CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Electric Vehicle Readiness Plan for Ventura, Santa Barbara, and San Luis Obispo Counties (Central Coast)

Prepared for: California Energy Commission

Prepared by: EV Communities Alliance
With Contributions from the Plug-in Central Coast Coordinating Council Steering Committee Represented by Ventura County Air Pollution Control District, Santa Barbara County Air Pollution Control District, San Luis Obispo County Air Pollution Control District, Community Environmental Council, and the Central Coast Clean Cities Coalition

Gavin Newsom, Governor

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-10-602 to assess Region Plans to Support Plug-in Electric Vehicle Readiness. In response to PON-10-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards June 7th, 2011 and the agreement was executed as ARV-11-003 on February 17th, 2012.

ABSTRACT

This Plug-In Electric Vehicle Readiness Plan for the California Central Coast guides the development of Plug-in Electric Vehicle charging infrastructure for the tri-counties, Ventura, Santa Barbara and San Luis Obispo. The deployment of Plug-in Electric Vehicle Chargers on the Central Coast will encourage local drivers to consider purchasing Plug-in Electric Vehicles, which is the ultimate goal of this planning effort. The major benefits of adopting Plug-in Electric Vehicles include improvement in local air quality, reduction of greenhouse gas emissions that impact climate change, increase in the use of renewable energy such as photovolataic solar energy, more efficient use of existing grid energy by off-peak Plug-in Electric Vehicle charging, and increase in energy security by reducing the use of petroleum fuels, which may be imported from unstable parts of the world.

This Plan is intended to encourage and facilitate mass adoption of Plug-in Electric Vehicles in the tri-county Central Coast region. The installation of Plug-in Electric Vehicle charging infrastructure near major highways in the tri-counties is a critical factor to support this goal. The development of this plan has coincided with the construction of almost 200 Level 2 charging stations and several Direct Current Fast Charge stations along the Central Coast. This initial infrastructure has not only provided range-extending electrical miles for Plug-in Electric Vehicles, but it also serves to showcase the technology and raise public awareness.

Keywords: California Energy Commission, Plug-In Vehicle, Plug-in Electric Vehicle Readiness Plan, Central Coast, Ventura County, Santa Barbara County, San Luis Obispo County, Chargers, Charging Infrastructure

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CHAPTER 1:
SUMMARY OF PLUG-IN CENTRAL COAST GOALS, PARTICIPATION, ROLES, AND ENGAGEMENT PLAN

Plug-in Electric Vehicles (PEV) have enormous potential to help meet California's environmental, economic, and energy security goals. Many PEVs are three times more energy efficient than gasoline cars, achieving over 100 mpg equivalent Environmental Protection Agency (EPA) ratings. Battery Electric Vehicles (BEV) produce zero tailpipe emissions, while reducing greenhouse gas emissions by up to 75 percent per mile compared to a conventional gasoline-powered vehicle. While the benefits of PEVs are significant, there are many challenges to widespread adoption, which this Central Coast PEV Readiness Plan seeks to address.

NOTE: For additional background in the basic operation of Plug-in Vehicles and the high-level principles of community readiness for PEVs, please view the Governor's Office of Planning and Research document *Zero-emission Vehicles in California: Community Readiness Guidebook*, available at http://opr.ca.gov/docs/ZEV_Guidebook.pdf. This document provides an overview of PEVs, the California PEV market, and guidance on statewide readiness efforts to achieve the Governor's goal of 1.5 million zero-emission vehicles on California's roads by 2025.

Overview of Plug-in Central Coast

The mission of Plug-in Central Coast (PCC) is to encourage and facilitate mass adoption of PEVs in the tri-county Central Coast region. To advance this mission, PCC is bringing together a public-private collaborative network of leaders from counties, cities, public entities, community organizations, private industry, and utilities. The Council is encouraging strategic alignment of policies, programs, and resources to develop PEV-friendly infrastructure and policies throughout the Central Coast. This is the first ongoing EV readiness effort encompassing all the counties of the Central Coast, and key stakeholders. As such, PCC is filling a critical need for integrated planning and action to accelerate the EV transition. Plug in Central Coast is:

- **Facilitating resource development** – by partnering with stakeholders to act as a clearing house for and attractor of federal, state, regional, and public/private investments and initiatives.
- **Coordinating stakeholder engagement** – by acting as a neutral space for strategy development and operational coordination among public agencies, industry, utilities, and the community.
- **Developing and facilitating implementation of the region's PEV Readiness Plan** – by encouraging adoption of best practices and policies and identifying available strategies and resources to achieve them.

- **Developing plans for a regional EV charging network** -- that is providing an efficient and user-friendly charge network to enable all-electric travel within Central Coast communities and along our principal travel corridors.
- **Identifying EV-friendly policies** – that spur development of EV-ready infrastructure, EV-friendly road and parking incentives, vehicle-to-grid (V2G) connections, and EV-related economic and workforce development initiatives.
- **Promoting public and leadership awareness** – through coordinated Go EV messaging and related vehicle and infrastructure incentives and programs.

PCC Vision, Goals, and Metrics Framework

The PCC has established the following vision below, and the goals and metrics are identified in Table 1. This table evaluates each of the plan goals by determining a quantitative measurement for each one and provides a projected numerical target.

Plug-in Central Coast Vision

The Central Coast will be a leader in mass Electric Vehicle deployment, with robust EV education and outreach; a convenient public charging infrastructure, streamlined charger installation, efficient integration into the grid, and optimized utilization of renewable energy resources.

Table 1: Plug-in Central Coast – Goals and Metrics Framework

Goal	Quantitative Measure	Target
1. Promote mass adoption of PEVs	1A. # of PEV's sold	60,000 by 2025[1]
	1B. % of PEV's sold vs. gas or diesel vehicles	2020: 5–10%
2. Develop a public charge network enabling all-electric travel throughout the region	2A. # of Level 1 charge points	2014: 100–200
	2B. # of Level 2 charge points	2014: 200300
	2C. # of Fast Charge points	2014: 5–10
3. Streamline EVSE installation to promote rapid EVSE deployment	3A. # of jurisdictions and # of population in jurisdictions that have adopted enhanced EV readiness policies and practices	2013: 20% 2015: 40–60% 2020: 80%–100%
4. Integrate vehicles and the grid to minimize peak usage, optimize utilization of renewable energy resources, and reduce costs	4A. # of vehicles linked to vehicle-to-grid (V2G) and/or vehicle-to-building demonstration projects employing "smart" charging systems that integrate battery storage, distributed renewable resources, or participation in grid services markets.	Goal: CEC funded pilot project in 2014-16 timeframe.
5. Provide consumer and leadership education and outreach on the benefits of PEVs	5A. # of people attending "green vehicle" showcases and other EV-related public events 5B. # of meetings and # of local leaders briefed on "PEVs and the Future of the Central Coast"	Annual Goal: 3 Green Vehicle events per year with 50,000 people/year 6 meetings and 125 leaders in 2013-14.
6. Reduce greenhouse gas (GHG) emissions and criteria pollutants from light-duty vehicle	6A. Total emissions from the LDV fleet 6B. Grams per vehicle mile travelled for the total light-duty vehicle fleet 6C. Grams per "electric mile" travelled by PEVs	Accomplishment of local and regional Climate Action Plans and Clean Air Plans goals

Source: Plug-in Central Coast

1 The Central Coast share of Governor Brown's goal of 1.5 million ZEVs by 2025 is approximately 60,000 vehicles, given the Central Coast population of 1.54 million. While Governor Brown's target includes hydrogen Fuel Cell Vehicles, the PCC Steering Committee has set 60,000 PEVs as an aspirational goal given the uncertainties of FCV commercial deployment and fueling infrastructure.

Stakeholder Participation and Roles

PCC is currently being organized by a Steering Committee composed of the following key organizations and individuals, shown in Table 2.

Table 2: Plug-in Central Coast Steering Committee

Organization	Individual	Title	Roles
Ventura County Air Pollution Control District (VCAPCD)	**Stan Cowen**	Air Quality Project Engineer	Lead public entity and fiscal agent for CEC grant
Community Environmental Council	**Michael Chiacos**	Transportation Manager	Coordination Lead for *Plug-in Central Coast*
San Luis Obispo County Air Pollution Control District (SLOAPCD)	**Aeron Arlin Genet**	Manager, Planning & Outreach Division	San Luis Obispo APCD representative
Central Coast Clean Cities Coalition	**Melissa Guise**	Coordinator, C5	Central Coast Clean Cities Coalition (C5) representative and lead for DOE grant funding and PEVC statewide planning efforts
Santa Barbara County APCD	**Molly Pearson**	Community Programs Supervisor	Santa Barbara County APCD representative

Source: Plug-in Central Coast

Stakeholder Engagement

As part of the organizing process, the following organizations provided formal letters of participation in the work of PCC:

- **COUNTIES:** Ventura County, Santa Barbara County, San Luis Obispo County
- **TRANSPORTATION & PLANNING AGENCIES:** Ventura County Transportation Commission (VCTC), Santa Barbara County Association of Governments (SBCAG), and the San Luis Obispo Council of Governments (SLOCOG)
- **CLEAN CITIES COALITION:** Clean Cities Coalitions of the Central Coast (C5)
- **CITIES:** Santa Barbara, Grover Beach, Arroyo Grande, Ventura, Oxnard, Thousand Oaks, Simi Valley, Ojai
- **UTILITIES:** Southern California Edison (SCE), Pacific Gas & Electric (PG&E)

To ensure that stakeholders obtained an initial basis of education on PEV issues, the PCC Steering Committee co-hosted a PEV readiness workshop with the California PEV Collaborative on May 17, 2012 that introduced regional stakeholders to PCC and regional EV ecosystem issues, challenges, and opportunities. In addition, the PCC Steering Committee invited

prospective Council members to attend a PCC Kick-off Meeting to review the draft Charter document (below). At the next Steering Committee meeting on July 31, 2012, the Council was formally seated, adopted the charter document, and reviewed the draft (v.2) of the Readiness Plan.

Plug-in Central Coast Mission and Charter

Plug-in Central Coast – Charter

Mission: The mission of the PCC is to facilitate and encourage mass adoption of PEVs in the tri-county Central Coast region – including Ventura, Santa Barbara, and San Luis Obispo Counties. To advance this mission, the Council recommends and encourages the adoption of policies, programs, and resources to develop "PEV-ready" infrastructure and "PEV-friendly policies" throughout our Central Coast region and assesses the progress of local jurisdictions toward their EV readiness goals.

Roles: PCC is a public-private collaborative network of leaders from counties, cities, public entities, community organizations, private industry, and utilities. As the formally established PEV coordinating council for the Central Coast region, the principal roles of PCC are to:

- **Facilitate resource development** – PCC will act as a clearing house for and "attractor" of major federal, state, regional, and public/private investments and initiatives.
- **Coordinate stakeholders** – PCC will provide a neutral space for strategy development and coordination among public entities, industry, utilities, and the community.
- **Develop and implement an EV Readiness Plan** – PCC will assess the extent of adoption of EV Readiness policies and practices by local jurisdictions and identify available strategies & resources to assist them in plan implementation. PCC will develop a Central Coast EV Readiness Plan, in cooperation with local, regional, state, and federal agencies, stakeholders, and funders.
- **Encourage the development of a regional EV charging network** that will provide an efficient and user-friendly charge network for our communities and principal travel corridors.
- **Promote EV-friendly policies** – PCC will promote coordinated development of EV-ready infrastructure, EV-friendly road and parking incentives, V2G connections, and EV-related economic and workforce development initiatives.
- **Build public and leadership awareness** – PCC will build awareness of the EV value proposition through a coordinated "Go EV" campaign and related vehicle and infrastructure incentives and programs.

Membership: PCC membership will reflect key sectors engaged in facilitating regional EV infrastructure and provide appropriate geographic representation of the tri-county Central Coast region. Members will include representatives from:

- Air Pollution Control Districts
- Regional and local transportation and planning agencies
- Cities and Counties
- Central Coast Clean Cities Coalition

- Business associations and select firms with EV-related interests
- Businesses interested in providing public EV infrastructure – including (but not limited to) retail outlets, shopping centers, hotels and motels, workplaces, and etc.
- Utilities and key energy-related companies (including PG&E and SoCal Edison)
- Environmental and civic organizations (NGOs)
- Public entities (e.g. universities) and other non-profit organizations
- Fleet operators (public and private)

Legal Status and Fiscal Agency: PCC shall function as a voluntary public-private organization, as described in the Council Charter and freely entered into by PCC members. PCC recommended projects may be performed by individual members at the discretion of their governing body.

Steering Committee and Roles: The Steering Committee will develop and administer funding proposals, based on consensus among Steering Committee agencies (currently including the Central Coast Clean Cities Coalition, the Ventura County APCD, the San Luis Obispo County APCD, the Santa Barbara County APCD, and the Community Environmental Council.)

Operating Procedures: The Steering Committee shall function as the Nominations Committee. Members will initially be seated by a vote of all nominated members. The Chair will be elected by the Nominations Committee (The current Chair is Aeron Arlin Genet of San Luis Obispo APCD). The Council will provide substantive input and guidance in EV plan development -- and assist in implementation tasks in alignment with their own organizational mission and goals.

CHAPTER 2:
OVERVIEW OF BARRIERS AND SOLUTIONS TO DEPLOYMENT OF PEVS

PEVs are seeing rapid growth nationally with annual sales of 17,000 in 2011 tripling to 53,000 in 2012 and projected to double again in 2013 to approximately 100,000. California is a clear leader, with around one third of all PEV sales, or triple national rates considering per capita vehicle sales.

Locally, as of December 2013, data from the California Vehicle Rebate Project[2] shows that there are approximately 1814 PEVs on the Central Coast, with about 129 new PEVs being purchased in our region monthly. Rebate Project data reflects the number of Central Coast residents receiving rebates, and staff administering the project estimate that 25 percent of PEV owners do not apply for the rebate, so we have added an adjuster. Data is further broken out by County:

- Ventura County - 906 PEV rebates x 1.33 = 1,205 PEVs
- Santa Barbara County – 289 PEV rebates x 1.33 = 384 PEVs
- San Luis Obispo County - 169 PEV rebates x 1.33 = 225 PEVs
- Total 1,814 PEVs on the Central Coast, with approximately 129 purchased monthly

While this growth is impressive, PEV sales are still a small percentage of overall vehicles sales. In order to prepare our region for continued PEV growth, PCC is developing a comprehensive regional PEV infrastructure plan, which will include guidelines to build a robust EV infrastructure. The challenges that must be met by PEV stakeholders include issues of vehicle cost, ease of installation, and use of charging infrastructure, as summarized below.

Perceived High Cost

At market launch in 2011, PEVs initially faced significant barrier of high cost, with MSRPs ranging from $29,000–$40,000. Price reductions in 2013 have lowered prices to MSRPs of $23,000–$35,000, with Federal and State incentives reducing this cost by approximately $9,000–$10,000. New PEVs in California are now available at prices of $13,000 after incentives. Many PEVs are now less expensive than the average new vehicle, at $31,000 in 2013. However, some potential buyers may not have the tax liability to take all of the federal tax credit.

One potential solution is leasing, as manufacturers can take the incentives and offer a more attractive lease offer. The majority of California EV owners are leasing, using the $2,500 California rebate to contribute to the down payment. Lease payments of as low as $200 per month can also facilitate significant gas savings. Future strategies now being considered by vehicle makers include separate financing of the battery, which can be structured with the

2 This interactive data map can be found at http://energycenter.org/clean-vehicle-rebate-project/cvrp-project-statistics

electricity payment as a "bundled solution" that is still less than the price of gasoline. This strategy is now deployed in Europe (by Renault) and in China. Over the next several years, battery prices are also expected to decline, with DOE projecting price-parity with internal combustion engine vehicles by 2022, based on battery pricing dropping from the current range of $500–$600 per kWh of capacity to approximately $250/kWh, as well as advances in lightweight design and materials.

Public Charging Infrastructure

Systematic education of local government and business leaders will lead to building EV Chargers in new construction and retrofits at key locations. Additionally, PCC is exploring the feasibility of utilizing 110- and 240-volt outlets (in conjunction with portable EV chargers provided as standard equipment by vehicle manufacturers), rather than more costly commercial EV charging stations, which are typically priced in the $2000 - $4000 range.

Unlike any other vehicle purchases, would-be Battery-Electric Vehicle (BEV) consumers are not merely buying a car, they must also "buy into" (at least conceptually) a completely new fueling ecosystem that functions very differently from the familiar and ubiquitous gasoline station. Not surprisingly, the preponderance of today's modestly informed consumers have some initial views regarding the minimum performance standards to win their business. According to a 2011 survey by Deloitte and Touche, for more than 80 percent of respondents, convenience to charge, range, and cost to charge were all "extremely important" or "very important" considerations for buying an EV. Charging time of two hours or less were critical for 55 percent of respondents, and widespread availability of public charging stations was very important for 85 percent of respondents. To address these consumer concerns, PCC is outlining a range of policies and initiatives that local governments will be encouraged to adopt, including:

- Streamlining single-family residential charger installation
- Developing charging options for multi-unit developments
- Creating more comprehensive public EV charging networks
- Promoting EV-ready buildings and parking lots

Each of these challenges is discussed briefly below, along with policy recommendations for consideration by the PCC Steering Committee.

Single-Family Residential Charger Installation Streamlining Overview

Residential charging is the backbone of the EV charging infrastructure, with some estimates concluding 90 percent of all charging takes place at home. It is the most convenient option for most drivers, and the least costly based on availability of special EV or "time-of-use" (TOU) utility rates. Overnight charging also poses a reduced burden on the utility grid, including its generation and distribution systems. Unfortunately, installation costs for charging at home can be highly variable, and generally these costs are passed on directly to the customer.

Depending on the age and condition of electrical infrastructure in a particular residence, the installation costs can vary widely. For example, a simple Level 2 installation, including hardware, may cost as little as $1200. However, if total electrical load of the home exceeds safety standards, a panel upgrade may be required. This can cost as much as $500 to $2500 additional. If conduit or trenching is required, these can add additional costs. Because of this

expense, many Plug-in Electric Hybrid (PHEV) drivers and BEV drivers that travel less than 50 miles per day are opting for Level 1 charging at home. This can often be done for free by using the portable charging equipment that comes with their car and a 110-volt outlet in a garage or driveway, though some homes may need a dedicated or new 110 outlet in a convenient location installed, which may cost a few hundred dollars.

To access a less expensive EV-specific electricity rate, SCE and PG&E customers can specify a "time-of-use" or TOU rate for their home or business or purchase a separate meter to access a special EV-only rate. For all charging installations, contractors must pull a permit at the beginning of the job and – depending on the complexity of the work involved – they may be required to schedule an inspection with the local permitting authority to sign off on the work. In some cases, the combination of permitting, inspection, and utility "hand-offs" can result in significant delays before a charger installation is complete. Table 3, shown below, indicates the complex set of "handoffs" required in many charging station installation scenarios.

