services, Fast Charging may be a high-priority need and worth the extra cost. The table below provides some indication of the range of costs likely in different charging circumstances:

Charger Type	Charge	Time to Charge Vehicles at Various States of Charge			Charger Hardware Costs[39]	Installation Costs[40]	Typical Range of Total Costs	Average Total Costs
		Volt 16 kWh	Leaf 24 kWh	Tesla 53 kWh				
Level 1 1.4 kW 110 volts	Half	6 hrs	8.5 hrs	19 hrs	$300 - $500	$300 - $500	$600 – $1000	$900
	Full	11 hrs	17 hrs	38 hrs				
Level 2 7.5 kW 240 volts	Half	1 hrs	1.5 hrs	3.5 hrs	$500 - $1500 home $2000 - $6000 commercial	$500 - $2500/home $3,000 – 5,000 commercial	$1500 – $4,000/home $4,000 - $11,000 commercial	$2200/ home $8000/ commercial
	Full	2 hrs	3 hrs	7 hrs				
DC Fast 50 kW 480 volts	Half	10 min	15 min	35 min	$25,000 $55,000	$15,000 - $30,000*[41]	$40,000 $85,000	$65,000
	Full	20 min	30 min	70 min				
DC Fast 150 kW 480 volts	Half	5 min	8 min	17 min				
	Full	10 min	16 min	35 min				

Estimated Vehicle Charging Times and Charger Hardware and Installation Costs

Comment [WU6]: Need replacement chart, rows cut off

***Comment**: the federal Alternative Fuel Infrastructure Tax Credit provides a credit of 50% of the cost of installing EV charging stations, not to exceed $50,000 for commercial stations and $2,000 for residential chargers. This credit will expire at the end of 2011 unless extended by Congress.*

[39] Hardware costs are trending downward quickly

[40] For hard-to serve installations, costs can vary upwards

[41] Higher-cost units have multi-car charging capability

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Fleet Charging and Management

Fleet operators have unique opportunity software tools available to centrally manage charging status and charging information. Several manufacturers, including Aerovironment, ECOtality, Coulomb, GE, and others, currently have or plan to offer EV fleet charging software of varying levels of sophistication. For example, the Coulomb Network Fleet Manage provides status and location of EVs in the fleet via its fleet management application, indicating whether the vehicle is fully charged, charging, or not plugged in. E-mail or SMS summaries are available along with driver and vehicle workflow management. Analytics enable tracking and reporting of GHG reduction, fuel efficiency, and other data to manage and measure fleet performance by driver, vehicle, department, or fleet. Data on charge duration, start and stop times, and e-fuel use are available to be exported or integrated with other applications.

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Section 8 Appendices

8.1 Glossary of terms

- **AC —** Alternating current, an electric current which changes direction with a regular frequency
- **AB32 —** Assembly Bill 32-California Global Warming Solutions Act of 2006
- **ABAG —** Association of Bay Area Governments
- **AFV —** Alternative Fuel Vehicle
- **AHJ —** Authority Having Jurisdiction
- **ARRA—**American Recovery and Reinvestment Act
- **BAAQMD —** Bay Area Air Quality Management District
- **BEV —** Battery Electric Vehicle
- **CA MUTCD**—California Manual on Uniform Traffic Control Devices
- **CARB** or **ARB —** California Air Resources Board
- **CBC**—California Building Code
- **CBSC —** California Building Standards Commission
- **CalTrans** – California Department of Transportation
- **CAP**—Climate Action Plan
- **CCID—**Charge Current Interrupting Device
- **CCR, Title 24**—California Code of Regulations, Title 24 (commonly known as the California Building Standards Code)
- **CEC**—California Electrical Code
- **CEC —** California Energy Commission
- **CEQA —** California Environmental Quality Act
- **CFC**—California Fire Code
- **CO_2**—Carbon Dioxide
- **CPUC** or **PUC**—California Public Utility Commission
- **CTP**—Comprehensive Transportation Plan
- **CVC —** California Vehicle Code
- **DC —** Direct Current
- **DOE —**Department of Energy
- **DOT —**US Department of Transportation
- **EPRI —** Electric Power Research Institute
- **EREV —** Extended Range Electric Vehicle
- **EV —** Electric Vehicle
- **EVCS—**Electric Vehicle Charging Station
- **EVI —** Electric Vehicle Infrastructure
- **EVSE —** Electric Vehicle Supply Equipment
- **FHWA —**Federal Highway Administration
- **GHG —** Greenhouse Gases
- **ICC—**International Code Council
- **ICE —** Internal Combustion Engine
- **kWh —** Kilowatt hour
- **LEED**—Leadership in Energy and Environmental Design
- **MTC —** Metropolitan Transportation Commission

Comment [WU7]: This glossary primarily came out of Sonoma County work, and is northern California centric….if we include PG&E and MTC we should have consistency across the planning areas….or remove regional planning and utility entities all together

Comment [J8]: So. Ca. equivalents?