Table 3: Residential Installation Process

Steps	Primary Role	Tasks
1	**Customer**	Contacts utility to evaluate rate and meter options
2	**Electrician**	Performs site visit to determine electrical capacity, panel requirements, and meter options
3	**Utility**	Visits site to evaluate meter location (if new meter requested)
4	**Electrician**	Provides quote/contract including panel upgrade if needed and second meter option if requested
5	**Customer**	Approves estimate and signs contract
6	**Electrician**	Pulls permit and performs work
7	**City Inspector**	Possible interim inspections for trenching or panel work
8	**Electrician**	Completes work
9	**City Inspector**	Inspects installation, approves or issues notices of correction
10	**Electrician**	If no new meter, trains customer on use and job is complete
11	**City Inspector**	Sends notice of final inspection to the utility
12	**Utility**	Returns to install separate meter, if necessary
13	**Electrician**	If new meter, electrician turns on meter, and trains customer on its use. Job is complete

Source: Plug-in Central Coast

Recommendations for Streamlining Residential EV Charger Installations

Given the challenges that customers may face in installing residential EV charging stations, it is recommended that jurisdictions establish low and flat fees for installation of charging stations and undertake additional streamlining recommendations identified in Table 4, shown below, with explanatory discussion for each recommendation.

Table 4: Recommendations for Streamlining Residential EV Charger Installations

Recommendation	Next Steps
R-1: Develop a charger permit form identifying all required elements	1A: Distribute model PEV application and checklists to city/county leads. (See Appendix 1 for sample application).
R-2: Provide installation process guidance and checklists	2A: City/ County leads to modify and adopt.
R-3: Encourage online permitting for simple installs	3A: Present online permit options to cities 3B: Report on online access provisions developed by local jurisdictions.
R-4: Establish reasonable – and flat – charger permit fees.	4A: Present information on existing fee structures and recommendation for standardization where feasible and appropriate. 4B: Report on any fee adjustments by localities.
R-5: Waive plan requirements for simple installations.	5A: Present evidence on plan waiver feasibility. 5B: Report on waiver policy adjustments by localities.
R-6: Establish phone & online inspection request systems.	6A: Present examples of online and phone inspection request systems in California. 6B: Report on online access initiatives by localities.
R-7: Provide training on EVSE technologies and installation	7A: Host EVSE product information and installation workshop for prospective site hosts and contractors.
R-8: Provide utility notification of EVSE installations	8A: Host meetings to develop utility notification protocols as needed with local jurisdiction staff.

Source: Plug-in Central Coast

Discussion of Recommendations for Residential Installations

Develop a Charger Permit Form (R-1)

Because of the relative novelty of EV charging equipment, some jurisdictions in the tri-County area may be uncertain regarding the appropriate format of the electrical permit to be issued. For jurisdictions that want to highlight EV charger-specific issues to guide contractors, site hosts, and inspectors, a sample charger-specific permit is provided in Appendix A. This generic permit form highlights relevant sections of the National Electrical Code and has been co-developed with the National Electrical Manufacturers' Association.

Provide Installation Process Guidance (R-2)

The International Code Council and its various regional chapters have provided guidance for local permitting authorities on plan check and inspection procedures for both residential and commercial chargers. Exemplary guidance documents for California jurisdictions have been developed by the Tri-Chapter Uniform Code Council of the greater Bay Area, which is highlighted as a statewide model in the *Ready, Set, Charge California! Guidelines for EV-Ready Communities.* These guidance documents are included in Appendix B (for residential installations) and Appendix C (for commercial and multifamily installations).

Implement Online Permitting (R-3)

The City and County of Los Angeles and the City of San Francisco are among many California jurisdictions that have implemented online permitting procedures for simple EV charger installations. The City of Los Angeles defines a simple EV charger installation eligible for an online "express permit" as an:

> *Electrical installation for electric vehicle charging in single family dwellings with up to 400 amps of service. (Including any needed charging equipment, service upgrade, receptacle and associated wiring.)*
>
> (Source: LADBS is available at http://ladbs.org/LADBSWeb/LADBS_Forms/InformationBulletins/IB-P-GI2011-003ExpressPermits.pdf)

The system for accessing online permits can be viewed at http://ladbs.org/LADBSWeb/e-permit.jsf. Clearly, the interests of both consumers and municipalities can be well-served by reducing burdens on staff and contractors to wait for permits to be issued over the counter or to conduct plan checks on routine EV charger installations that meet the parameters identified above. Further, a variety of off-the-shelf online permit software packages are available for municipalities that choose to implement a "plug and play" solution.

Establish Reasonable Charger Permit Fees (R-4)

Currently, permitting fees for Central Coast communities vary significantly. To encourage charger station adoption, communities with higher fees should consider targeted fee reductions that will help reduce the overall cost of EV ownership, and to reflect the reduced societal cost burden that EVs impose by virtue of their reduced greenhouse emissions and contributions to energy security.

Waive Plan Requirements for Simple Installations (R-5)

Many jurisdictions have recognized that most EV charging installations are as simple and straightforward as a typical water heater installation, and that they need not be subject to automatic plan submission and plan check requirements. Further, where plans are required without due cause, a substantial cost and time burden is imposed on would-be EV drivers and electrical contractors. It is recommended that Central Coast jurisdictions follow the lead of many major cities in California in waiving plan submission and plan check requirements for simple installations.

Establish Phone & Online Inspection Requests (R-6)

The process of requesting an inspection can also be a barrier to timely EV charger installation. To reduce this barrier, and save staff time and costs, jurisdictions are encouraged to implement automated phone and/or online inspection request systems, as other jurisdictions (including Los Angeles and San Francisco) have done.

Provide Training on EVSE Technologies (R-7)

EV chargers and technologies are unfamiliar to many electrical contractors and building officials. To address this information gap, Plug-In Central Coast proposes to host a workshop for contractors and permitting officials in each County.

Provide Utility Notification of EVSE Installations (R-8)

EV chargers rated at Level 2 (240 volts) may impose significant impacts on grid infrastructure, especially local transformers, particularly if multiple EVs are charging at the same time on a street served by a common transformer. This may reduce the life of the transformer or in worst cases cause a localized outage. With several years of data, utilities are finding grid impacts are less than anticipated and they can often update EV hotspots by prioritizing these areas during routine grid upgrades. That said, utilities strongly emphasize the importance of putting in place utility notification procedures from local governments, in the event that the site host does not otherwise proactively contact the utility (e.g., for a service upgrade or new EV-specific rate plan.) A call to the utility service planning department at PG&E or Southern California Edison can establish a simple notification protocol.

Multi-Unit Residential Charger Installation Challenges and Solutions

EV stakeholders face a more complex set of challenges in facilitating charger installations in multi-dwelling units (MDUs) – including condominiums, apartments, townhomes, and "garage-less" dwellings. A good introduction to the process of multi-family charger installation has been provided by San Diego Gas and Electric, available at http://sdge.com/sites/default/files/documents/PreppingMultiUnitsforPlugInVehicles.pdf.

Depending on local circumstances, multi-unit dwelling residents and building owners may be challenged by these problems. For each problem, there is a mitigation, if not a perfect solution, but good will is required on both owner and tenant to work toward a fair and efficient allocation of costs and benefits.

- **Limited parking:** When lots are crowded or spaces are assigned or deeded, finding feasible spaces for chargers may require re-shuffling of designated parking or other

use-policy changes. In the cases of deeded parking spaces, HOA's may be justified in requiring that local residents pay the full cost of initial installations. However, in apartments, some cost-sharing may be feasible if building owners exercise their right to exact a surcharge on energy used at the site, or to charge a monthly lease fee for equipment that is retained by the apartment owner and re-assigned to future EV driving tenants.

- **Distance between utility meters, parking, and electrical panels:** A new 240V charging circuit typically requires a connection between the charger location and the EV owner's electrical panel. In multi-family dwelling units, the electrical panel may be inside the residential unit and located at a long distance from the parking area. This can impose significant cost barriers. In new construction, provisions for EV readiness can be built in at nominal cost by running appropriate conduit and pre-wiring for EVSE. This will be discussed in the section to follow on updated building codes. For existing multi-unit buildings, a new program to develop 10,000 "make-ready" EV charging sites is being undertaken by NRG, an energy company now investing in California as part of its settlement of a lawsuit with the California Public Utilities Commission. These make-ready improvements will bring adequate power and stub-outs to the designated sites. In the first 18 months following the completion of the make-ready site, the site host is obligated to contract exclusively with NRG to install a Level 2 charger, after this time they could install a charger from any company. NRG will also initiate installation of the charger once a specific EV driver is identified who will commit to utilize that site on a regular basis, e.g., as an employee of a business on the site, or as a resident of a multi-unit development on the site. During this 18-month NRG exclusive period, the prospective charge station user must sign up for the NRG monthly subscription program to trigger the installation of the EVSE. In a legal settlement (related to past monopolistic pricing behavior of their Dynegy subsidiary), NRG is mandated to invest $100 million dollars to develop both "make-ready" sites and to install 200 Fast Chargers around the state. At this point, only Ventura County is eligible for the DC Fast Chargers (and the first one was installed in Camarillo), as installations will be focused on the greater Bay Area, the South Coast area, and the Central Valley. However, Central Coast communities are encouraged to pro-actively contact NRG to identify possibilities for potential development of the free "make-ready" sites.
- **Challenges to accessing off-peak charging rates:** Off-peak EV charging rates may require a new meter and utility service. Most MDUs have meters clustered in a central location. There may not be space to add another meter. In such cases, landlords or building managers may be permitted to simply establish a flat monthly fee for energy use. Alternative load management technologies for multi-unit scenarios are also available from EverCharge, a company that specializes in multi-dwelling EV charge management. EverCharge provides a "powershare" hardware device that can shift the electrical load among a number of charging devices and ensure that existing electrical panels are not overloaded. Powershare information is available at www.EverCharge.net. Other charger companies, including Coulomb Technologies, have billing solutions that work on multiple charger platforms to apportion energy costs to EVSEs among different multi-unit tenants and management. Coulomb billing solutions are available at http://www.coulombtech.com/products-apartments.php.

- **Limited electrical capacity:** Level 2 chargers typically require a minimum of a 40-amp circuit. Upgrading capacity can be costly and may trigger requirements to bring the property up to current building code. In these circumstances, power-sharing technology to enable multiple chargers to charge sequentially (rather than simultaneously) may reduce the burden, as referenced above. Another low-cost option is to deploy dedicated Level 1 chargers, which are already present in some garages and car ports. Level 1 charging may be adequate for overnight charging of EV owners that drive less than 50 miles per day. If common power is used in car ports, some condo living EV owners use low cost devices such as the "Kill-a-watt" meter, which costs less than $20 and enables one to track energy use and reimburse the HOA.

Cost mitigation strategies can include placement of charging equipment in guest parking or other common areas. Where feasible, property management organizations or Homeowners' Associations (HOAs) can adopt policies to install charging stations in common areas serviced by the same master meter that covers other common services such as landscape lighting. Rates can be established for Radio Frequency Identification or credit card payment to the property management group and/or HOA to cover electricity costs based on vehicle time-of-use and maintenance costs.

Multi-family installations sometimes require engineered drawings that include a) a site plan; b) a layout showing the electrical work needed and; c) specifications for the equipment. A plan check is usually required, including sign-off from a city engineer, planning and/or building departments, and the city or county fire marshal. With safety issues paramount, significant consolidation in the number of inspections may not be feasible. However, local jurisdictions can streamline approval processes by considering and implementing the streamlining recommendations below, adapted from the statewide *Ready, Set, Charge California! Guidelines*, available at www.ReadySetCharge.org.

Recommendations for Multi-Dwelling Residential Charger Installation

To summarize, EV stakeholders, including local governments, advocates, and property management associations will need to work closely together to develop a range of MDU solutions that will necessarily be site specific in most instances, and based on voluntary cooperation toward shared goals for a healthy environment and an energy-secure community. Where appropriate, municipalities and counties with larger numbers of residents in multi-unit dwellings may also wish to consider stronger policy options that could mandate multi-unit development stub-outs or actual charger installations, either in the context of new construction, major remodels, or at the time of sale. While these options are considered, additional education and outreach activities will be developed through the PCC partners, as identified in the initial recommendations in Table 5.

Table 5: Recommendations for Streamlining Multi-Dwelling Residential EV Charger Installations

Recommendation	Next Steps
R-9: Outreach to HOAs and property managers to offer MDU solutions	9A: Develop HOA solutions with utilities, industry experts, and installation contractors
R-10: Adopt building code amendments to mandate pre-wiring for EVSE in new and remodeled multi-unit buildings.	10A: Present model EV-friendly building code amendments to city staff 10B: Report on results of outreach and engagement process

Source: Plug-in Central Coast

Discussion of Recommendations for Multi-Unit Dwellings

Develop HOA solutions (R-9A)

Owners may want to first see if low cost Level 1 solutions are possible. If EV owners drive less than 50 miles per day and have access to or can arrange access to a 120 volt outlet near a parking space, they can utilize Level 1 charging and a simple energy measurement device, such as a "Kill-a-watt" meter to reimburse the HOA for power. If this isn't possible, owners, building managers, and renters who may wish to install EV charging stations need access to information about their charging needs, options, and potential solutions. To address these needs, PCC will work with local stakeholders to present solutions for multi-unit developments. Solutions for multi-unit developments are inherently complex, insofar as MDU installations must typically conform to the association's or development's architectural standards and existing parking layout; economically access adequate power, with potential "re-shuffling" of parking assignments to permit cost-effective installations of EV charging stations for EV-driving tenants; develop protocols for cost-sharing of both capital and operating costs for the station, including energy and other maintenance and operational expenses.

To prepare for the possibility of installing EV charging equipment, stakeholders in a multi-unit complex may find it helpful to undertake these activities (adapted from guidance provided by San Diego Gas and Electric):

1. Conduct a poll and provide information to residents on EVs: Find out how many people in the building may be interested in EVs and when they might wish to buy one. It may help to provide some general information on EV costs, benefits, and availability, which can be found at www.pluginamerica.org.
2. Access utility and EV advocacy organization resources: Plug-in Central Coast, Southern California Edison, available at http://www.sce.com/info/electric-car/default.htm?from=pev, and the Community Environmental Council, available at http://www.cecsb.org/pluginsb, offer information and periodic workshops to help consumers learn about EV charging options, costs, and business models. It will be helpful to access online or workshop resources to inform stakeholders of the latest programs and technologies for EV charging. Charging technologies for multi-unit use

range from simple "plug and charge" standalone units that are open to all users, to networked units with automated user ID and payment systems. Chargers with more advanced communication and scheduling can provide metering capabilities to track users' use; access control; user-specific billing and service fee options; and remote control and monitoring capabilities. Single or multiple cord sets may be housed in a box mounted to a wall, pole, ceiling or floor, depending on site-specific needs. To get an idea of the wide array of EVSE options that are available for residential and commercial charging, visit Plug In America, available at www.pluginamerica.org/accessories, Advanced Energy, available at www.advancedenergy.org/transportation/evse, or GoElectricDrive, available at www.GoElectricDrive.com.

3. Identify the challenges: To address the needs at a site, practical obstacles need to be identified and addressed one by one. This list of prompts can help an MDU team identify the issues to be addressed:
   - How well will the property layout – including the location and type of electric metering, wiring and parking spaces – accommodate the desired charging equipment?
   - What existing rules in the covenants, conditions and restrictions ("CC&Rs") would affect the installation of charging stations in common areas and private areas?
   - Which assigned and unassigned parking spaces could accommodate EV charging equipment?
   - What local regulations relate to common area use of charging infrastructure?
   - Will some charging units, sidewalks, parking spaces need to meet Americans with Disabilities Act (ADA) standards for accessibility?
   - How should property owners deal with initial equipment and service costs versus future tenant demands and needs?
   - Consider partnering with an EVSE vendor, such as NRG, which may be able to offer installation, maintenance, and power as part of a monthly subscription program for the EV driver. Information on the free "make-ready" program for multi-unit residential developments in California is available at www.evgonetwork.com.
4. Develop consensus on the scope of work: The installation of EV chargers in a multi-unit development will require shared decisions by property owners, property managers and (in some cases) residents. To provide potential contractors a starting point for cost estimation, the MDU site host needs to determine:
   - Estimated number of spaces to be served by charging equipment and in what configuration: Level 1 charging (at 110 volts, requiring a 10–12-hour recharge time), or Level 2 charging (requiring 240 volts and a 4–6-hour recharge time). Level 2 chargers are typically preferred and may be essential for Battery-Electric Vehicle (BEV) owners, whereas Level 1 charging may be adequate for PHEVs.
   - Charger management preferences (networked with multi-party billing options, or non-networked without smart billing allocation).
   - Suggested location(s).
5. Choose a qualified contractor: When selecting an installer for charging equipment, consider the contractor's experience, licensing, insurance and training, such as the

EVSE installation training offered through organizations like the National Electrical Contractors Association, International Brotherhood of Electrical Workers and Underwriters Laboratories.

6. Coordinate on-site evaluation: Prospective contractors will need to visit the site to answer any remaining questions about project requirements before providing estimates. As part of the evaluation, the contractor should calculate power loads with the added charging stations, decide whether existing electric panels need to be upgraded or replaced, and see whether the utility needs to upgrade electric service or install new electric meters. The contractor should coordinate with the utility for review of the project design and, if necessary, an on-site visit.
7. Begin installation: Once the contractor's price quote is approved, the contractor will order the selected charging stations, obtain any necessary permits, place the utility service order, schedule installation, coordinate the project and arrange for any required inspections by SCE or PG&E and the city. (The chart below summarizes the critical pathway for project completion.)
8. Inform residents: Current and future residents should receive information on where, when, and how to use the new charging stations.

As Table 6 below indicates, there are a large number of steps involved in the installation of charging in a multi-unit development. To move through the process, it is helpful to reach out to charging station vendors and utility staff with hands-on experience in solving the many challenges in multi-unit building installations. Leading EV charger companies can be expected to provide some consulting assistance in cases where end users will be specifying their equipment.

Table 6: Multi-Dwelling Residential EV Charger Installation Process

Step	Primary Role	Tasks
1	Tenant	Determines PEV Charging Needs/Contacts Building Rep
2	Building Rep	Initiates installation as value-add/Contacts HOA
3	Tenant	Orders PEV and notifies Building Rep to initiate process
4	Building Rep	Assesses external install resources and potential contractors
5	Building Rep	Make preliminary design/layout decisions with contractor
6	Contractor	Prepares estimates and layout for site visit from utility
7	Utility	Reviews plans and issues recommendations
8	Contractor	Revises plans if necessary and initiates install
9	Contractor	Applies for permits and orders any necessary equipment
10	Utility	Installs equipment as needed
11	Contractor	Installs chargers
12	Contractor	Contacts local building inspector or inspection
13	Utility	Initiates service.