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- **MUTCD —** Manual on Uniform Traffic Control Devices
- **NECA –** National Electrical Contractors Association
- **NEC —** National Electrical Code
- **NEV —** Neighborhood Electric Vehicle
- **NFPA —** National Fire Protection Association
- **NREL —** National Renewable Energy Laboratory
- **OHS**—Occupational Health and Safety Act
- **PG&E—**Pacific Gas and Electric Company
- **PHEV —** Plug-in Hybrid Electric Vehicle
- **RFID**—Radio Frequency Identification subscription service
- **SAE —** SAE International(Society of Automotive Engineers)
- **SCS**—Sustainable Communities Strategy
- **TFCA**—Transportation Fund for Clean Air
- **TOU —** Time of Use
- **VMT —** Vehicle Miles Traveled
- **V2G —** Vehicle-To-Grid
- **ZEV**—Zero Emission Vehicle

8.2 Matrix of incentives

Alternative Fuel Vehicle Refueling: This is a federal tax credit for commercial charging infrastructure. The credit amount is up to 30% of the cost, not to exceed $30,000 for equipment placed into service in 2011. Consumers who purchase qualified residential fueling equipment may receive a tax credit of up to $1,000.

Ecotality offers EVSE at no cost to individuals in the Los Angeles and San Diego metropolitan areas. To be eligible for free home charging stations, individuals living within the specified areas must purchase a qualified electric vehicle (EV) or plug-in hybrid electric vehicle (PHEV). Individuals purchasing an eligible EV or PHEV should apply at the dealership at the time of vehicle purchase. The EV Project incentive program will also cover most, if not all of the costs of EVSE installation. All participants in the EV Project incentive program must agree to anonymous data collection after installation. Additional restrictions may apply.

Coulomb Technologies' ChargePoint America program offers EVSE at no cost to individuals or entities in the San Jose, San Francisco Bay, Sacramento, and Los Angeles metropolitan area. To be eligible for a public or commercial charging system, an entity must be located within the specified metropolitan areas and in defined potentially "high use" areas, and provide public access to the charging system. Companies and municipalities may apply on the ChargePoint America Web site. To be eligible for free home charging stations, individuals living within the specified areas must purchase a qualified EV or PHEV.

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Individuals purchasing an eligible EV or PHEV should apply for the ChargePoint America program at the dealership or with the vehicle manufacturer at the time of vehicle purchase. In most cases, installation will be paid for by the EVSE owner; some cities, states, and utilities, however, will provide funding towards installation costs. All participants in the ChargePoint America program must agree to anonymous data collection after installation. Additional restrictions may apply.

Los Angeles Department of Water and Power Electric Vehicle Supply Equipment (EVSE) Rebate is available to the first 1,000 customers who purchase or lease a new electric vehicle and install Level 2 EVSE with a separate time-of-use meter at that submit a completed application

Motor Vehicle Registration Fees: State law authorizes air districts to assess Motor Vehicle Registration fees "to reduce air pollution from motor vehicles and for related planning, monitoring, enforcement, and technical studies necessary for the implementation of the California Clean Air Act of 1988." Several air districts are

currently using these funds for EVSE charging infrastructure including South Coast Air Quality Management District and Bay Area Air Quality Management District

California Energy Commission: Under its AB 118 program, the California Energy Commission has awarded grants for a number of EVSE infrastructure projects, including matching federal funding, replacement of existing obsolete charging infrastructure and creating new networks of charging infrastructure. This multi-year program (through 2014) requires adoption of an annual Investment Plan to direct funding priorities. RFPs are released based on the adopted Investment Plan

Under its AB 118 program, the California Energy Commission has awarded grants for a number of EVSE infrastructure projects, including matching federal funding, replacement of existing obsolete charging infrastructure and creating new networks of charging infrastructure. This multi-year program (through 2014) requires adoption of an annual Investment Plan to direct funding priorities. RFPs are released based on the adopted Investment Plan.