Source: San Diego Gas & Electric and Sacramento Municipal Utility District for Electric Power Research Institute

Adopt Building Code Amendments to Mandate Pre-wiring (R.10)

A strong policy approach to advancing deployment of chargers in multi-unit development is mandated pre-wiring. The City of Beverly Hills was the first to mandate pre-wiring in 2011, and their policy can be viewed at http://www.beverlyhills.org/business/constructionlanduse/commercialbuildings/electricvehiclecharging. Other jurisdictions, such as the City of Palo Alto, the County of Santa Clara, Sunnyvale, and Emeryville, are adopting similar standards, though no such building codes have been adopted yet on the Central Coast. The threshold for mandated pre-wiring can be set at new construction or at the time of a major re-model. In its role as an EV planning consultant to the Southern California Association of Governments (SCAG), the Luskin Center for Innovation at UCLA has also made a policy recommendation for the SCAG region (which includes Ventura County) that EV charging stations – not merely pre-wiring (also known as "stub-outs") be required of all multi-unit developments at the time of an ownership change. This may not be viewed as politically feasible even in the context of the EV planning process. However, in light of the NRG settlement requirement to develop 10,000 "make-ready" sites, it is likely that mandating actual EVSE installations may not be more costly over the next several years than mandating pre-wiring would be, since an EVSE can be procured and installed at a pre-wired location for potentially in the range of $1,000 to $3,000 per charger. Of course, all decisions regarding local building code enhancements that exceed the California building code (CalGreen) are under the jurisdiction of cities or (in the case of unincorporated areas) the relevant county. Therefore, recommendations of the PCC would be advisory to cities and counties, and it would likely require mobilization of additional political support to achieve the adoption of either a pre-wiring mandate or an actual charger installation mandate.

CHAPTER 3: COMPREHENSIVE CHARGING NETWORK DEVELOPMENT – CHALLENGES AND SOLUTIONS

Plug in Central Coast has been quite successful in building an initial network of EV chargers. The Coordinating Council actively sought out and encouraged sites to install equipment through various federal and state grant programs, and there are now over 200 public EVSE's in our region, including two DC Fast Chargers in Thousand Oaks and Camarillo, and most cities have Level 2 public charging facilities.

This initial backbone of public charging is only starting to meet the needs of the region's PEV drivers in 2013 and beyond. To address the situation, PCC is actively pursuing grant opportunities to increase public charging opportunities and is encouraging workplaces, cities, businesses, multi-unit residential, and other property owners to invest in charging infrastructure.

To help further guide and catalyze the growth of a robust charging network in the Central Coast region, the PCC infrastructure plan has mapped existing charging stations and identified potential new sites for infrastructure, including a minimum level of DC Fast Chargers. Based on this mapping data (including in Appendix R), PCC stakeholders are identifying state and other funding sources needed to further advance development of a comprehensive regional charging infrastructure.

Other Local, State and Federal-Funded Charger Deployment Projects

Important state and federally-funded programs implemented in the Central Coast region included the Clipper Creek Re-Connect program – which retrofitted many older "legacy" charger installations from the 1990s, the ChargePoint America program, which offered free chargers and installation subsidies in many locations throughout California, and the ECOtality EV Project, which included both free Level 2 stations and free Fast Chargers in select locations, with partial installation subsidies available. Central Coast stakeholders were very successful in attracting these programs to our region, contributing significantly to the 200+ Level 2 chargers deployed by the end of 2013.

With completion of the California Energy Commission (CEC) and United States Department of Energy (DOE) funded infrastructure planning process, PCC is expanding its outreach to ensure continued co-investment by both public and private entities in the development of the region's EV charging infrastructure. In addition, local incentives to support PEV charging infrastructure—including deployment of Level 2 and DC Fast Charge stations—is available. As of 2013, all three APCDs in Ventura, Santa Barbara, and San Luis Obispo counties have formed EV Infrastructure grant programs, with a combined total of $282,000 allocated.

Encouragement of Local Charger Investment

In addition to leveraging publicly funded infrastructure deployed through larger EV charger companies, individual site owners in the PCC region are encouraged to invest their own resources in publicly accessible charging. Additional outreach activities will be conducted at the

annual Green Car shows developed by the Community Environmental Council and C5. PCC, the Santa Barbara Community Environmental Council, and EV Communities Alliance will also jointly produce EV Readiness workshops in each central coast county.

Private Partnership Funded Projects

EV charging infrastructure can also be deployed by local property owners via partnership arrangements with a charge station vendor (such as ChargePoint) or charge network operator (such as NRG) that may be willing to install, maintain, and operate the charging equipment at no cost to the owner. The vendors can collect monthly subscription plan fees (with unlimited charging privileges) or per session fees from EV drivers.

Recommendations for Comprehensive Charger Network Development

Siting recommendations for this regional EV Plan are based on the principle that EV owners need charging to extend the range of their vehicles and plug-in hybrid owners strongly prefer to drive in EV mode over gas mode. In short, a robust public charging network enables more electric miles to supplant gas miles. To support enhanced electric range for all types of PEVs, including those with Fast Charge capability, both the Central Coast and Monterey Bay PEV Readiness Plans focus on highway corridors that connect Southern and Northern California along the 101 Freeway, workplace charging, regional commercial centers, and destination charging sites. Corridor charging locations with DC Fast Chargers located every 30 or 40 miles from Ventura County through Santa Barbara County and on to San Luis Obispo County will enable Battery EVs to take longer trips and recharge from near empty to 80 percent charge in approximately thirty minutes.

Workplace charging can most effectively increase electric range for those PEV drivers whose effective all-electric range is less than their roundtrip commute distance to work. The PCC regional plan has identified prime locations in the tri-county region to host workplace charging. In addition, "destination charging" sites include popular shopping centers, parks, harbors, airports, train stations, colleges, government buildings, downtowns, beaches, and cultural facilities. Another key category for EV charging infrastructure is MDU, discussed in Section 2C.

Table 7: Charger Network Development Recommendations

Recommendation	Next Steps
R-11: Pro-actively meet with EVSE providers to ensure PCC sites are prioritized	11A. Coordinate plans for Central Coast charger network deployment with key vendors, e.g., NRG, Coulomb, AeroVironment, Clipper Creek, as part of CEC-funded site analysis process.
R-12: Establish PCC EVSE network development and siting principles in EV Infrastructure Plan	12A. Siting Principles incorporated into Phase I EV Plan (completed 5/12). 12B. Siting Principles to inform site selection process incorporated in Final PCC Readiness Plan (completed 12/13)
R-13: Identify key stakeholders to provide ongoing oversight of EV infrastructure plan	13A. Identify and inform staff from local jurisdictions and key planning entities to enable input into the EVSE siting plan, to include (at a minimum) a representative from each of the relevant APCDs, transportation agencies, COGs, utilities, counties, and major cities of the region
R-14: Promote building code amendments that promote EV-ready and solar-ready buildings, parking facilities, and public works for new construction or major renovations.	14A. Promote model ordinances and guidelines specifying: -- minimum levels of pre-wiring (going beyond the raceway and conduit in the voluntary 2012 CalGreen standards) -- minimum levels of EV-ready parking, such as a 3% minimum for office, lodging, medical, and governmental; 1% minimum for retail, recreational, and cultural facilities; and 10% minimum for multiple-dwelling units, based on recommendations of the PCC and local stakeholders.
R-15. Encourage integration of PEVs into local fleets	15A. Support participation by fleet managers in Green vehicle showcases hosted by Community Environmental Council and Clean Cities Coalition of the Central Coast (C5) 15B. Track and promote opportunities for special fleet lease/purchase deals offered by major OEMs

Source: Plug-in Central Coast

Recommendations R-12 – R-14 to Advance Integrated EV Ecosystem Planning

The PCC Steering Committee and many cities and counties have benefitted from grant funded charging station projects, and new grant programs continue to be introduced through California Energy Commission solicitations. Priorities that are currently being addressed by vendors and PCC Steering Committee members include the following:

- Corridor planning: PCC has assessed high-priority siting options for DC Fast Charging on key travel routes. Of most importance is a corridor of charging stations along Highway 101, connecting our largest cities approximately every 30 miles. A second tier of sites include additional locations along Highway 101, as well as sites on other regional

highways, some in key corridors connecting to I-5. Maps of suggested DC Fast Charging sites are included in Appendix R. New DCFC installations funded by the California Energy Commission are mandated to include an upgrade path to ensure dual compatibility between the current dominant DCFC standard – known as CHAdeMO (supported by Japanese manufacturers)-- and the SAE Combo fast charging capabilities now being introduced by American and European manufacturers.

- Surveying workplace and fleet EV users: As part of the EV Readiness Planning effort, PCC Steering Committee members are surveying workplace and fleet charging users. Maps of large employers throughout the Central Coast are included in Appendix R, and outreach efforts have been made to many of these workplaces and others. Outreach includes informing workplaces and fleets of federal and state incentives and grant opportunities, education and questions answered, best practice sharing, fostering peer to peer relationships by connecting those having added EVs and/or charging infrastructure to those whom are considering it, and EV 101 lunch and learns at selected large employers.
- Coordinated response to upcoming CEC or other solicitations: PCC community stakeholders benefit from coordination of funding proposals among local agencies and prospective charging network operators. PCC is monitoring solicitations and communicating options to local stakeholders as opportunities arise.
- Possible deployment of subscription plans: Subscription plans may raise issues of interoperability with other charging networks. Currently, some EV network vendors have made commitments to development of inter-operable networks – whereby consumers can have access to any charge station in a manner similar to the STAR system for Automated Teller Machine (ATM) inter-operability. These include the Collaboratev partnership launched by ChargePoint, and open networks such as Greenlot's SKY network. However, these agreements have not yet been formalized across all vendors, and communication, clearance, and settlement protocols not yet fully developed. EV advocacy groups have pointed out that drivers will not be well-served if they must join multiple networks and pay multiple monthly network fees to have full access to California's public EV chargers. The California Energy Commission has required open standards for grant opportunities. PCC is continuing to monitor this situation and will provide comment to vendors as plans are further developed.
- Common protocols for identification of network operating and usage status. Drivers need to know if charging stations are in operation or if they are being utilized. A National Electrical Manufacturers Association EV technical committee is working to develop and deploy these protocols, likely in the 2013-14 timeframe.
- Possible deployment of reservation systems, particularly for Fast Chargers. This issue is being discussed as part of the Collaboratev partnership, and standards are likely to emerge in 2014.

As noted in Recommendation #13 above, the EV infrastructure planning process will benefit from the inclusion of both public sector and industry input to ensure that selected sites meet community needs, and that installation, operation, and maintenance cost factors are all considered in evaluating public charging site opportunities. To that end, the Community Environmental Council, on behalf of all PCC stakeholders, has reached out to key network

operators, including NRG, ChargePoint, AeroVironment, and others, to ensure regional coordination of charger siting and program opportunities.

High-Level Siting Recommendations

The following high-level siting recommendations are provided as a framework to guide ongoing siting work.

1. **Financial feasibility:** Select sites must be financially feasible given available installation incentives or provide other real benefits to the site owners. (Note that average Level 2 installation costs are typically in the $3,500 to $4,500 range, although a broader cost range can sometimes be accommodated for larger-scale deployments.)
2. **Visibility and accessibility:** Select highest-utilization, highest-visibility, publicly accessible locations for the first few chargers. Examples include government office buildings, shopping malls, restaurants, hotels, parks, marinas, municipal parking garages, colleges, schools, and airports.
3. **Power supply:** Select a location where Level 1 (120/15A) or Level 2 (240V/40A), or Fast Charge (480 volt) electrical supply is or can be made available with relative ease and minimal cost.
4. **ADA Access:** Consider and comply with ADA guidelines for disabled access and take precautions to ensure that charger cord management is optimized to reduce risk of accident or injury.
5. **Security:** Select secure locations with adequate lighting.
6. **Signage:** Provide enforcement and other signs that comply with the Manual on Uniform Traffic Control Devices (MUTCD) and California Vehicle Codes.
7. **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 bollards, while simultaneously taking into consideration ease of access to the charger, mobility of users, and foot traffic in the area.

In the Appendices below, sample language is provided addressing the following key elements of PEV infrastructure:

- **Standard plans, details and specifications** for public infrastructure projects to accommodate EV charging stations.
- **Ordinance language** requiring the installation of electric vehicle charging stations when significant development or redevelopment occurs.
- **Zoning code amendment language** requiring a percentage of parking spaces in new multi-unit dwelling projects to include EVSE.
- **Building and electrical code guidelines** requiring that:
    1. Electrical supply infrastructure and equipment be scaled to accommodate PEVs, and
    2. All new residential units should include basic infrastructure, such as conduits, junction boxes, wall space, and electrical panel and circuitry capacity to accommodate future upgrades for both EVSE and PV systems.

Ratio of Charging Stations to PEVs

The Electric Power Research Institute (EPRI) has conducted research on how much EV

charging infrastructure is needed to serve a given level of PEVs, with a focus on workplace and public usage. EPRI developed a "benefits tested scenario" to arrive at a recommendation to guide planners seeking to establish a ratio of charging stations per vehicle. EPRI's analysis yields a scenario in which the charging station-to-vehicle ratio ranged from 0.01 to 0.15 for BEVs and PHEVs. Applying this forecast to a long-range PEV regional estimate of 23,000 (which could be achieved by the early 2020s) yields the following EVSE deployment goal, as shown in Table 8.

Table 8: Estimated Non-Residential Level 1 and 2 EV Chargers Needs in 2020s

Vehicle Forecast	Level 1 and Level 2 EV Chargers
PHEV = 18,854 **BEV= 4,753** **TOTAL = 23,607**	Low Estimate = 2,647 High Estimate = 9,412 EPRI Method = 4,323

Source: Electric Power Research Institute

Based on analysis conducted by ICF International for the greater Bay Area PEV Readiness Plan, installation costs of Level 2 EVSE were estimated to range from $900–$2,350 for deployment at MDUs or workplaces. However, cost range can increase significantly for publicly accessible charging, depending on site characteristics. For instance, trenching and cutting costs can increase the installation costs by upwards of $3,000–$5,000 for Level 2 EVSE installations. Costs can be much lower if EVSE are installed as part of new construction.

The level of investment required to support the forecasted PEV populations for the Region is difficult to estimate for many reasons. The most significant reasons include: a) it is unclear what the split between Level 1 and Level 2 charging needs will be as the market develops and expands; b) the costs of installation will vary considerably based on site characteristics; and c) the level of charging that will be required based on PEV technology and deployment trends is uncertain. If real-world ranges of 200 miles or more become the norm after 2020, the demand for public Level 2 charging may decline on a per vehicle basis, as an even higher percentage of charging will occur at home or at Fast Charge and (potentially) at switch stations. It is also important to note that Level 1 and Level 2 AC charging costs do not exist in a vacuum. DC Fast Charging and other emerging charging technologies may put downward pressure on the price and need for Level 1 and Level 2 charging.

Plug-in Central Coast stakeholders are pro-actively responding to opportunities for state and federal investment in charging infrastructure, in order to further extend the region's charging network. The sites indicated on the attached maps (see Appendix Q) provide a starting point for the needed efforts to recruit site hosts and build partnerships with EV Service Providers. PCC will continue to cultivate prospective sites and match them with EV Service Providers that use sustainable business models for the development and operation of a viable regional charging network that will leverage private and public resources for the benefit of the community as a whole.

Regional Charging Station Site Planning Process

As part of the CEC-funded planning process, and in alignment with "encouraged" DOE plan components (elements #6 – 13), the Ventura County Air Pollution Control District completed

its comprehensive regional charging site mapping process in December 2013, and maps of prospective sites are included in Appendix R. An initial literature review was conducted on siting strategies based on materials developed by the California PEV Collaborative, the *Ready, Set, Charge California!* project, ETEC, Pacific Gas & Electric, Southern California Edison, SDG&E, Puget Sound Regional Council, the Transportation Authority of Marin, the EV Project, and other resources. In addition, the Santa Barbara County Climate Action Plan, the San Luis Obispo County Clean Air Plan, and the Central Coast regional transportation plans identify the importance of EV-friendly policy development to enable the region to meet its air quality and sustainability goals.

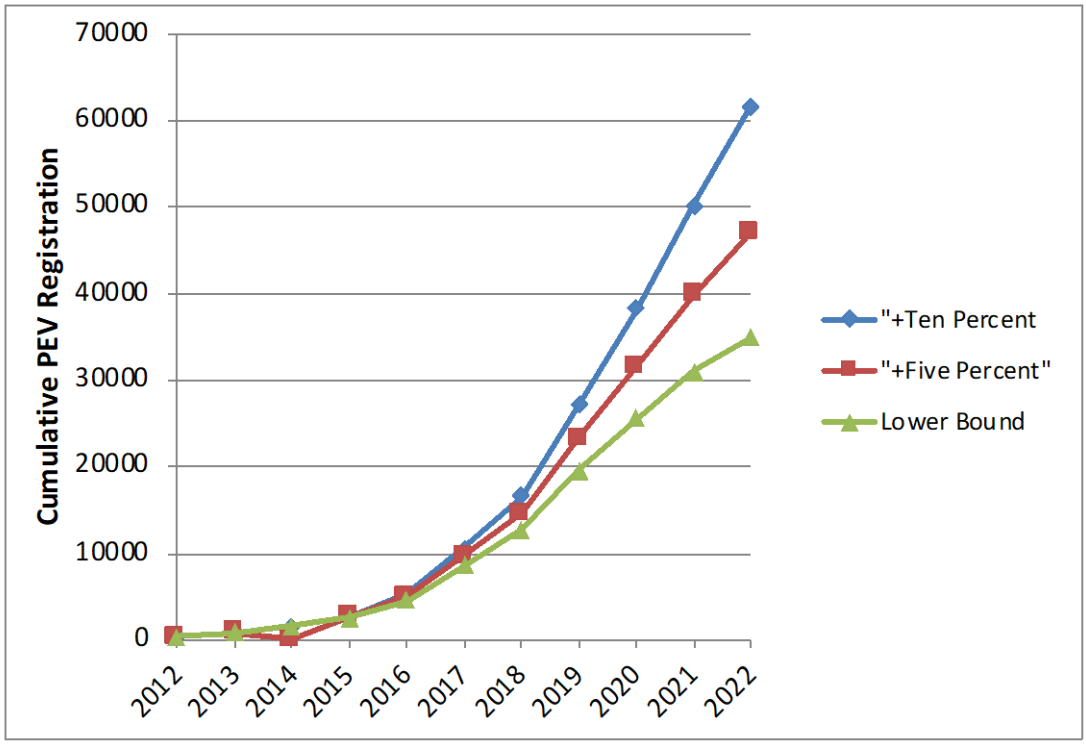
Luskin Center Methodology for Developing Charger Locations

Ventura County is also a member of the Southern California Association of Governments (SCAG), and as such is part of the broader South Coast EV planning effort with respect to EV charger location analysis. However, Santa Barbara and San Luis Obispo Counties are not in the SCAG territory. The methodology utilized by Luskin to identify Ventura County sites takes into account the following data points obtained from Central Coast transportation and planning agencies, and county assessors, and statewide resources such as the Clean Vehicle Rebate Program (CVRP). Data points include:

- Residential PEV ownership
- MDU (multi-family) density
- Workplace (employee) density
- Commercial/retail destinations
- Location of existing charging station infrastructure (per existing data developed by the Community Environmental Council and other agencies)
- EV Clean Vehicle Rebate count data by Zip code (from the California Center for Sustainable Energy)

To determine PEV growth rates, Plug-in Central Coast is utilizing the mid-range estimates cited by the California PEV Collaborative. Shown in Figure 1 is the trendline data applied to Ventura County in the analysis for SCAG performed by the UCLA Luskin Center.