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Incentive	How to Apply	Deadlines or Key Dates
Alternative Fuel Vehicle Refueling Property	IRS Form 8911--equipment must be placed in to service	Expires 12/31/11
Ecotality	http://www.theevproject.com/index.php	evpsupport@etecevs.com
Coulomb Technologies	www.chargepointamerica.com	Stations must be installed by 12/31/11
Los Angeles Department of Water and Power EVSE Rebate	www.ladwp.com/ladwp/cms/ladwp002056.jsp	The program will expire on June 30, 2013 or when the funds are exhausted, whichever occurs first.
Motor Vehicle Registration Fees	www.baaqmd.gov www.aqmd.gov	Contact local air district
California Energy Commission	www.energy.ca.gov/altfuels/index.html	Check website for application dates

Applications and Deadlines

8.3 Case studies

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8.4 EVSE ROI Calculator

Costs based on hours of use of charger based on vehicle with 16kWh battery, i.e. Chevy Volt.[42]

220v charger

Input Assumptions--battery (16 kwh)			16
Costs			
A	Electricity Cost per kwh	$	0.12
B	Kilowatts used per hour		3.3
C	Number of hours each car chargers to completely fill 16 kwh battery half way		2.42
D	Cost per charge	$	0.96
E	Number of cars charging per day		1
F	Days per year charger is used		245
	Cost per year (A*B*C*E)	**$**	**235.20**

Costs based on hours of use of charger based on vehicle with 24kWh battery, i.e. Nissan Leaf.

220v charger

Input Assumptions--battery (24 kwh)			24
Costs			
A	Electricity Cost per kwh	$	0.12
B	Kilowatts used per hour		3.3
C	Number of hours each car chargers to completely fill 16 kwh battery half way		3.6
D	Cost per charge	$	1.44
E	Number of cars charging per day		1
F	Days per year charger is used		245
	Cost per year (A*B*C*E)	**$**	**352.80**

[42] Note: Equates to charging for approximately 10,000 total miles per year

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Revenue based on cost assumptions

Per charge cost	$	5.00
Days Used		261
Revenue per year		**$1,305.00**
Electricity cost per year	$	235.20
Profit per year		**$1,069.80**

Return on Investment

Investment (from quote)	$	10,000.00
Tax Credit (30%) (expires 12/31/11)	$	3,000.00
Accelerated depreciation (at 34% tax rate)	$	2,380.00
Final Cost	$	4,620.00
ROI (Final Cost/Annual profit)		**4**

8.5 Emission reduction calculations

It is difficult to calculate emission reductions specifically for EVSE since the plug-in vehicle is really the emission-reducing entity. However, since most battery powered vehicles cannot operate without being recharged, it seems reasonable to share at least some of the emissions benefit with the infrastructure. In general, kilowatt hours of charge can be translated into miles driven which can be translated into emissions reduced.

For example if a Nissan Leaf charges for 2 hours at 3.3 kilowatts per hour, it has gained a total of 6.6 kilowatts of battery capacity. For the 24 kilowatt hour Leaf battery pack this equates to 27.5% of the total battery capacity. Since the Leaf gets approximately 100 miles to a charge, 27.5% of the battery pack equates to 27.5 miles. If we assume that an equivalent gasoline vehicle would get about 27.5 miles per gallon the 27.5 miles represents the emissions reduction from one gallon of gas or 19.4 lbs[43]. At least some of the EVSE manufacturers are including GHG calculations in their data reporting programs.

[43] California Air Resources Board light duty on road emissions inventory.

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8.6 Checklist for building inspectors for residential EVSE installation

1INFORMATION

PLAN CHECK NO.: EXPIRATION DATE: STATUS:

PROJECT ADDRESS:

WORK DESCRIPTION:

APPLICANT'S NAME: TEL. NO.:

ADDRESS: EMAIL:

INSTRUCTIONS

Your application for a permit, together with plans and specifications, has been examined and you are advised that the issuance of a permit is withheld for the reasons hereinafter set forth. The approval of plans and specifications does not permit the violation of any sections of the Electrical Code or other local ordinances or state laws.

In an effort to streamline the plan review process, please follow the steps outlined below to ensure that there is no delay in processing your application and reviewing your responses to these plan check comments.

- Comments with circled item numbers apply to this plan check.
- Revised plans and calculations shall incorporate or address all comments marked on the original checked set of plans, calculations, and this plan review checklist. Provide a written response to each comment and show where and how it has been addressed. Identify the sheet number and detail or reference note on the revised plans where the corrections are made. Time spent searching for the corrected items on the revised plans or calculations will delay the review and approval process. Once all comments on the plans, calculations, and this checklist have been addressed, contact the plan check staff to **schedule an appointment** to review the changes made.

PLAN REVIEWER: _____ TEL. NO.: _____

ADDRESS: _____

EMAIL: _____ WEBSITE: _____

Should you have any questions or need clarification pertaining to the comments made on your project, you may contact the plan check staff by telephone from to M T W TH F.

- Bring the original checked set of plans and calculations along with this checklist to the meeting. Do not schedule an appointment meeting with the plan check staff until all comments have been addressed.
- Incomplete, indefinite or faded drawings or calculations will not be accepted.

NOTE

Numbers within the parenthesis ( ) refer to the section of the applicable code. 2011 Edition of the California Electrical Code (CEC).

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A. GENERAL PERMITTING REQUIREMENTS

1. Provide site plan of project location and identify the proposed location of the Electric Vehicle Supply Equipment.
2. Demonstrate physical protection of Electric Vehicle Supply Equipment. (CEC 110.27)
3. Provide electrical load calculations of existing and/or proposed electrical system, including EVSE model number and full load amperage.
4. Provide electrical single line diagram of proposed work.

B. ELECTRICAL INSTALLATION REQUIREMENTS

Electric Vehicles – an automotive type vehicle for on-road use, such as passenger automotive, buses, van, neighborhood electric vehicles primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electrical current. (CEC Art. 625.2)

1. LOCATION IDENTIFICATION - Identify the equipment installation location.
2. INDOOR SITES:
   a. Installation of Electric Vehicle Supply Equipment shall comply with California Electrical Code Article 625.29
   b. Equipment Height – The coupling means of the electric vehicle supply equipment shall be stored at a height of 18 – 48 inches above the finished floor. (CEC Art 625.29(B))
3. FASTEN EQUIPMENT - Electric Vehicle Supply Equipment must be permanently connected and fastened in place unless (CEC Art. 625.13):
   a. The supply equipment is rated at 125 volts, single phase, 15 or 20 amperes; or,
   b. Electric Vehicle Supply Equipment is provided with an interlock that de-energizes the electric vehicle connector and it cable whenever the electric connector is uncoupled from the electric vehicle.
   c. Electrical connection per manufacturer specifications.
4. EQUIPMENT PROTECTION – Electrical Vehicle Supply Equipment operating at 50 volts or more shall be guarded against accidental contact by approved enclosures. (CEC Art. 110.27)
5. – When equipment is rated more than 60 amps or more than 150 volts to ground, the disconnecting means shall be provided and installed in a readily accessible location. (CEC Art. 625.23)
6. SYSTEM CERTIFICATION - Verify the equipment is listed by a nationally recognized testing laboratory (as recognized by the Authority Having Jurisdiction.

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TRI-CHAPTER
UNIFORM CODE COMMITTEE (TUCC)

POLICY NUMBER: **17**

APPROVAL DATE: **August 12, 2010**

REVISION DATE: **APRIL 14, 2011**

SUBJECT: **Electric Vehicle (EV) charging system in Single Family Residence (SFR)**

This guideline is developed by the Tri-chapter Uniform Code Committee and is intended to enhance regional consistency in application and enforcement of the Building Code. Please verify acceptance of this guideline with your local building department prior to its application.

CODE REFERENCE (S):

2010 California Electrical Code; Underwriters Laboratory (UL) listed charging system

ISSUE (S):

Efficient permitting and inspection for EV electric charging system will be required to help encourage the use of EV in California. Ideally with the proper documentation, permits to install Electric Vehicle Supply Equipment (EVSE) could be issued over-the-counter. As most jurisdictions have not dealt with EV charging system, a TUCC EV sub-committee was formed in June, 2010 to research and understand the technical requirement for EV and develop a guideline to expedite the permit and inspection process.