Figure 1: PEV Growth Rate for the Central Coast

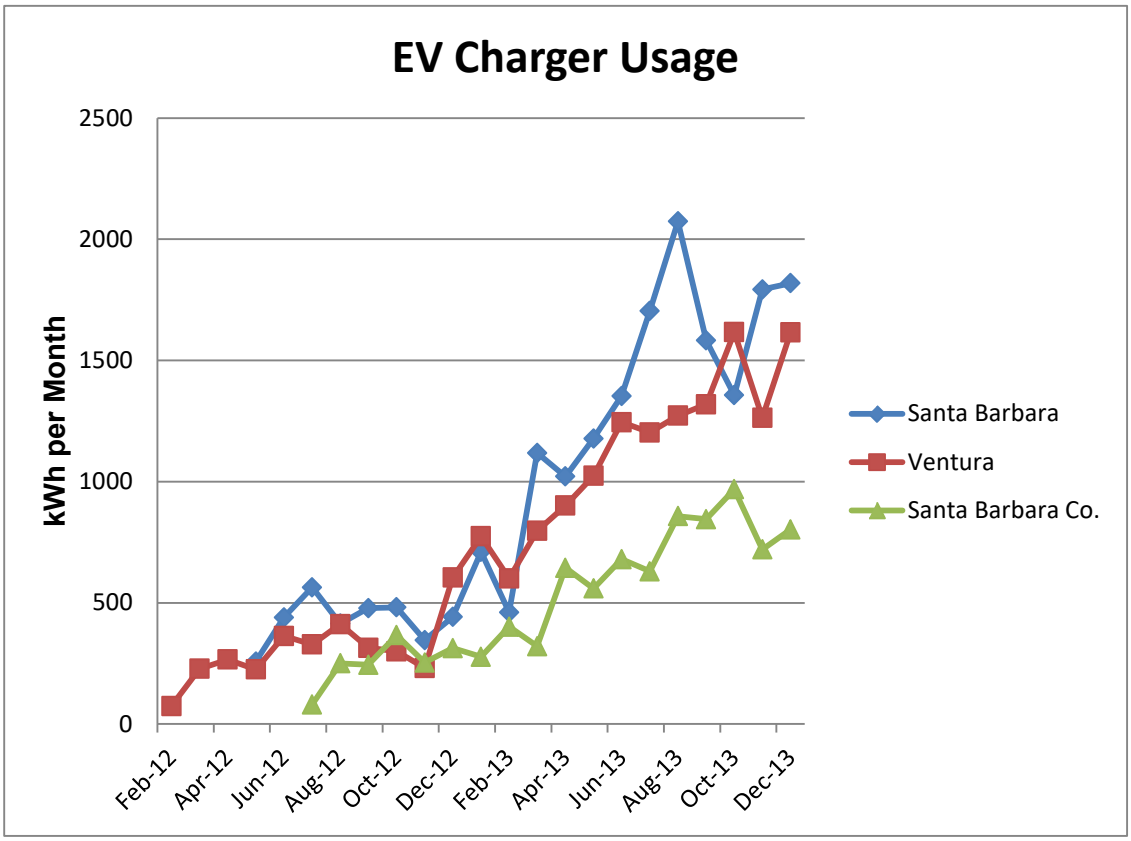


Source: UCLA Luskin Center, Southern California PEV Readiness Plan, December 2012.

Growth in Utilization of Charging Stations:

Recent data collected by the Community Environmental Council of Santa Barbara — via the ChargePoint EVSE network monitoring software — highlights a strong trend toward increased utilization of the Central Coast charging network that is consistent with PEV growth in the region. Over the 18-month period from July of 2012 to September of 2013, chargers in the two largest cities in the region — Ventura and Santa Barbara — along with the County of Santa Barbara, experienced a combined growth rate of more than 350 percent, measured by kilowatt hours (kWh) of energy consumed, shown in Figure 2. It is anticipated that public charger utilization will continue to increase at rates equal to or exceeding the PEV growth rate until there is significantly greater coverage of key charging sites identified in the site plan developed by the Ventura Air Pollution Control District.

Figure 2: EV Charger Usage Trends in Ventura and Santa Barbara



Source: ChargePoint Usage Data from Networked Level 2 EV Chargers

In response to the increase in charger utilization rates, some Central Coast cities have observed the development of EVSE "hot spots" where patterns of congestion have emerged, frustrating drivers counting on charger availability in these locations. Plug-in Central Coast is working with site owners to refine pricing plans that reflect a charge for energy consumed (kWh) as well as a price for parking time in the EV stall, to accurately reflect the value of each service, and to encourage more rapid turnover of EV spaces. Another approach being implemented in some workplaces is to increase parking rates after a set period of time (e.g., four hours) to encourage greater utilization of parking where charger data indicate that many drivers are using the space for several hours after "topping off" their batteries.

It is likely that one reason for the significant increase in kWh consumed in the 2012–013 period is that newer EVs are capable of charging at 6.6 kW (also the maximum recharge rate of most Level 2 chargers) rather than the earlier norm of 3.3 kW. For example, the Leaf charging rate has increased to 6.6 kW, and the new Ford EVs recharge at the 6.6 kW rate. Also, many Tesla owners are also using their vehicles on road trips to the region, as evidenced by many instances of charging stations dispensing 30-70 kWh in one session. Plug in Central Coast is helping local municipalities calculate cost recovery while keeping charging affordable, and are advocating for them to switch to (or layer on) both energy-based and time-based dynamic pricing, rather than the current hourly rates of 45 cents to one dollar per hour that encourage use of EV slots for parking-only, even after charging sessions are complete.

Promotion of EV-ready Buildings and Parking Lots

The highly variable cost of installing Level 2 EV infrastructure (ranging as widely as $2,000 or less to $10,000 or more) is due in large part to the fact that garages and parking areas – in residential and commercial structures – have not been consistently prepared with the requisite conduit and panel capacity to support a 240 volt plug in a convenient location. By requiring new conduit and stub-outs or plugs with appropriate capacity in the next generation of buildings and public works, the cost of new EV charger installations can be dramatically reduced. In response to this opportunity, many jurisdictions in California and beyond have adopted ordinances requiring the installation of EV charger (and solar photovoltaic) pre-wiring in new or substantially remodeled commercial and residential structures. Additionally, effective in July 2012, Title 24 of the state building code, also known as the CalGreen standards, recommended a voluntary standard that calls for new residential units to include a raceway and conduit from the subpanel or main service to the proposed location for the charging system, terminated into a listed box or cabinet. For multi-unit developments (greater than 2 units), the CalGreen standard recommends at least 3 percent of the total parking spaces, but not less than one, to be capable of supporting future EVSE for Level 2 charging (Part 11 A4.106.2). The current voluntary standards may be recommended for mandatory implementation in 2016.

Going beyond the CalGreen standards, local agencies may wish to add additional requirements for pre-wiring (as opposed to just the raceway and conduit). In addition, some jurisdictions are also specifically requiring actual installation of EV infrastructure for larger developments (e.g., over 10,000 square feet), as in the ordinance language developed by the city of Mountlake Terrace in Washington as shown in Table 9.

Table 9: City of Mountlake Terrace (Washington) Ordinance for EV Chargers Deployment

Land Use Type	Percentage of Total Parking Reserved for PEVs
Multi-household Residential	10% (1 minimum)
Lodging	3% (1 minimum)
Retail, Eating and Drinking Establishments	1%
Office, Medical	3%
Industrial	1%
Institutional, Municipal	3% (1 minimum)
Recreational, Entertainment, Cultural	1%

Source: City of Mountlake Terrace

As a starting point for PCC consideration, Recommendation R.14 above recommends a 3 percent "EV make ready" minimum for office, lodging, medical, and governmental; 1 percent minimum for retail, recreational, and cultural facilities; and 10 percent minimum for multiple-dwelling units.

EVs and Photovoltaic Connections:

EVs and distributed photovoltaic (PV) charging are highly complementary technologies, particularly when EV drivers switch to Time-of-Use rates that enable inexpensive nighttime "super off-peak" charging of EVs, with rates as low as 9 cents/kWh and use their solar array to feed valuable "on-peak" power to the grid, being credited at rates of 20-46 cents/kWh. By charging at night and allowing solar power to flow to the grid at the most lucrative daytime rates, EVs and solar operate in a synergistic manner to decrease the cost and quicken payback times for both technologies.

Given the environmental and economic synergy between EVs and renewable electricity, communities, NGOs, and industry partners should build on existing public education strategies that link outreach and awareness efforts on EVs and solar PV where feasible and appropriate. The Community Environmental Council is reinforcing this message through their "Driving on Sunshine" campaign. This slogan captures the benefits of EV + PV in an easy to understand and remember tagline and features blog posts on local residents that have solar and EVs, highlighting the economic, environmental and energy security advantages of using a local solar power array on a rooftop to power an EV. More information on section 4 below, and stories are available at http://www.cecsb.org/tag/blog/driving-on-sunshine. At recent Green Car Shows, solar carports have been displayed, further linking the connection between solar and EVs in an exciting visual display seen by tens of thousands and with information provided by solar companies.

Solar should also be encouraged at public charging sites, along with the addition of fixed battery storage that can enable stored solar power to supplant more expensive, peak rate, higher-carbon power from the grid. Solar and storage can also lessen the cost of higher daytime electricity rates often faced by public charging, along with exorbitant demand charges that local utilities charge, particularly for DC Fast Charging. Additional barriers could be reduced by policy initiatives that link pre-wiring for EV chargers and solar PV, and mandated pre-wiring for EV chargers in new construction or major remodels. Future solar installations will be made easier by a new Title 24 energy code provision starting January 1, 2014, for new construction and major remodels. These codes now require solar readiness, with provisions such as requiring a SE to W facing part of roofs be "solar ready" with pathway for conduit from the solar zone to the main service panel and sufficient space reserved for solar at the service panel.

Charger Accessibility Issues and Americans with Disabilities Act Compliance

EV Charging Stations must comply with provisions of the Americans with Disabilities Act. Unfortunately, there is not yet definitive state-level legal guidance on how provisions of the ADA will be applied to all of the specific issues that arise in EV charging. However, the statewide *Ready, Set, Charge! Guide for EV Ready Communities* represent the most authoritative guidance document to date and was reviewed by a technical committee of leading EV experts. The guidance for ADA compliance is contained in Appendix H of this document. Local communities are strongly urged to follow the recommendations contained in this guidance.

EV-Related Signage

EV related signage can provide a substantial boost to EV community awareness. By providing signs for each EV charging station that comprehensively cover the surrounding streets, community members will be reminded that EVs are a mainstream mobility option, and that the community is "EV-ready." Signage must conform to state and federal guidelines, which are discussed extensively in the Appendix. Central Coast communities are strongly recommended to budget adequately for signage as part of each newly approved EV charging station. A typical rule of thumb is to plan for sign costs of $250 each, multiplied by the number of signs needed.

Summary Checklist of EV-Friendly Policies and Practices for Central Coast Jurisdictions

The following checklist, shown in Table 10, summarizes the recommendations R1 – R14 above, while adding a final recommendation on the key issue of EV fleet deployment: *R15: Integrate PEVs into Local Fleets.* Additional information on this recommendation and on the issue of EV fleets is contained in Appendix J: *Guidelines for EV Fleets.*

Table 10: Checklist of EV-Friendly Policies and Practices for Central Coast Jurisdictions

Recommended Practice	Current Status	Next Steps (target dates)
R-1: Develop a charger permit form identifying all required elements		
R-2: Provide EV charger installation process guidance and checklists		
R-3: Advance online (or streamlined) permitting		
R-4: Establish reasonable – and flat – charger permit fees		
R-5: Waive plan requirements for simple installations		
R-6: Establish phone & online inspection request systems		
R-7: Participate in training on EVSE and installation issues		
R-8: Provide utility notification of EVSE installations		
R-9: Outreach to HOAs and property managers to offer multi-unit development solutions		
R-10: Adopt building code amendments to mandate pre-wiring for EVSE in new and remodeled multi-unit buildings		
R-11: Meet with charging vendors to ensure local sites are prioritized		
R-12: Establish EVSE siting principles in public works guidelines		
R-13: Identify key internal stakeholders to provide oversight of EV infrastructure and EV-friendly policy plans		
R-14: Adopt building code amendments that promote EV and solar ready buildings, parking, and public works		
R-15: Integrate PEVs into local fleets		

Source: Plug-in Central Coast

CHAPTER 4:
EFFECTIVE PEV MARKETING AND OUTREACH

Consumer surveys indicate that a principal barrier to PEV deployment is initial purchase price of PEVs relative to equivalent ICEs. However, when consumers are introduced to the full range of PEV models, and understand the very low-cost leasing deals now available, interest can be effectively sparked. Individual regions within the state, as well as the state as a whole, are now developing "Go EV" campaigns that provide "ride and drive" opportunities to bring PEVs directly to consumers via special PEV-only events at workplaces, malls, fairs, and other community events. These events build on existing networks of grass-roots organizations, including environmentally conscious businesses, environmental and consumer advocacy groups, EV organizations, Clean Cities coalitions, and others. Central Coast stakeholders are now working to expand PEV ride and drive events with additional state and local match funding.

Encouraging Adoption of PEVs via "EV 101" Activities, Green Car Shows, and other Educational Programs

PCC is actively educating the public, major employers, and fleets through Green Car Show and other events. The largest events include Green Car Shows in Ventura and Santa Barbara produced by the Community Environmental Council and, in San Luis Obispo, by the C5 Clean Cities Coalition. The annual Green Car Shows are expected to collectively draw over 50,000 people in conjunction with Earth Day festivities in Santa Barbara and the 4th of July Street Fair in Ventura and include as many as 40 models of green cars featuring virtually all major EV models on the market. The Santa Barbara event also includes a large-scale "ride and drive" that enables 600-900 people the opportunity to drive or ride along in an electric or hybrid car. Green car shows also include "owner's corners" where people can talk to local owners of various EV models, solar carports and solar companies that explain the benefits of driving on sunshine, charging station displays, and other educational opportunities. Details on the 2013 events are available at http://sbearthday.org/festival-highlights/green-car-show.

The other local major EV educational events occur during National Plug in Day in September, which was celebrated in 2012 in Santa Barbara and expanded to Santa Barbara and Ventura in 2013, organized by PCC members. These events occurred in high profile shopping centers and at a farmer's market, and included owners displaying over a dozen different models of EVs, ride and drives from dealers, solar company displays, and showcase displays in the food court of the mall with educational signage and owners answering questions from the public.

PCC members also periodically host workshops on EV 101 and EV policies, which include information on: EV product options (current and forthcoming); EV life-cycle costs; vehicle purchase incentives; EV infrastructure choices, costs, and incentives; the EV economic and environmental value proposition for the region; the current state of EV-readiness planning and EV-friendly policy deployment; and ways to connect with EV vendors.

Educational efforts on the web and through social media are also a large component of the PCC education campaign. The website, www.PlugInSB.org, highlights the above information

and also links to charging station maps, blog stories, and other resources. The Plug in Santa Barbara Facebook page is liked by over 300 local followers and gets the word out about new charging stations and advances in the EV world. The Driving on Sunshine blog stories and other social media posts highlight the economic, environmental and energy security advantages of using a local solar power array on a rooftop to power an EV. These stories are available at http://www.cecsb.org/tag/blog/driving-on-sunshine. These blog stories are also shared on Facebook, Twitter, and other social media and are some of the most popular blog and Facebook posts that the Community Environmental Council does. People like reading about their neighbors and envisioning how new technology could work for them. In addition, when profiled community members share these stories on their own Facebook pages and through their own networks, this peer to peer education and leadership has shown to be highly effective in encouraging others in their network to go solar and EV.

Outreach to Inform and Encourage Workplace Charging

EV 101 events described above are now also including significant outreach to employers that are most likely to respond to the EV value proposition and the imperative to provide robust EV charging infrastructure throughout the region. These include larger employers, property managers, retail establishments, businesses concerned with their sustainability profile and green image, public employers such as colleges, universities, and medical centers, transit agencies, and community-based organizations. The PCC is holding EV 101 lunch and learns at select workplaces that already have charging infrastructure installed, highlighting that many long-distance commuters can see significant cost savings by switching to a 100 MPGe+ EV. The workshops also introduce local employee EV drivers to prospective EV drivers in a parking lot display of EVs, which helps establish peer to peer expert relationships with "EV champion drivers" in each workplace. In some cases, local commuters, as shown on http://www.cecsb.org/item/phillips-are-driving-on-sunshine, are saving hundreds of dollar per month by switching to an EV and solar versus their gas car and high monthly gasoline costs. Workplace charging and fleet resources, such as the U.S. Department of Energy (DOE) Clean Cities guide to EV fleets, available at http://www.afdc.energy.gov/pdfs/pev_handbook.pdf, and the companion guide to workplace charging, available at http://www.afdc.energy.gov/pdfs/51227.pdf, along with complementary local information on the websites of the Air Pollution Control Districts and the Community Environmental Council.

Development of Information Resources on EVs, Incentives, Charging, Utility Programs, and Support Services:

As noted above, information resources on EVs, incentives, charging, utility programs, and support services are being communicated at the PCC EV outreach workshops (in 2012-13 and ongoing), and at annual Green Car events in Santa Barbara. Additionally, information resources are hosted on the three Air Pollution Control District websites and the Community Environmental Council website, with links to additional resources, including Southern California Edison, PG&E, EV automakers, Plug-in America, and GoElectricDrive, among many others.

CHAPTER 5:
TRAINING AND EDUCATION

Plan for Outreach and Education for Building Inspectors, Utilities, Facilities, Public Works Personnel, and First Responders and Public Safety Officers

As noted above, PCC has hosted *EV infrastructure and readiness workshops* as part of the EV Readiness Plan development process and is planning additional workshops in each Central Coast County to discuss the plan's most important elements. Presentation on EV Readiness will also be made to City Councils and other key decision makers at regularly scheduled meetings. These workshops bring together building inspectors and other local government staff (e.g., planners, sustainability officers, and city managers), along with utilities, facilities and public works personnel to address:

- EVSE location issues
- EVSE operations and product types
- EVSE Safety
- Inspection and compliance issues
- Installation process streamlining
- PEV-friendly public works guidelines
- PEV-friendly building codes

PCC has contracted with EV Communities Alliance and the Community Environmental Council to support this outreach and education. They are building on a series of workshops offered in the Bay Area and the South Coast as part of the "Ready, Set, Charge, California" program. The education and outreach team will include Richard Schorske, Executive Director of the EV Communities Alliance and Jim Helmer of LightMoves Consulting, who was principal consultant on the EV Readiness Guidelines for Sonoma County and for the Ready, Set, Charge California project. Workshops will be calendared in alignment with California Energy Commission funding requirements and local stakeholder needs.

Sharing of Best Practices for PEV Infrastructure, Inspection, Installation, Permitting, ADA Compliance, and Signage:

PCC is fully committed to sharing of best practices relative to the key aspects of the EV transition – including issues related to PEV infrastructure, inspection, installation, permitting, ADA compliance, and signage. PCC Steering Committee members and consultants have integrated best practices identified in other regional EV plans as they have been released, and actively monitor other EV forums -- including the state PEV Collaborative website, the Electric Drive Transportation Association Go Electric Drive resources, Rocky Mountain Institute, EPRI, Advanced Energy, and others. In turn, the PCC has disseminated best practices through the PCC workshop series described above, and through inter-regional consortium conference calls and meeting.