Sample EV Charging System

Electric Vehicle Supply Equipment (EVSE) consists of the connector, cord, and interface to utility power. Currently the interface between the EVSE and utility power will be directly hard-wired to the control device, and each automaker has its own EVSE design. A single design called the J1772 Standard EV coupler will be available soon that will be applicable for all electric vehicles.

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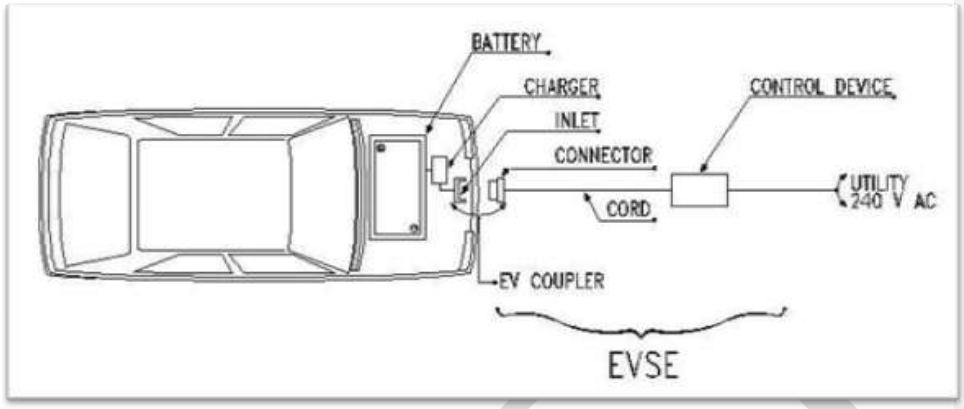
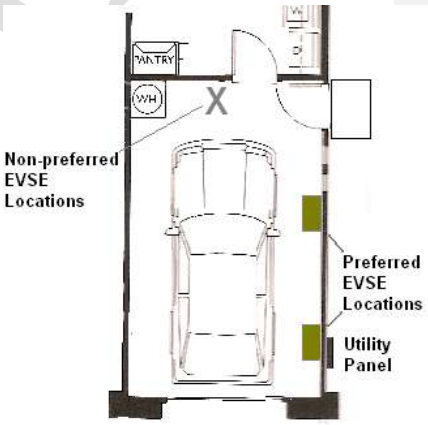


There are 2 levels of charging system for SFR – Level 1 (120 VAC, 15/20 A) and Level 2 (240 VAC, 40A). Level 2 is most likely be used because of less time to charge the vehicle.

Proposed Guidelines

An electrical permit is required for an EV charging system to be installed in the garage or carport of a SFR. The following information is required for a permit:

1. EV charging system information : level 1 or 2, EVSE system with UL listed number or other approved nationally recognized testing laboratory, in compliance with UL2202, "Standard for Electric Vehicle (EV) Charging System Equipment"
2. Existing electrical service panel information at the residence. Include EVSE load and circuit size to determine if electric panel upgrade is required.
3. Panel upgrade and electrical wiring shall be in conformance with the California Electrical code
4. Identify if a second electric meter is required to be installed because of electric utility rate for EV charging
5. Clarify EVSE location
6. EVSE shall be installed in accordance with manufacturer's guideline and must be suitable for the environment (indoor/outdoor).
7. Manufacturer installation guideline has to be available for the inspector at the site.



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TRI-CHAPTER
UNIFORM CODE COMMITTEE (TUCC)

POLICY NUMBER: **18**

APPROVAL DATE: **April 14, 2011**

SUBJECT: **Commercial or Multi-Family Electric Vehicle (EV) charging station**

This guideline is developed by the Tri-chapter Uniform Code Committee and is intended to enhance regional consistency in application and enforcement of the Building Code. Please verify acceptance of this guideline with your local building department prior to its application.

CODE REFERENCE (S):

2010 California Electrical Code (CEC)
2010 California Building Code (CBC)
2010 California Green Building Standards Code (CGBSC)
Underwriters Laboratory (UL) listed charging system

ISSUE (S):

TUCC approved the Residential EV charging system guideline on August 12, 2010. This is the second part of the guideline for commercial and multi-family electric vehicle charging system. The employment of electrical vehicles will greatly help to reduce the air pollutants to meet the State and Federal emission targets. Efficient permitting and inspection for EV electric charging system will help encourage the use of EV in California. Currently, there is no clear requirement in the building code regarding accessibility with EV charging station. A policy will provide consistency in EV permit approval in the Tri-chapter area. Ideally with complete documentation and plans, plan check can be reviewed on a short cycle (1 to 3 weeks of plan check turnaround time depending on the work load of individual jurisdictions).

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Proposed Guideline:

A building and electrical permit are required for an EV charging system to be installed on commercial, industrial or multi-family dwelling properties.

Accessibility requirement:

The minimum number of accessible charging stations required per site is one. The accessible EV charging parking space shall not be counted as one of the required accessible parking spaces as required by CBC, because the space is allowed to be used by non-disabled people. The size of the accessible EV charging parking space and its access aisle and other accessible requirement shall be in compliance with the current CBC, except it needs not be striped or provided with signage as required for accessible parking space. An informational sign shall be posted with suggested wording: "Parking for Electrical Vehicle charging only". Suggested wording for the accessible space: "Accessible parking for Electrical Vehicle charging only".

The accessible charging station equipment shall meet all applicable reach range provisions and accessible path under the current CBC accessibility requirement.

The EV charging parking space(s) may be counted towards the number of required low-emitting/fuel-efficient parking in the CGBSC.

Other requirements:

- Charging system equipment, EVSE (Electric Vehicle Service Equipment), installed inside individual garage of multi-family dwellings shall follow TUCC policy #17 for EV charging system in single family dwelling, with the exception that Homeowners' Association or owner's approval (in the case of rental property) is required. Charging stations installed outside the multi-family dwelling buildings shall follow this guideline.
- Publicly available charging system shall follow this guideline. But lighting and shelter are important consideration at public sites.
- Identify all EV charging station locations on the plan.
- Identify if site is in the flood zone. If so, charging station shall be elevated or designed according to the flood requirement.
- Identify if a second electric meter is required to be installed because of electric utility rate for EV charging.
- EV system with UL listed number or other approved nationally recognized testing laboratory shall be provided on plan.
- Provide electric load calculation and design for the charging stations. Dedicated new branch circuits from the central meter distribution panel to the charging station may be required.
- Planning. Engineering and Fire Departments approval may be required.

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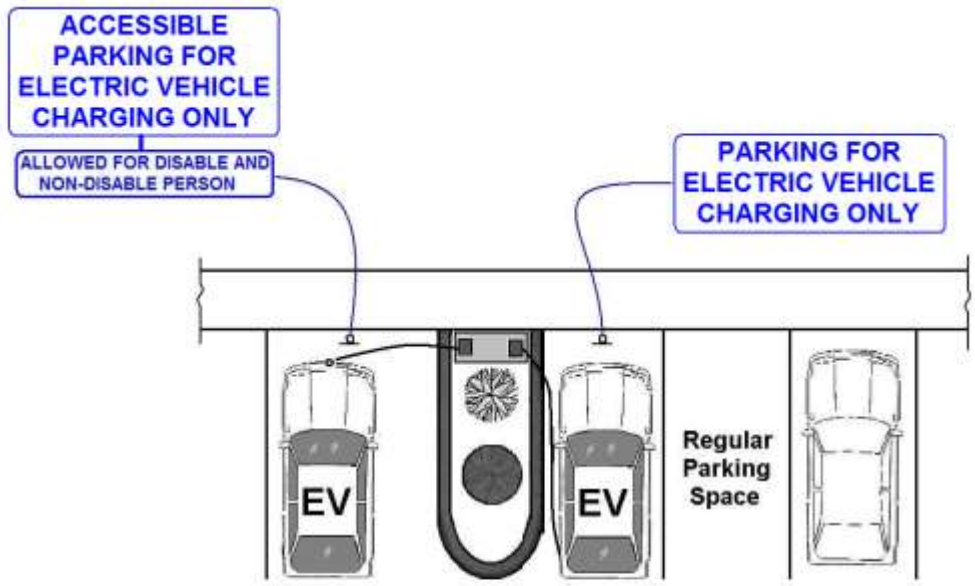
- EVSE shall be installed in accordance with manufacturer's guideline and shall be suitable for the environment (indoor/outdoor).
- Manufacturer installation guideline shall be available for the inspector at the site.



SAMPLE EV CHARGING PARKING SPACES