GLOSSARY

AEROVIRONMENT, INC. (AV)—A technology company in Monrovia, California, and Simi Valley, California, that is primarily involved in energy systems, electric vehicle systems, and unmanned aerial vehicles.

ALTERNATING CURRENT (AC)—Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

ALTERNATIVE AND RENEWABLE FUELS AND VEHICLE TECHNOLOGY PROGRAM (ARFVTP)—Now known as the Clean Transportation Program, created by Assembly Bill 118 (Nunez, Chapter 750, Statutes of 2007), with an annual budget of about $100 million. Supports projects that develop and improve alternative and renewable low-carbon fuels, improve alternative and renewable fuels for existing and developing engine technologies, and expand transit and transportation infrastructures. Also establishes workforce training programs, conducts public education and promotion, and creates technology centers, among other tasks.

AMERICANS WITH DISABILITIES ACT (ADA)—One of the most significant federal laws governing discrimination against persons with disabilities, passed in 1990. Prohibits discrimination against individuals with disabilities in employment, housing, education, and access to public services. The ADA defines a disability as any of the following: 1. "a physical or mental impairment that substantially limits one or more of the major life activities of the individual." 2. "a record of such impairment." or 3. "being regarded as having such an impairment."

BATTERY ELECTRIC VEHICLE (BEV)—Also known as an "All-electric" vehicle (AEV), BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

CALIFORNIA AIR RESOURCES BOARD (ARB)—The "clean air agency" in the government of California whose main goals include attaining and maintaining healthy air quality, protecting the public from exposure to toxic air contaminants, and providing innovative approaches for complying with air pollution rules and regulations.

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

CALSTART—A nonprofit organization working nationally and internationally with businesses and governments to develop clean, efficient transportation solutions. CALSTART is a network that connects companies and government agencies and helps them do their jobs better. CALSTART is located in Pasadena, California.[3]

DIRECT CURRENT (DC)—A charge of electricity that flows in one direction and is the type of power that comes from a battery.

ELECTRIC POWER RESEARCH INSTITUTE (EPRI)—An independent, nonprofit organization for public interest energy and environmental research that focuses on electricity generation, delivery, and use, in collaboration with the electricity sector, its stakeholders, and others. Conducts research, development, and demonstration projects to enhance quality of life by making electric power safe, reliable, affordable, and environmentally responsible.[4]

ELECTRIC VEHICLE (EV)—A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE)—Infrastructure designed to supply power to EVs. EVSE can charge a wide variety of EVs, including BEVs and PHEVs.

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NOx), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

INTERNAL COMBUSTION ENGINE (ICE)—The ignition and combustion of the fuel occurs within the engine itself. The engine then partially converts the energy from the combustion to work.

LOW CARBON FUEL STANDARD (LCFS)—A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore reduce greenhouse gas emissions. The LCFS standards are expressed in terms of the carbon intensity of gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California that aim cut greenhouse gas emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

MILES PER GALLON GASOLINE EQUIVALENT (MPGe)—A measure of the average distance traveled per unit of energy consumed. MPGe is used by the United States Environmental Protection Agency (U.S. EPA) to compare energy consumption of alternative fuel vehicles, plug-in electric vehicles and other advanced technology vehicles with the energy consumption of conventional internal combustion vehicles rated in miles per US gallon.

NATIONAL RENEWABLE ENERGY LABORATORY (NREL)—The United States' primary laboratory for renewable energy and energy efficiency research and development. NREL is the only Federal laboratory dedicated to the research, development, commercialization, and

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[3] CALSTART (https://calstart.org/)

[4] Electric Power Research Institute is available at (https://www.epri.com/#/about/epri?lang=en)

deployment of renewable energy and energy efficiency technologies. Located in Golden, Colorado.**Error! Bookmark not defined.**

PLUG-IN CENTRAL COAST (PCC)–Initiated in 2011 as the regional PEV Coordinating Council for Ventura, Santa Barbara, and San Luis Obispo counties. The planning process for Plug-in Central Coast was initiated by the joint efforts of the Clean Cities Coalition of the Central Coast, the Community Environmental Council of Santa Barbara, and the Air Pollution Control Districts of Ventura, Santa Barbara, and San Luis Obispo Counties. Key leaders from these organizations formed the Steering Committee of Plug-in Central Coast and obtained grants for tri-county PEV planning from the U.S. Department of Energy and the California Energy Commission.[5]

PLUG-IN ELECTRIC VEHICLE (PEV)—A general term for any car that runs at least partially on battery power and is recharged from the electricity grid. There are two different types of PEVs to choose from—pure battery electric and plug-in hybrid vehicles.

PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV)—PHEVs are powered by an internal combustion engine and an electric motor that uses energy stored in a battery. The vehicle can be plugged in to an electric power source to charge the battery. Some can travel nearly 100 miles on electricity alone, and all can operate solely on gasoline (similar to a conventional hybrid).

SOUTHERN CALIFORNIA EDISON (SCE)—One of the nation's largest electric utilities, which delivers power to 15 million people in 50,000 square miles across central, coastal, and Southern California, excluding the City of Los Angeles and some other cities.

UNITED STATES DEPARTMENT OF ENERGY (U.S. DOE)—The federal department established by the Department of Energy Organization Act to consolidate the major federal energy functions into one cabinet-level department that would formulate a comprehensive, balanced national energy policy. DOE's main headquarters are in Washington, D.C.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA)—A federal agency created in 1970 to permit coordinated governmental action for protection of the environment by systematic abatement and control of pollution through integration or research, monitoring, standards setting, and enforcement activities.

VEHICLE-GRID INTEGRATION (VGI)— Helps align electric vehicle charging with the needs of the electric grid. To do this, electric vehicles must have capabilities to manage charging or support two-way interaction between vehicles and the grid.[6]

VEHICLE-TO-GRID (V2G)—A system in which there is a capable of controllable, bi-directional electrical energy flow between a vehicle and the electric grid. The electrical energy flows from the grid to the vehicle in order to charge the battery; it flows in the reverse direction when the grid requires energy.[7]

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[5] PCC (https://www.ourair.org/sbc/plug-in-central-coast/)

[6] California Public Utilities Commission (https://www.cpuc.ca.gov/General.aspx?id=6442454110)

[7] U.S. Department of Energy (https://www.energy.gov/sites/prod/files/2014/02/f8/v2g_power_flow_rpt.pdf)

APPENDIX A: SAMPLE EV CHARGING PERMIT AND JURISDICTION CHECKLIST

Permit for Charging Equipment Installation

Jurisdiction: City, State

Compliance with the following permit will allow the construction and operation of electric vehicle charging equipment at a residence in the City, State jurisdiction. This permit addresses one of the following situations:

- Only a branch circuit and meter would be constructed at the residence
- A hard-wired charging station would be constructed at the residence. The requirements for the charging station are taken directly out of the 2011 edition of the National Electrical Code® (NEC) NFPA 70, Article 625 Electric Vehicle Charging System

This permit contains a general reference to the NEC or electrical code used in the jurisdiction. All work and installed equipment will comply with the requirements of the NEC or the electrical code used in the jurisdiction. The jurisdiction maintains the authority/responsibility to conduct any inspections deemed necessary to protect public safety; however, due to the projected PEV volume, it is suggested for consideration that a qualified electrician be approved to self-inspect the system enabling system operation in advance of jurisdiction inspection. The charging station installer shall also be responsible for notifying or coordinating any work with the utility company where needed.

Permit Application Section 1

The permit application requires basic identifying information be submitted in Section 1, shown in Figure 3. Note that there is a separate portion of the form requesting information on the property owner who may not be the individual requesting the installation.

Permit Application Section 2

Section 2 of the permit application in Table 11 identifies which code needs to be complied with depending on whether a branch circuit and meter or a hard-wired charging station is being installed.

The technical installation requirements address the following specific elements of electric vehicle charging station safety:

- Listing and labeling requirements
- Wiring methods
- Breakaway requirements
- Overcurrent protection
- Indoor siting
- Outdoor siting

Permit Application Section 3

Section 3 of the permit application consists of standard certification statement in Figure 4 that could be modified as needed by the jurisdiction. By signing the certification statement, the applicant agrees to comply with the standard permit conditions and other applicable requirements. This consent would give the jurisdiction the option of allowing the applicant to proceed with installation and operation of the charging equipment.

Permit Application Section 4

Section 4 of the permit application in Table 12 gives an example of a checklist the jurisdiction could develop to track key information on the application. The example under section 4 contains only a few items of the many that the jurisdiction might wish to track.

This permit package also includes a schematic drawing depicting a typical indoor installation. In this installation the wiring path follows the exterior of the structure, and the charging station is located indoors. The NECO allows for interior wiring and outdoor installations. The purpose of the schematic is only to show how the charging station equipment could be arranged and is not intended to convey any permit requirements.

Figure 3: Permit Application Section 1

Name:			
Installation Street Address (P.O. box not acceptable):	Contact Person:		Phone Number: ( ) -
City:	County:	State:	ZIP Code:
Owner Name:	Street Address:		Phone Number: ( ) -
City:	State:		ZIP Code:
Submitter's Name/Company	Street Address:		Phone Number: ( ) -
City:	State:		ZIP Code:
General description of equipment to be installed:			

Source: National Renewable Energy Laboratory, reprinted in *Ready, Set, Charge California! Guidelines for EV Ready Communities*, pp 71-72.

Table 11: Permit Application Section 2, Code Information

NECO Chapter or Article	CODE DESCRIPTION
Chapter 2 and 3	**BRANCH CIRCUIT** A new electrical box added on a branch circuit shall comply with NFPA 70 National Electrical Code® Chapter 2 Wiring and Protection and Chapter 3 Wiring Methods and Materials and all administrative requirements of the NEC or the electrical code in effect in the jurisdiction
625.4	**VOLTAGES** Unless other Voltages are specified, the nominal ac system voltages of 120, 120/240, 208Y/120, 240, 480Y/277, 480, 600Y/347, and 600 Volts shall be used to supply equipment
625.5	**LISTED OR LABELED** All electrical materials, devices, fittings, and associated equipment shall be listed or labeled.
625.9	**WIRING METHODS** The electric vehicle coupler shall comply with 625.9(A) through (F). (A) Polarization. The electric vehicle coupler shall be polarized unless part of a system identified and listed as suitable for the purpose. (B) Noninterchangeability. The electric vehicle coupler shall have a configuration that is noninterchangeable with wiring devices in other electrical systems. Nongrounding-type electric vehicle couplers shall not be interchangeable with grounding-type electric vehicle couplers. (C) Construction and Installation. The electric vehicle coupler shall be constructed and installed so as to guard against inadvertent contact by persons with parts made live from the electric vehicle supply equipment or the electric vehicle battery. (D) Unintentional Disconnection. The electric vehicle coupler shall be provided with a positive means to prevent unintentional disconnection. (E) Grounding Pole. The electric vehicle coupler shall be provided with a grounding pole, unless part of a system identified and listed as suitable for the purpose in accordance with Article 250. (F) Grounding Pole Requirements. If a grounding pole is provided, the electric vehicle coupler shall be so designed that the grounding pole connection is the first to make and the last to break contact.
625.13	**ELECTRIC VEHICLE SUPPLY EQUIPMENT** Electric vehicle supply equipment rated at 125 volts, single phase, 15 or 20 amperes or part of a system identified and listed as suitable for the purpose and meeting the requirements of 625.18, 625.19, and 625.29 shall be permitted to be cord-and-plug-connected. All other electric vehicle supply equipment shall be permanently connected and fastened in place. This equipment shall have no exposed live parts.

Table 11 (continued): Permit Application Section 2, Code Information

625.14	**RATING** Electric vehicle supply equipment shall have sufficient rating to supply the load served. For the purposes of this article, electric vehicle charging loads shall be considered to be continuous loads.
625.15	**MARKINGS** The electric vehicle supply equipment shall comply with 625.15(A) through (C). (A) General. All electric vehicle supply equipment shall be marked by the manufacturer as follows: FOR USE WITH ELECTRIC VEHICLES (B) Ventilation Not Required. Where marking is required by 625.29(C), the electric vehicle supply equipment shall be clearly marked by the manufacturer as follows: VENTILATION NOT REQUIRED The marking shall be located so as to be clearly visible after installation. (C) Ventilation Required. Where marking is required by 625.29(D), the electric vehicle supply equipment shall be clearly marked by the manufacturer, "Ventilation Required." The marking shall be located so as to be clearly visible after installation.
625.16	**MEANS OF COUPLING** The means of coupling to the electric vehicle shall be either conductive or inductive. Attachment plugs, electric vehicle connectors, and electric vehicle inlets shall be listed or labeled for the purpose.
625.17	**CABLE** The electric vehicle supply equipment cable shall be Type EV, EVJ, EVE, EVJE, EVT, or EVJT flexible cable as specified in Article 400 and Table 400.4. Ampacities shall be as specified in Table 400.5(A)(1) for 10 AWG and smaller, and in Table 400.5(A)(2) for 8 AWG and larger. The overall length of the cable shall not exceed 7.5 m (25 ft) unless equipped with a cable management system that is listed as suitable for the purpose. Other cable types and assemblies listed as being suitable for the purpose, including optional hybrid communications, signal, and composite optical fiber cables, shall be permitted.
625.18	**INTERLOCK** Electric vehicle supply equipment shall be provided with an interlock that de-energizes the electric vehicle connector and its cable whenever the electrical connector is uncoupled from the electric vehicle. An interlock shall not be required for portable cord-and-plug-connected electric vehicle supply equipment intended for connection to receptacle outlets rated at 125 volts, single phase, 15 and 20 amperes.

Table 11 (continued): Permit Application Section 2, Code Information

625.19	**AUTOMATIC DE-ENERGIZATION OF CABLE** The electric vehicle supply equipment or the cable-connector combination of the equipment shall be provided with an automatic means to de-energize the cable conductors and electric vehicle connector upon exposure to strain that could result in either cable rupture or separation of the cable from the electric connector and exposure of live parts. Automatic means to de-energize the cable conductors and electric vehicle connector shall not be required for portable cord-and-plug-connected electric vehicle supply equipment intended for connection to receptacle outlets rated at 125 volts, single phase, 15 and 20 amperes.
625.21	**OVERCURRENT PROTECTION** Overcurrent protection for feeders and branch circuits supplying electric vehicle supply equipment shall be sized for continuous duty and shall have a rating of not less than 125 percent of the maximum load of the electric vehicle supply equipment. Where noncontinuous loads are supplied from the same feeder or branch circuit, the overcurrent device shall have a rating of not less than the sum of the noncontinuous loads plus 125 percent of the continuous loads.
625.22	**PERSONNEL PROTECTION SYSTEM** The electric vehicle supply equipment shall have a listed system of protection against electric shock of personnel. The personnel protection system shall be composed of listed personnel protection devices and constructional features. Where cord-and-plug-connected electric vehicle supply equipment is used, the interrupting device of a listed personnel protection system shall be provided and shall be an integral part of the attachment plug or shall be located in the power supply cable not more than 300 mm (12 in.) from the attachment plug.
625.23	**DISCONNECTING MEANS** For electric vehicle supply equipment rated more than 60 amperes or more than 150 volts to ground, the disconnecting means shall be provided and installed in a readily accessible location. The disconnecting means shall be capable of being locked in the open position. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed. Portable means for adding a lock to the switch or circuit breaker shall not be permitted.
625.25	**LOSS OF PRIMARY SOURCE** Means shall be provided such that, upon loss of voltage from the utility or other electrical system(s), energy cannot be back fed through the electric vehicle and the supply equipment to the premises wiring system unless permitted by 625.26.

Table 11 (continued): Permit Application Section 2, Code Information

625.26	**INTERACTIVE SYSTEMS** Electric vehicle supply equipment and other parts of a system, either on-board or off-board the vehicle, that are identified for and intended to be interconnected to a vehicle and also serve as an optional standby system or an electric power production source or provide for bi-directional power feed shall be listed as suitable for that purpose. When used as an optional standby system, the requirements of Article 702 shall apply, and when used as an electric power production source, the requirements of Article 705 shall apply.
625.28	**HAZARDOUS (CLASSIFIED) LOCATIONS** Where electric vehicle supply equipment or wiring is installed in a hazardous (classified) location, the requirements of Articles 500 through 516 shall apply.
625.29	**INDOOR SITES** Indoor sites shall include, but not be limited to, integral, attached, and detached residential garages; enclosed and underground parking structures; repair and nonrepair commercial garages; and agricultural buildings. (A) Location. The electric vehicle supply equipment shall be located to permit direct connection to the electric vehicle. (B) Height. Unless specifically listed for the purpose and location, the coupling means of the electric vehicle supply equipment shall be stored or located at a height of not less than 450 mm (18 in.) and not more than 1.2 m (4 ft) above the floor level. (C) Ventilation Not Required. Where electric vehicle nonvented storage batteries are used or where the electric vehicle supply equipment is listed or labeled as suitable for charging electric vehicles indoors without ventilation and marked in accordance with 625.15(B), mechanical ventilation shall not be required. (D) Ventilation Required. Where the electric vehicle supply equipment is listed or labeled as suitable for charging electric vehicles that require ventilation for indoor charging, and is marked in accordance with 625.15(C), mechanical ventilation, such as a fan, shall be provided. The ventilation shall include both supply and exhaust equipment and shall be permanently installed and located to intake from, and vent directly to, the outdoors. Positive pressure ventilation systems shall be permitted only in buildings or areas that have been specifically designed and approved for that application. Mechanical ventilation requirements shall be determined by one of the methods specified in 625.29(D)(1) through (D)(4). (1) Table Values. For supply voltages and currents specified in Table 625.29(D)(1) or Table 625.29(D)(2), the minimum ventilation requirements shall be as specified in Table 625.29(D)(1) or Table 625.29(D)(2) for each of the total number of electric vehicles that can be charged at one time. (2) Other Values. For supply voltages and currents other than specified in Table 625.29(D)(1) or Table 625.29(D)(2), the minimum ventilation requirements shall be calculated by means of general formulas stated in article 625.39(D)(2). (3) Engineered Systems. For an electric vehicle supply equipment ventilation system designed by a person qualified to perform such calculations as an

	integral part of a building's total ventilation system, the minimum ventilation requirements shall be permitted to be determined in accordance with calculations specified in the engineering study. (4) Supply Circuits. The supply circuit to the mechanical ventilation equipment shall be electrically interlocked with the electric vehicle supply equipment and shall remain energized during the entire electric vehicle charging cycle. Electric vehicle supply equipment shall be marked in accordance with 625.15. Electric vehicle supply equipment receptacles rated at 125 volts, single phase, 15 and 20 amperes shall be marked in accordance with 625.15(C) and shall be switched, and the mechanical ventilation system shall be electrically interlocked through the switch supply power to the receptacle.
625.30	**OUTDOOR SITES** Outdoor sites shall include but not be limited to residential carports and driveways, curbside, open parking structures, parking lots, and commercial charging facilities. (A) Location. The electric vehicle supply equipment shall be located to permit direct connection to the electric vehicle. (B) Height. Unless specifically listed for the purpose and location, the coupling means of electric vehicle supply equipment shall be stored or located at a height of not less than 600 mm (24 in.) and not more than 1.2 m (4 ft) above the parking surface.

Figure 4: Permit Application Section 3, Certification Statement

I hereby certify that the electrical work described on this permit application shall be/has been installed in compliance with the conditions in this permit, NFPA 70, national electric code, Article 625, or applicable electrical code currently adopted and enforced within the jurisdiction of installation. Furthermore, all associated work with circuits, electrical service and meters shall be/has been completed in compliance with NFPA 70, national electric code, or applicable electrical code currently adopted and enforced within the jurisdiction of installation. By agreeing to the above requirements, the licensee or owner shall be permitted to construct and operate the charging station.	
Signature of Licensee:	**Date:**
Signature of Owner:	**Date:**

Table 12: Permit Application Section 4, Jurisdiction Checklist

Section 4: Jurisdiction Checklist
Information each jurisdiction would add to permit:
Date utility notified of work completed
Information on installation sent to tax assessor
Indoor/outdoor location
Modification to existing service required
Other items as determined by the jurisdiction

Source: National Renewable Energy Laboratory, reprinted in *Ready, Set, Charge California! Guidelines for EV Ready Communities*, pp 71-72.

APPENDIX B:
CHECKLIST FOR BUILDING INSPECTORS AND BUILDING CODE GUIDELINES FOR RESIDENTIAL EVSE INSTALLATION

General Permit 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.

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. Disconnect: 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 (AHJ).

Building Code Guidelines for Single Family Residential EV Charging Installations

ICC 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

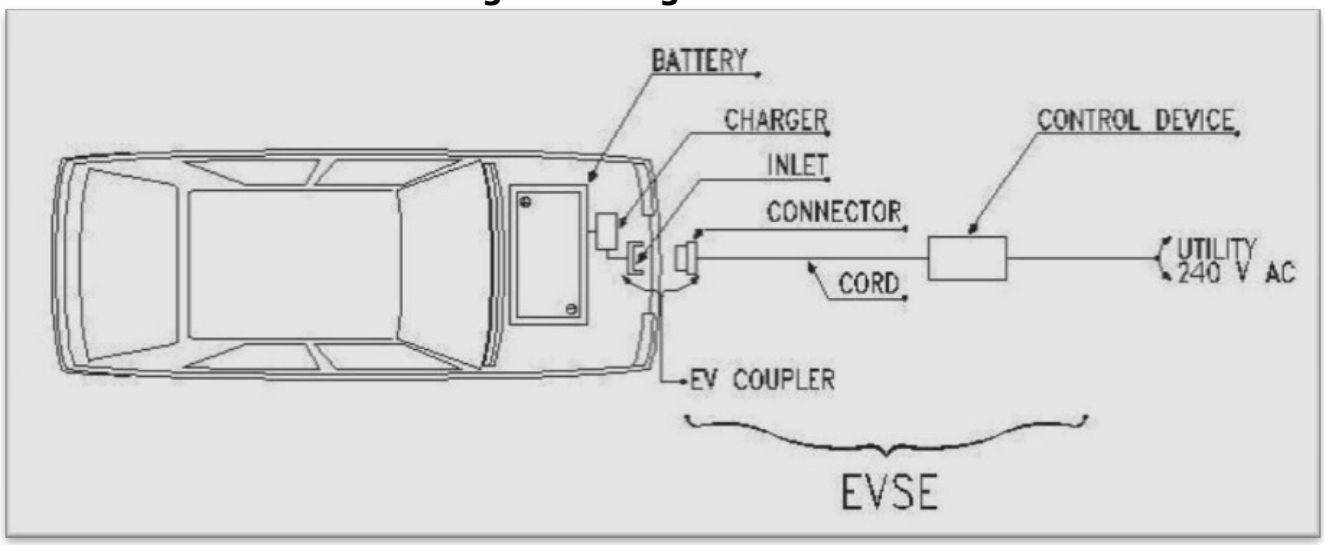
ISSUE(S):

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), shown in Figure 5, 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.

Figure 5: Diagram of EVSE



Source: Reprinted in Ready, Set, Charge California! Guidelines for EV Ready Communities, pp 64-67.

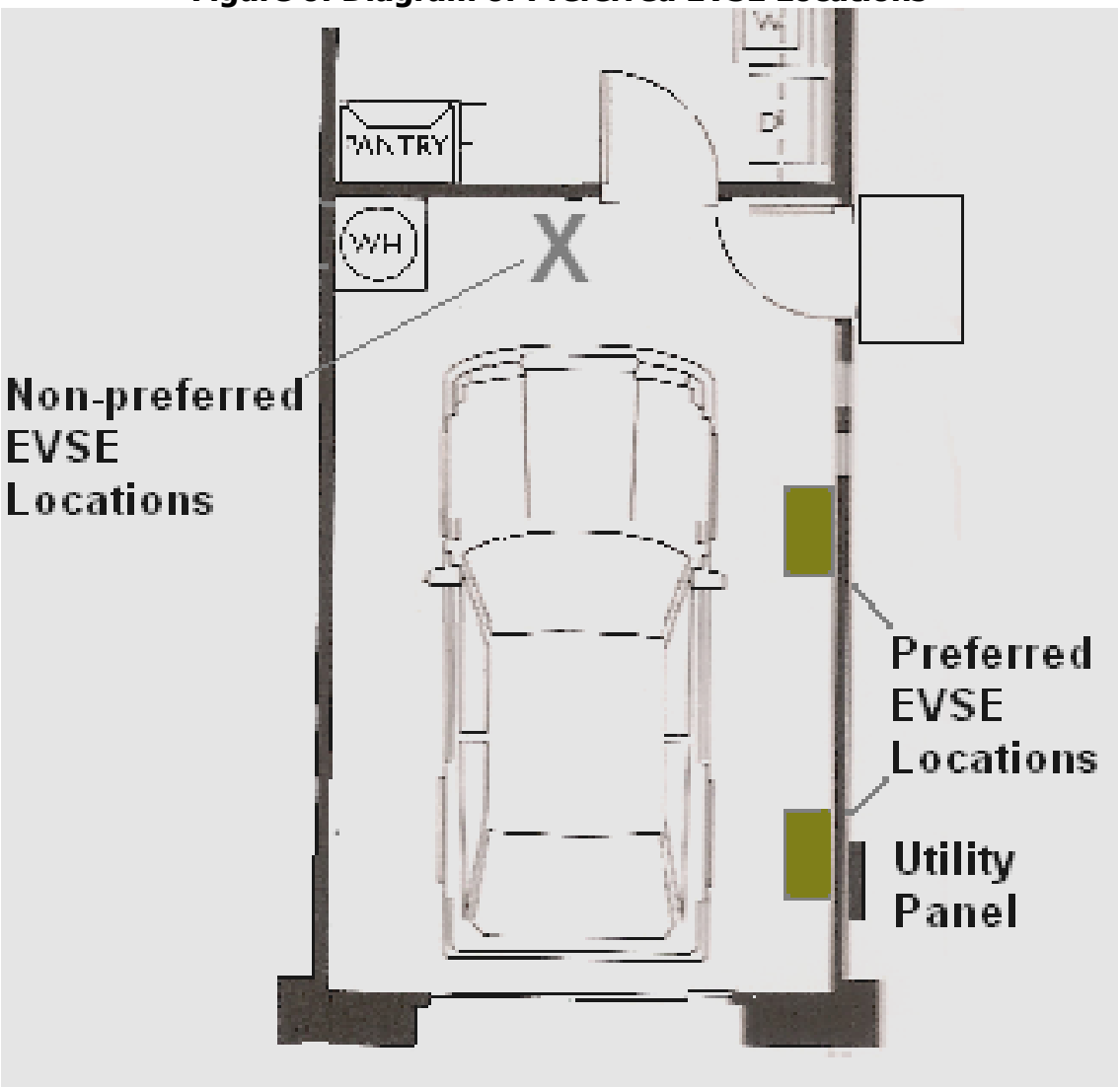
There are 2 levels of charging system for SFR – Level 1: 120 Volts Alternating Current (VAC), 15/20 Amps) and Level 2 (240 VAC, 40A). Level 2 is most likely be used because of less time to charge the vehicle.

Proposed Guidelines

An electrical permit is required for an EV charging system to be installed in the garage or carport of an 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.

Figure 6: Diagram of Preferred EVSE Locations



Source: Reprinted in Ready, Set, Charge California! Guidelines for EV Ready Communities, pp 64-67.

APPENDIX C:
CHARGER INSTALLATION GUIDANCE FOR COMMERCIAL INSTALLATIONS

Building Code Guidelines for Commercial or Multi-Family EV Charging Installations

ICC 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

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 workload of individual jurisdictions).

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.

California Building Code 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 need not be striped or provided with signage as required for an 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.

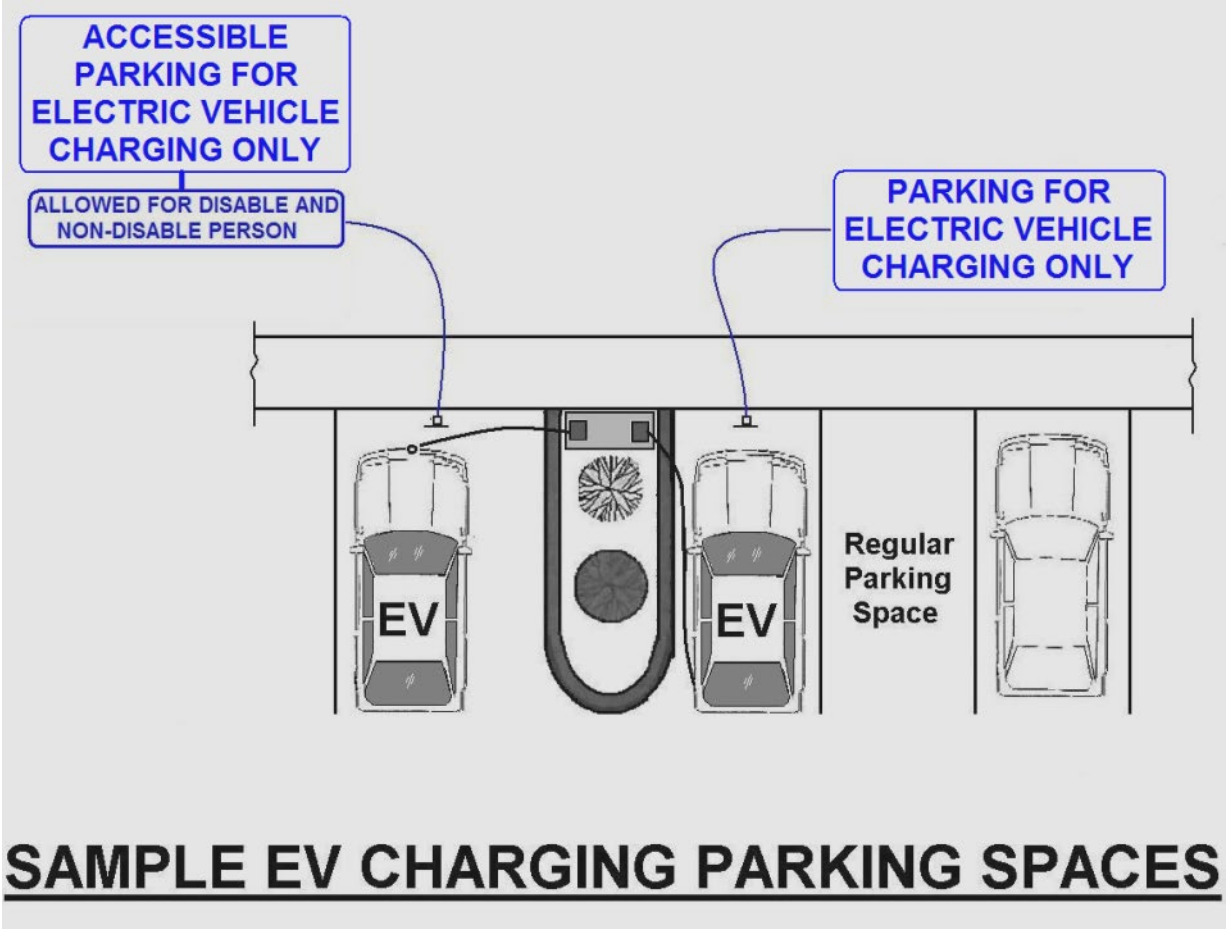
The EV charging parking space(s) may be counted towards the number of required low-emitting/fuel-efficient parking in the CGBSC.

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

Figure 7: Sample EV Charging Parking Spaces



Source: Tri-Chapter Uniform Code Committee of the International Code Council, *Ready, Set, Charge California, pp 68-69*

APPENDIX D: SPECIFICATIONS FOR CHARGING STATIONS ON STREETS, SIDEWALKS, AND OTHER PUBLIC PLACES

This section 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. Applicable information, including definitions and signage guidelines, can be inserted into code chapters as determined appropriate by local agencies.

On-Street Electric Vehicle Charging Stations

Purpose

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

Permitted Locations

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 should 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

1. Size. An Electric Vehicle charging station may be the same size as a standard parking space.
2. Signage.
    a. Each electric vehicle charging station should 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 should be installed immediately adjacent to and visible from the electric vehicle charging station.
    b. Advance Signage. Installation of signs at important decision points to guide motorists to electric vehicle charging stations may be provided.
3. Location.
    a. When installing only one EVCS, utilizing the last space on a block face in the direction of travel reduces cable management issues and places the EVCS closer to crosswalks and curb ramps (to facilitate cost-efficient ADA access).
    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. Battery 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 (applies when the curb is on the right hand side of the direction of travel), and placed between two electric vehicle charging stations for dual connectors.

4. Obstructions. When charging station equipment is placed in a sidewalk or walkway adjacent to the on-street charging station, it should not interfere with minimum pedestrian clearance widths as defined in Chapter 11B of the California Building Code or ADA Standard. Cords, cables and connector equipment should not extend across the path of travel within the sidewalk or walkway.
5. Clearance. When charging station equipment is placed in a sidewalk or walkway adjacent to roadway, it should have a minimum clearance of 24-inches from the face of the curb.
6. 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 should be installed. (California Fire Code Part 9, Title 24)
7. Controls and Equipment.
8. Charging station card-readers, controls and connector devices should be no lower than 36-inches or higher than 48-inches from the pedestrian surface.
9. Provide either cord retraction devices or a place to hang permanent cords and connectors when not in use, with adequate clearance above the pedestrian surface.
10. Area Lighting. Well-lit lighting should exist where charging station equipment is installed to minimize risk of tripping or damage to charging station equipment from vehicle impact.
11. Maintenance. Charging station equipment should contain a phone number or other contact information for reporting malfunctioning equipment, other problems or to seek information on charging procedures.
12. Notification. Information on any fees or terms of use should be clearly visible in day or nighttime conditions.
13. Communications. Charging station equipment should be equipped with cellular phone service, wired or wireless communications.

    Comment: The rationale for the requirement for charging station equipment communications or networking requirement is two-fold: 1) For PEV 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 PEVs and cellular phones. 2) As PEVs are more broadly deployed, utilities and charger owners may need to regulate charging rates during peak hours to better manage grid impacts.

Off-Street Electric Vehicle Charging Stations

Purpose

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

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 should 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

1. **Size.** Electric vehicle charging stations may be the same size as standard parking spaces or accessible parking spaces. The installation of a charging station should not reduce the electric vehicle charging station length to below minimum local zoning requirements for off-street parking spaces.
2. **Signage.**
    a. Each electric vehicle charging station should include guide signage identifying the space as an "Electric Vehicle Charging Station".
    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 should 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. (See Section 3.6 on Signage)
3. **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 (applies when the curb is on the right-hand side of the direction of travel) and placed between two electric vehicle charging stations for dual connectors.
4. **Accessibility.** Where a battery charging station is provided within an adjacent pedestrian circulation area, such as a sidewalk or accessible "path of travel" to the building entrance, the charging station should be located so as not to interfere with minimum pedestrian clearance widths as defined in Chapter 11B of the California Building Code and ADA Standard. Cords, cables and connector equipment should not

extend across the path of travel within sidewalks or walkways. (See Section 3.5.2 on Americans with Disability Act and Reasonable Accommodations)

5. **Lighting.** Where charging station equipment is installed, lighting levels should be compliant with local codes. Higher lighting levels will improve visibility of cables, charging equipment and vehicle inlets.
6. **Maintenance.** Charging station equipment should contain a phone number or other contact information for reporting malfunctioning equipment, other problems or to seek information.
7. **Notification.** Information on any fees or terms of use, voltage or amperage levels should be clearly visible in day or nighttime conditions.
8. **Communications.** Charging station equipment should be equipped with cellular phone service, wired or wireless communications.

Source: Ready, Set, Charge California Guidelines pp. 17-31

APPENDIX E:
MODEL ORDINANCES RE: CHARGING INFRASTRUCTURE IN NEW CONSTRUCTION OR MAJOR REMODELS

The following guidelines, adopted from the *Ready, Set, Charge California!* Guide to EV Ready Communities, provides sample zoning code provisions for the placement of PEV infrastructure in various land-use designations. It includes a sample table for "Allowed Uses" in typical zoning districts. Sample zoning ordinance amendments are also included with recommendations regarding potential inclusion in local zoning ordinances.

Sample Zoning Code Provisions: Electric Vehicle Infrastructure—Allowed Uses

Purpose

This Chapter provides sample 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.

Zoning District Tables

Electric Vehicle Infrastructure (EVI) -- in the form of charging stations of various electrical levels -- are permitted in zoning districts as shown in Table 13. The first column designates the zone, 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. In low-density residential, high-density residential, and recreational zoning districts, all charging infrastructure (except battery sway stations) are allowed as an accessory to a principal outright permitted use. Local jurisdictions may choose to allow Level 3 DC fast charging stations as an outright permitted use, or to adopt development standards applicable to high-density residential, mixed-use residential or other zoning districts.

Table 13: Sample Zoning Districts and Allowed Electric Vehicle Charging Infrastructure

Zoning District	Level 1 and Level 2 Charging Station	DC Fast Charging Station	Battery Swap Station
Low Density Residential	Permitted Use	Permitted Use	Not Permitted
High-Density Residential	Permitted Use	Permitted Use[3]	Not Permitted
Mixed-Use	Permitted Use	Permitted Use	Not Permitted
Commercial	Permitted Use	Permitted Use	Permitted Use
Industrial	Permitted Use	Permitted Use	Permitted Use
Institutional	Permitted Use	Permitted Use	Permitted Use
Recreational	Permitted Use[1]	Permitted Use[1]	Not Permitted

Source: Ready, Set, Charge California Guidelines pp. 17-20

Design and Installation Criteria

1. Size. Electric vehicle charging stations may be the same size as standard parking spaces or accessible parking spaces. The installation of a charging station should not reduce the electric vehicle charging station length to below minimum local zoning requirements for off-street parking spaces.
2. Signage.
    a. Each electric vehicle charging station should include guide signage identifying the space as an "Electric Vehicle Charging Station."
    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 should be installed immediately adjacent to, and visible from the electric vehicle charging station.
3. 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 should be located so as not to interfere with minimum pedestrian clearance widths as defined in Chapter 11B of the California Building Code or ADA. Cords, cables and connector equipment should not extend across the path of travel within sidewalks or walkways.
4. Number of Accessible Electric Vehicle Charging Stations. At each public parking site, the first two charging stations equipped with card-reading devices must be accessible (a charging station equipped with card-reading controls that can simultaneously charge two or more PEVs would qualify to meet this requirement)
5. Lighting. Where charging station equipment is installed, lighting levels should be compliant with local codes. Higher lighting levels are encouraged to improve visibility of cables, charging equipment and vehicle inlets.

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

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. Please note that the adopted code language samples are of actual code language adopted by the locations denoted. Original sources are footnoted below.

EV Charging Stations Count Towards Minimum Parking Requirements:

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 allow for the inclusion of EV Charging Stations in the calculation of minimum required parking.

Adopted Code Language: SeaTac, Washington

Electric Vehicle Charging Station Spaces – Allowed as Required Spaces (15.40.040)

> Electric vehicle charging station spaces shall be allowed to be used in the computation of required off-street parking spaces as provided under SMC 15.15.030; provided, that the electric vehicle charging station(s) is accessory to the primary use of the property.[8]

Note: In California, an EV charging station, once provided with an EV charging station sign, is considered to be reserved exclusively for EVs under California motor vehicle code.

EVSE required for new development [CalGreen Tier 1 Requirement]

When significant new developments or redevelopments occur, permitting agencies should require electric vehicle supply equipment (EVSE) to be installed.

Recommendation:

Local agencies should adopt ordinance language requiring the installation of EVSE in residential, office, lodging, industrial or other land uses.

Adopted Code Language: CalGreen Standards, Title 24 (Part 11, A4.106.6):

> Effective July 01, 2012, Title 24 CalGreen Standards (Part 11, A4.106.6) will require new residential units to include a raceway and conduit from the subpanel or main service to the proposed location for the charging system and terminated into a listed box or cabinet. For multi-unit developments (greater than 2 units), CalGreen will require

8 SeaTac Municipal Code. 14 December 2010. September 2011, available at http://www.codepublishing.com/WA/Seatac/html/Seatac15/seatac1540.html

at least 3 percent of the total parking spaces, but not less than one, to be capable of supporting future EVSE for Level 2 charging (Part 11 A4.106.2)[9].

Comment: CalGreen requirements should be considered the lowest level requirement (Tier 1). Local enforcing agencies may wish to have additional requirements as has been done in some communities such as pre-wiring, charging station installation or oversizing conduits to the utility service point for future expansion purposes.

Adopted Code Language:

Required facilities [Example of Tier 2 Requirement]:[10]

1. Beginning (insert date), development for each of the land uses identified in Table 14 of this section shall be required to provide electric vehicle infrastructure as shown in the table. For purposes of Table 14, electric vehicle charging stations shall be provided when the development is 10,000 square feet or more and one of the following occurs:
   a. A new building or a new off-street parking facility is developed;
   b. An addition or improvement to an existing building is made that meets a certain threshold, pursuant to (insert relevant code section); or
   c. The parking capacity of an existing building, site, or parking facility is increased by more than 50 percent.

Table 14: Required Number of Electric Vehicle Charging Stations

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

Source: CalGreen

1. The first column in Table 14 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.
2. Design for Expansion: To allow for additional electric vehicle charging in the future, beginning [insert date], all development that meets the criteria of subsection A of this

9 CalGreen Standards, available at http://www.documents.dgs.ca.gov/bsc/prpsd_chngs/2010/App-Stnd/HCD-01-10-FET-REV-Pt11.pdf

10 City of Mountlake Terrace, Washington (Ordinance 2553, Adopted November 01, 2010)

section shall be designed to allow for double the amount of electric vehicle parking shown in Table

a. Site design and plans must include the locations(s) and type of the EVSE, raceway methods(s), wiring schematics and electrical calculations to verify that the electrical system has sufficient capacity to simultaneously charge all the future EV charging stations at Level 2 charging levels with (240V/40 amperes per station.

EV Charging Stations Required for Existing Large Parking Lot

Local agencies should encourage or incentivize owners and operators of existing large public parking facilities to provide an appropriate number of electric vehicle charging stations based on local and regional infrastructure planning efforts. The sample code language that follows taken from the State of Hawaii requires large parking facilities to add EVSE.

Recommendation:

Local agencies should adopt zoning amendments that encourage or incentivize the provision of EVSE in large existing parking facilities.

Adopted Code Language: Hawaii, 2009, State Statute-Part 4, Section 291-71

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 December 31, 2010, provided that at least one of the parking spaces designated for EVs is located near the building entrance and is equipped with an electric vehicle 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[11].

11 Hawaii State Statutes, Part IV, Section 291-71. Adopted 2009, Effective upon adoption. Available at http://hawaii.gov/dbedt/info/energy/evrebatesgrants/copy_of_evpolicies.

APPENDIX F:
ZONING CODE AMENDMENT LANGUAGE ADDRESSING EV-READY PARKING

Below are sample regulations to discourage non-electric vehicles from occupying charging stations, and to regulate days and hours of operation for electric vehicle charging stations. These regulations apply only at charging stations intended for public use in public parking facilities or on public roads.

Purpose

This Chapter provides sample 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.

Electric Vehicle Charging Station Reservation for PEVs Only

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.

- Director. The "Director" means the head of the local jurisdiction department responsible for administering the off-street and on-street parking programs.
- Charging. For the purposes of this Chapter, "charging" means any parked PEV connected to the charging station.

Noticing

The Director should 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 should 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 should 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 plug-in electric vehicle should occupy such space, and no person should 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.

Violations and Penalties

1. Violations of the Chapter should be punishable as infractions. The amount of fine should not exceed the fine prescribed in the rate of fines resolution or ordinance.
2. 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.

Source: Ready, Set, Charge California Guidelines p. 21

APPENDIX G:
BUILDING CODE AMENDMENTS FOR PEV AND ON-SITE ENERGY SYSTEM READINESS

Below are examples of building code amendments pertaining to EV charging station installations and energy/storage management systems. The two are grouped so that local agencies can 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 the installation of EV charging stations. In some examples that follow, actual language is cited from existing codes in the U.S. and Canada, followed by recommendations and examples of amendments.

Require sufficient area and electrical infrastructure for PEVs

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

Recommendation

Properly size all electric vehicle supply equipment (EVSE), and the electrical room wall and floor area to accommodate the charging of electric vehicles.

ADOPTED CODE LANGUAGE: VANCOUVER, B.C.

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 percent of the parking stalls that are for use by owners or occupiers of the building or of the residential component of the building[12].

Single Family Residential PEV and Photovoltaic (PV) Readiness

Most PEV 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. Buyers of new homes 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:

12 Vancouver, British Columbia, Building By-law No. 9419, § 13.2.1 Electric Vehicle Charging, Section 13.2.1.2. Electrical Room

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 PEV charging.

Adopted Code Language: Chula Vista, Ca.

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[13].

Adopted Code Language: CalGreen (effective July 2012)

One-and Two-Family Dwellings

Install a listed raceway to accommodate a dedicated branch circuit. The raceway shall not be less than trade size 1. The raceway shall be securely fastened at the main service or subpanel and shall terminate in close proximity to the proposed location of the charging system into a listed cabinet, box or enclosure. Raceways are required to be continuous at enclosed or concealed areas and spaces. A raceway may terminate in an attic or other approved location when it can be demonstrated that the area is accessible, and no removal of materials is necessary to complete the final installation.

On-Site Energy Generation, Storage and Management Systems in Large Developments

To accommodate future growth of PEVs 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 provided 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

New parking areas and building facilities should 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, on-site renewable energy and storage systems should be installed before utility upgrades are required.

Example Building Code Language for On-Site Energy and Storage Systems:

Design for Energy Management

13 City of Chula Vista, Ca. Ord. 3173 § 1, 2010; Ord. 3121 § 1, 2009 15.24.065 Photovoltaic pre-wiring.

Effective [date], when a development of [insert square feet] or more occurs, the facility should 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 other hardship.

Design for EVCS 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 percent, the facility should be equipped with additional electric vehicle chargers to 10 percent 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.

In order to allow for additional electric vehicle charging in the future as the market for such vehicles grows, beginning [date], all development that meets the criteria of this chapter should 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.

Source: Ready, Set, Charge California Guidelines p .29

APPENDIX H:
GUIDELINES FOR ACCESSIBILITY AND ADA COMPLIANCE

Introduction to the Americans with Disabilities Act

The Americans with Disabilities Act 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.

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 interpretation of the 11C Standard is that it applies to card readers not only on liquid fuel pumps, but also on charging stations, because it lists 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 was developed to provide

14 Chapter 11C is available at http://publicecodes.citation.com/st/ca/st/b200v10/st_ca_st_b200v10_11c_section.htm

15 Internal Policy 97-03 is available at http://www.documents.dgs.ca.gov/dsa/pubs/policies_rev_01-01-11.pdf

guidance for the installation of charging equipment on State-owned parking lots, including public schools. It 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, Vehicle Code, or Manual on Uniform Traffic Control Devices; 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 on fuel dispensers and the State's internal policy on accessible EV charging stations has resulted in local agencies developing broad interpretations of the documents. The result has been widespread confusion and inconsistent applications of policy across the State, as well as across the nation. Until such time that a federal or State 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 consider using when designing, reviewing, installing and operating electric vehicle supply equipment. They should not be interpreted to dictate the manner in which a public agency chooses to administer the installation of public and restricted charging infrastructure.

An important objective of these guidelines is to ensure that accessibility provisions are met whenever possible and feasible. The guidelines take into consideration that planning EVI in new construction allows architects and engineers to match up the source and level of power supply, building use(s), and parking lot design with desired EVCS locations and charging levels. The guidelines also take into consideration the installation challenges in existing parking facilities such as uneven topography, use of existing electrical service, location of power supply, or space limitations. Because there are no definitive standards for the design and installation of EVCS, careful planning and consultation with the local Building Official is highly recommended before proceeding in both new and existing developments. In all cases the agency having jurisdiction will make the ultimate determination on permitted installations.

These guidelines identify the "battery charging station" as the accessible element, or as the point of service (see definitions). It is recognized that in conforming existing public parking facilities at least one van-accessible space already exists. By locating the first battery charging station within a van-accessible parking space, the requirement that the first battery charging station be accessible would likely be met. In doing so however, it would likely result in the van-accessible space closest to the building entrance having a very low turnover rate and less overall availability to disabled users that depend upon lift equipment, because of the long periods of time needed to charge electric vehicles. It may also result in unexpected "cable management" and tripping concerns as van-accessible parking is often on the shortest pedestrian route to the main building entrance.

Provisions for accessible card-reading equipment in the Chapter 11C standard apply to battery charging station installations as they do to liquid fuel pumps, because the standard defines electricity as a motor fuel. Therefore, as stated in Chapter 11C, the card-reading controls of the first two dispensers of any type of motor fuel need to be accessible in new or existing facilities.

For the next several years it is expected the vast majority of public EVCS will be installed in existing parking facilities, mainly private surface lots. Therefore, EVCS will likely take the place of existing standard parking spaces (assumed 9'-0" wide). The first EVCS must have accessible

equipment, thus a path of travel (see definitions) is required on either side of the space leading to the battery charging station. It is here where some agencies may require a path of travel as wide as an 8'0" access aisle (see definitions) so as to accommodate an electric van with lift equipment. However, lack of definitive standards for the installation of accessible battery charging equipment is resulting in some agencies authorizing the minimum 3'-0" path of travel between the equipment and vehicle inlet.

Until such time as Accessible EVCS installation standards are developed and adopted by the State, two courses of action may be considered by local agencies; one for new construction and one for existing parking facilities, as shown in Table 15. As local agencies eventually adopt ordinances, codes, private & public development standards and regulations, every effort should be made to update these guidelines to reflect current laws and regulations. New construction includes existing facilities increased in size by at least 50 percent or by 30 parking spaces (percent or number determined by local agency). If the first EVCS is a dual station that can charge two vehicles simultaneously, then the second EVCS would qualify as accessible as long as a card reading device was accessible.

Table 15: Minimum Installation Options for Accessible EV Charging Stations

	New Construction	Existing Parking Facility
1st EVCS	Be accessible and be installed in an existing van-accessible parking space or in a new 17-foot wide accessible parking space. If in a new space, no need for a D9-6/R7-8b (disabled parking symbol/VAN-accessible) or having a striped access aisle.	Be accessible, and may be installed in the existing van-accessible space, in an existing accessible space, in a standard space (> 9-ft wide) adjacent to an "access aisle", or in a standard space with a 3-foot wide unstriped travel path between the EVSE and the vehicle inlet.
2nd EVCS	Be accessible and be installed in an existing accessible parking space or in a new 14-foot wide space. If a new space, no need for a D9-6 (disabled parking sign) or having a striped access aisle.	Be accessible and be installed in a standard parking space (9-feet wide minimum) with a 3-foot wide (minimum) un-striped path of travel.
3rd EVCS	Standard parking width 9 feet.	Standard parking width 9 feet.

Source: California Building Code

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, and still ensure that the equipment is accessible for persons with disabilities. These guidelines identify the battery charging station as the accessible element. Below are the primary design requirements in Chapter 11C for accessible fuel-dispensing equipment as revised to coordinate with Title 24 and ADA Standards and other recommendations in the document:

- 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 PEVs from one card reader would qualify to meet this requirement)
- A level accessible area (see definitions) measuring no less than 30-inches by 48-inches (with the long dimension being parallel to and centered in front of the equipment, plus or minus 9-inches on either side) must exist.
- If on a raised surface, 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. The 2010 ADA Standard lowers height reach ranges to 48 inches maximum, except that the operable parts of fuel dispensers shall be permitted to be 54 inches maximum measured from the surface of the vehicular way where fuel dispensers are installed on existing curbs.
- Where protective posts or other guard devices are provided, they shall not obstruct accessible EVCS paths of travel or other accessible routes and shall not be located within 3-feet of the battery charging station controls and connector handle(s).
- 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 cable and connector may cross over the level accessible area when inserted in the vehicle charging inlet.

Figure 8, a gasoline dispenser with two hoses, protected by guard posts provides an illustration of the front of the controls where the gas handle and card-reader are situated, with a recessed curb centered beneath the card-reading device.

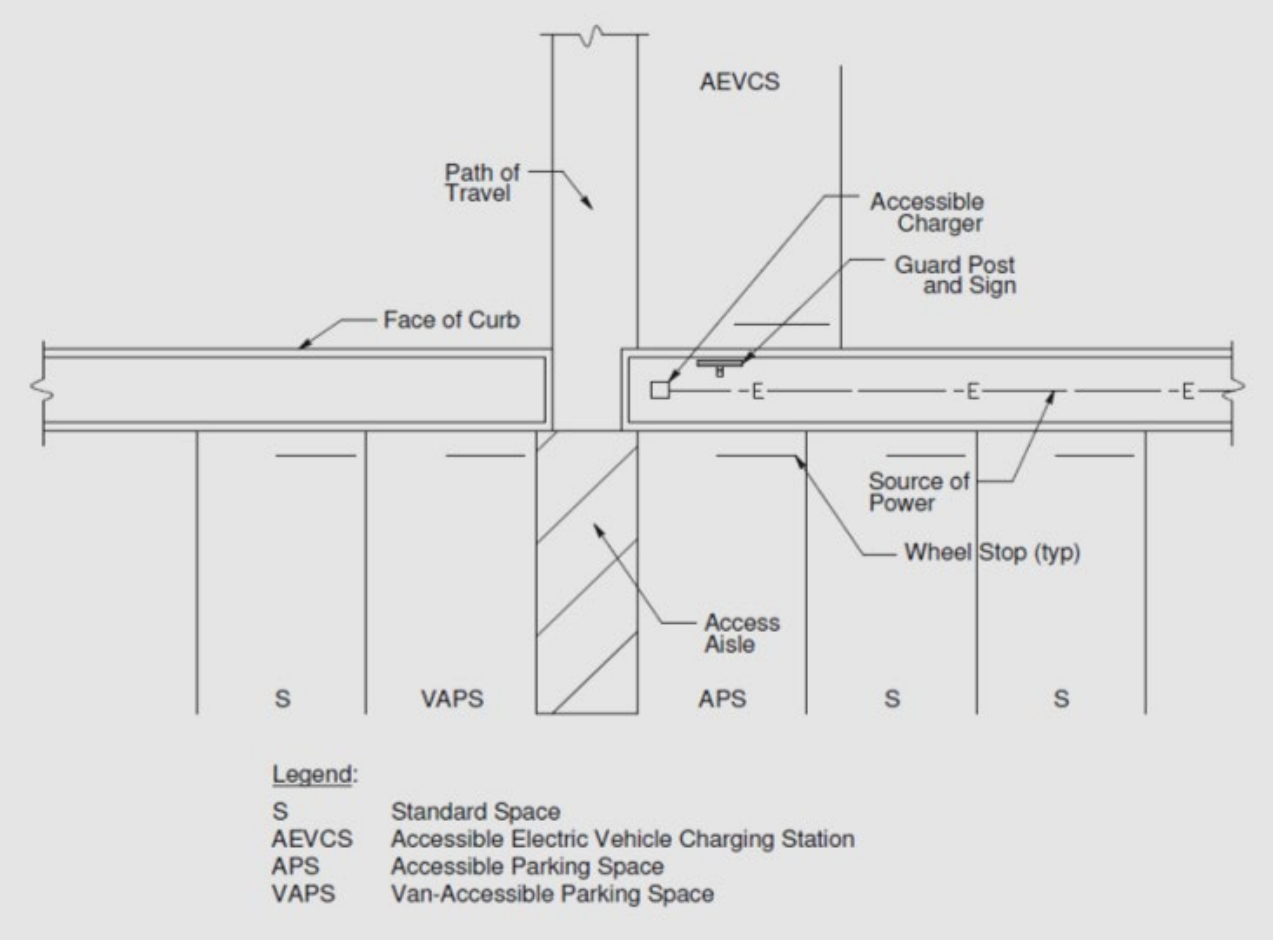
Figure 8: Accessible Liquid Fuel Dispenser

Source: Ready, Set, Charge California Guidelines p. 26

Figures 9, 10, and 11 and accompanying comments that follow provide guidance for accessible electric vehicle charging stations in various parking lot configurations. The examples are based upon conventional parking lot designs, review of ADA design standards, 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" section of the State Building Code, the details of the hardship should be recorded and entered in the files of the enforcing agency.

This example in Figure 9 illustrates how placement of dual port charging station in an existing parking facility 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 plates may occupy the accessible parking space including a PEV that could utilize the accessible battery charging station. Signs identifying the accessible parking space as an "Electric Vehicle Charging Station" would be added to the existing ADA signage. The accessible EVCS must meet the reach, height, clearance and slope requirements of accessible fuel-dispensing equipment (Chapter 11C, CBC) and ADA standards. This figure is patterned after Sonoma County EVCS Program and Installation Guidelines.

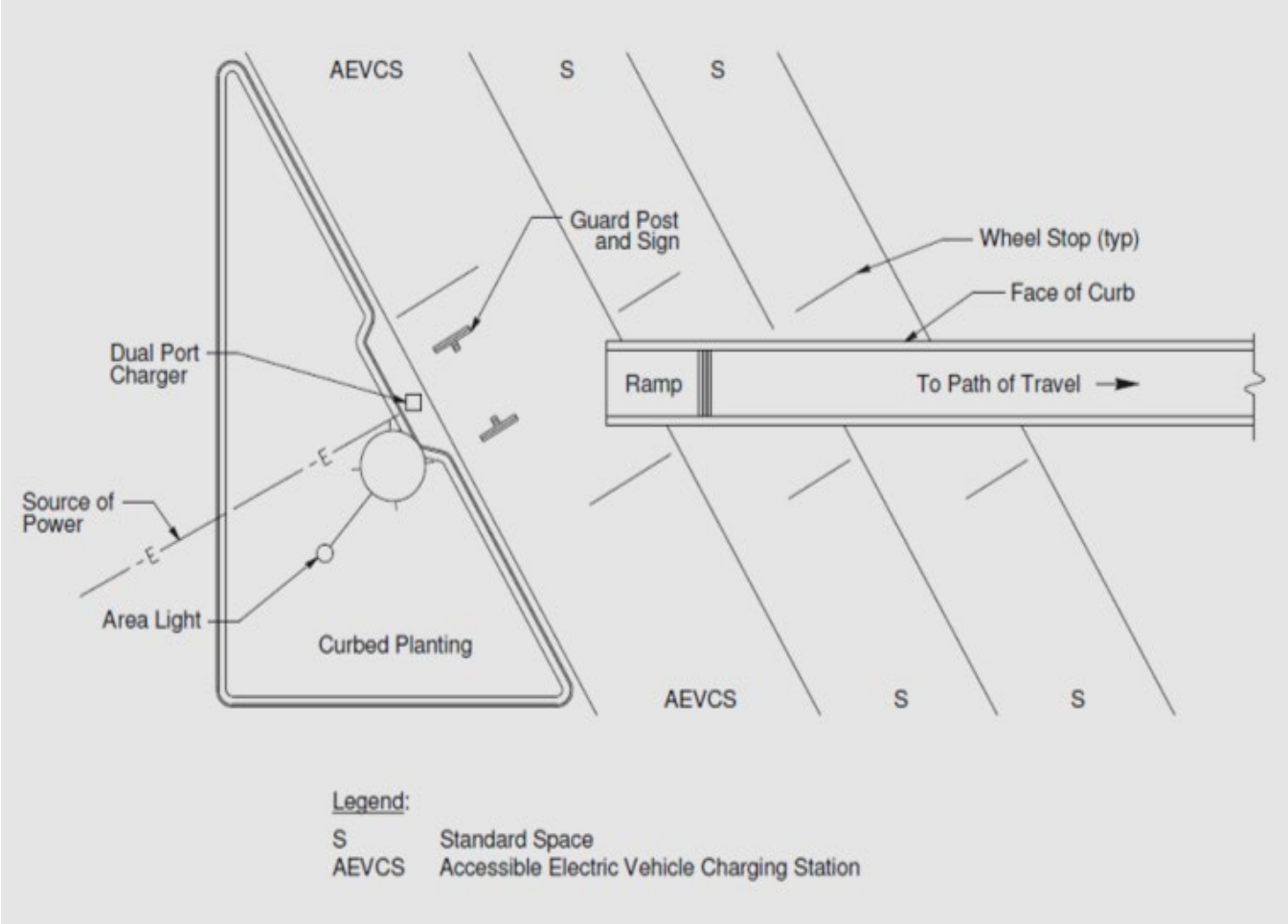
Figure 9: First EVCS in Existing Parking Facility



Source: Ready, Set, Charge California Guidelines p. 27

Figure 10 shows an existing parking facility 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. This figure is patterned after Sonoma County EVCS Program and Installation Guidelines.

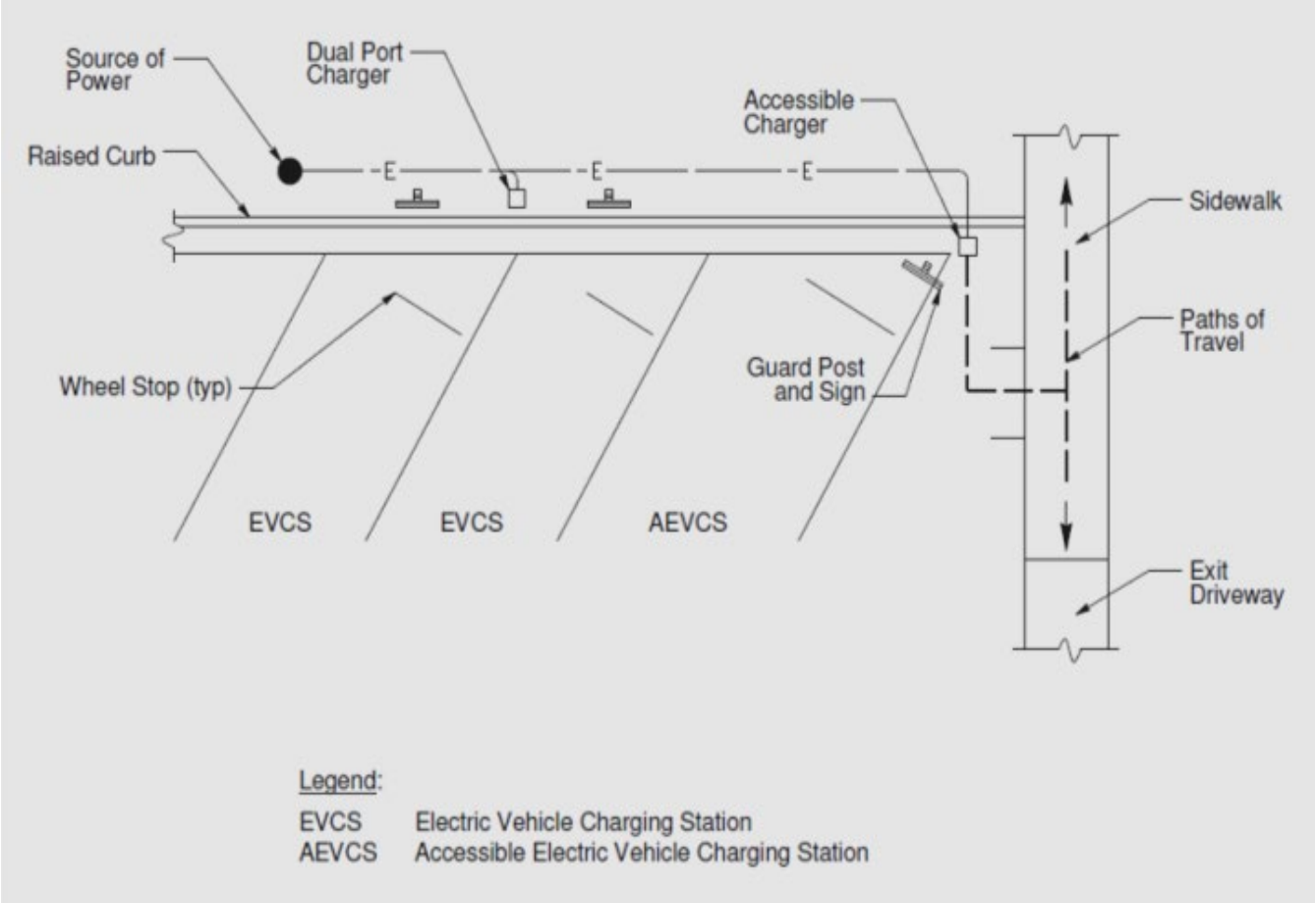
Figure 10: First Two EVCS in Existing Parking Facility



Source: Ready, Set, Charge California Guidelines p. 28

Figure 11 illustrates an accessible EVCS adjacent to a wide level paved area between the EVCS and sidewalk, where the sidewalk serves as the path of travel. Two EVCS are also shown. This figure is patterned after Sonoma County EVCS Program and Installation Guidelines.

Figure 11: Accessible EVCS and Two Additional EVCS



Source: Ready, Set, Charge California Guidelines p. 28

APPENDIX I:
EV-RELATED SIGNAGE GUIDELINES

Local and State agencies posting guidance or regulatory signs on public roadways, must do so in conformance with the current edition of the California 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 shown in Table 16.

Table 16: Color Format for General Service Signs

Letters	Symbols	Arrows	Borders	Background
White	White	White	White	Blue

Source: Ready, Set, Charge California Guidelines p. 30

Figure 12 shows 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.

Figure 12: General Service Signs with Recommended Sizes

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"

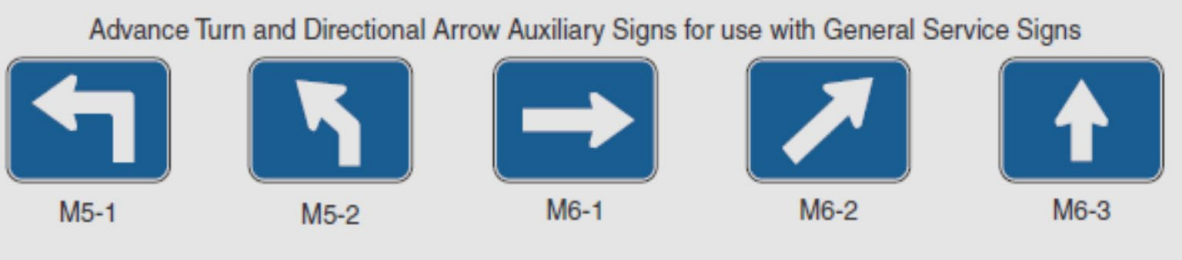
D9-11b

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

Source: Ready, Set, Charge California Guidelines p. 30

Shown in Figure 13 are the typical types of advance turn and directional arrows used with the electric vehicle charging signs. This section on signage is modeled after the Sonoma County Electric Vehicle Infrastructure Guidelines Report and the Puget Sound Regional Council EVI Deployment Guidelines Report. Figure 11 depicts a sign that has been tested in Oregon and Washington and has been adopted in Michigan.

Figure 13: Advance Turn and Directional Arrow Auxiliary Signs

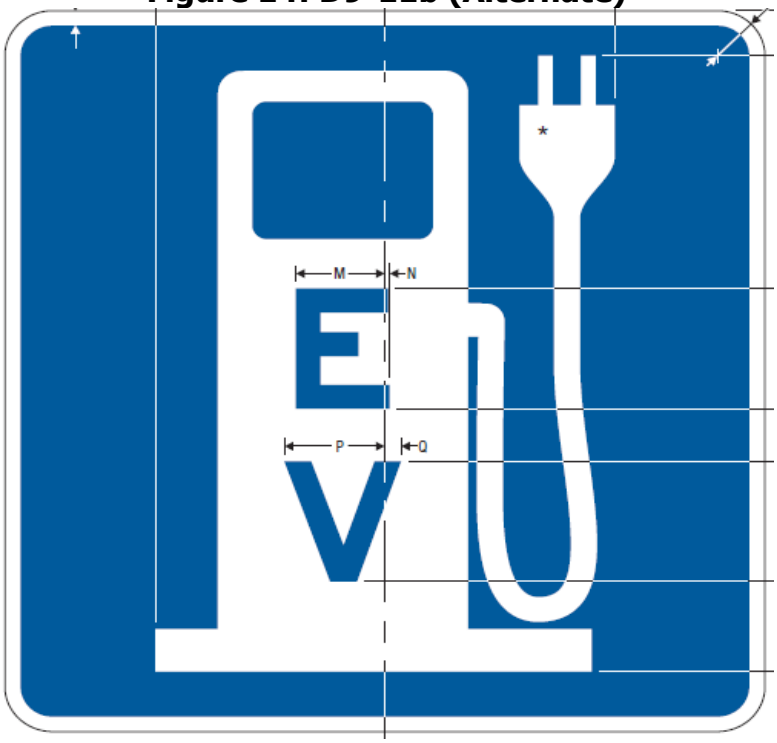


Source: Ready, Set, Charge California Guidelines p. 30

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, shown in Figure 14. 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.

Figure 14: D9-11b (Alternate)



Source: Ready, Set, Charge California Guidelines p. 30

Regulatory Signs

Regulatory signs are required for enforcing the time duration and days that electric vehicles are permitted to park and/or charge. Qualifying electric vehicles may be defined in local codes, and their charging status addressed (plugged in and charging, not charging, etc.) Currently, no regulatory signs exist for electric vehicle charging purposes in either the California MUTCD or the federal MUTCD. However, Figure 15, shown below, illustrates signs being tested in Oregon and Washington, and may be utilized in California. 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 should not be taken.

Figure 15: Regulatory Signs Undergoing Testing in Oregon and Washington

Source: Ready, Set, Charge California Guidelines p. 30

To be enforceable, 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 a PEV 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 should be installed below or to the right of the prohibitive sign.

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 Section 22511, and recommended ordinance language to authorize the enforcement of these signs is included in section 2.3 of this document.

APPENDIX J:
GUIDELINES FOR EV FLEETS

Context

Central Coast fleet operators will be a key stakeholder group that can help to drive the EV transition across the region. EV adoption within fleets will provide direct benefit to fleet operators *and* the community -- through reduced emissions, enhanced energy security, and improved operating economies. Importantly, by lending their organizational "stamp of approval" to EVs, fleet operators will help communicate the message to consumers generally that the EV value proposition is strong and EV charging infrastructure will continue to grow. Therefore, *Recommendation #15* of the PCC actions for consideration by local government stakeholders is to *Integrate PEVs into Local Fleets.*

Purchase and Evaluation Criteria:

Total Cost of Ownership, Environmental Criteria, and Climate Action Plan Considerations

The current pipeline of EV models is dominated by light-duty vehicles (LDVs). However, an increasingly large variety of medium duty vehicles (MDVs) and heavy-duty vehicles (HDVs) are also on their way. Both public and private fleet operators are potential targets for EV procurement. Thus, for local governments, *greening the fleet* with PEVs is a key part of becoming *EV-ready,* and will give local government staff invaluable hands-on experience with the benefits and challenges of the EV transition.

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 PEV 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 PEVs – and their steadily improving price/performance profile relative to conventional vehicles, green fleet programs will increasingly focus specifically on accelerated integration of PEVs into the fleet mix.

While PEVs 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 specific technology choices to achieve those goals. Thus, green fleet programs are typically focused on:

- Reducing costs
- Preparing for future conditions (including potential fuel price spikes or supply disruptions) and regulatory requirements
- Reducing the fleet's harmful impact on the environment and human health
- Support the advancement of AB 32 goals, SB 375 Sustainable Communities Strategies, and municipal and county-level Climate Action Plans

GHG Emissions Reduction Potential

The advantages of electricity over other fuel sources have been well-documented by the California Air Resources Board, given the relatively low carbon content of California's electricity grid. However, biofuel and hybrid emissions comparisons can be complex given the multiplicity of criteria air pollutants and greenhouse gases. To arrive at specific impacts, fleet managers can insert their own fleet variables into an emissions calculator based on the industry-standard model accepted by the DOE and the EPA, available through the Argonne National Labs at http://greet.es.anl.gov/fleet_footprint_calculator. Additional information on GHG impacts resulting from PEV deployment in the Central Coast area is available in Appendix P of this document (GHG Impact Analysis).

Cost Comparisons

At current prices, PEV fueling costs are significantly less than competing fossil fuel or biofuel options. While the initial purchase price of PEV fleet vehicles is typically higher than comparably equipped conventional vehicles, PEV buyers often enjoy lower total cost of ownership, based on reduced fuel costs, insulation from fossil fuel price shocks, and significantly lower maintenance costs (in the case of BEVs) as shown in Table 17. These advantages are leading many fleet managers to embrace PEVs as a core element in their green fleet plans. For pure Battery-Electric Vehicles (BEVs), the maintenance burden is significantly reduced compared to either internal combustion engine (ICE) or plug-in hybrid (PHEV) alternatives. BEV motors have fewer parts than internal combustion engines. Exhaust systems are non-existent, cooling systems radically simplified, and complex clutches and transmissions replaced with simplified units.

Table 17: Operating Cost Comparing Electric Vehicles to Internal Combustion Engine Vehicles

Operating Cost Comparison	**Internal Combustion** TYPE: 5 passenger RANGE: 400 mi. with 16 Gallon tank GASOLINE: $3.50/Gal. FUEL COST/TANK: $56.00/ 400 miles	**Battery Electric Vehicle** TYPE: Nissan LEAF ~ 1kWh = 4 mi. distance RANGE: 96 mi. w/ 24kWh battery ELECTRICITY: $0.056 / kWh (off-peak summer) eFUEL COST: $5.60 /	**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 – reg. gas Cost per mi.: = 14 cents/mile	**$0.014** Electricity cost = 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.)	~$100	~$0	**$100 savings in 6 Yrs.**
TOTALS	~$27,220	~$8,512	**~$18,708/6 Yrs.**

Source: Ready, Set, Charge California Guidelines p. 53

Even with a $10,000 to $15,000 or more price differential between a 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 Business Council on Climate Change uses a conservative $3.50/gallon gasoline cost and still produces a substantial savings over the vehicle lifecycle that more than makes up the difference in initial purchase price.

Recommended Steps to Advance EV Fleet Deployment

To engage a PEV-focused fleet initiative, it is recommended that fleet managers:

1. Develop fuel efficiency targets (which are convertible to GHG and other criteria pollutant emissions factors)
2. Analyze fleet duty cycles in comparison with available PEVs with regard to range, charging requirements, and operating costs
3. Develop a comprehensive green fleet plan that includes goals, milestones, staff responsibilities, commitments from top management, and monitoring and implementation strategies.
4. Assess opportunities for joint procurement with other public and private fleet operators, in cooperation with the California PEV Collaborative and statewide Clean Cities Coalitions.

Commercial PEV Technologies and Fleet Charging Challenges

As noted above, commercial classes of PEV vehicles are evolving rapidly and encompass nearly every class of vehicle. As of late 2013, PEV models 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, crossovers, pickups, 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, which tracks all classes of PEVs, and CalStart, which focuses on medium and heavy-duty options.

Co-Location of Fleet Charging with Publicly Accessible Charging

Fleet vehicle charging options span the full range from AC Level 1, AC Level 2, and DC Fast Charge options, depending on vehicle type and specific applications. As with any commercial charging arrangements, fleet managers need to be cognizant of utility surcharges known as demand charges, 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, AC Level 1 charging options may be most appropriate, as these may not require the same level of power supply upgrade costs as Level 2 charging. For vehicles needing the fastest turnaround for demanding applications such as shuttle or taxi services, DC Fast Charging may be a high priority need and worth the extra cost. It is important to note that it can be mutually advantageous for the general public and public fleet operators to co-locate fleet charging where practical. Specifically, many fleet vehicles may be gone most of the day and visitors could occupy charging stalls in the meantime. When visitors depart at closing time, then the fleet vehicle can be parked in that stall overnight.

Publicly Accessible Charger Cost Factors:

Table 18 provides some indication of the range of costs likely in different charging circumstances:

Table 18: Estimated Vehicle Charging Times, Charger Hardware, and Installation Costs

Charger Type	Charge	Time to Charge Vehicles at Various States of Charge			Charger Hardware Costs	Installation Costs	Typical Range of Total Costs	Average Total Costs
		Volt 16 kWh	Leaf 24 kWh	Tesla 53 kWh				
AC Level 1 1.4 kW 120V	Half	6 hrs.	8.5	19 hrs.	$300–$500	$300–$500	$600–$1000	$900
	Full	11 hrs.	17 hrs.	38 hrs.				
AC Level 2 7.5 kW 240V	Half	1 hr.	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	15	35 min	$25,000 $55,000	$15,000–$30,000*	$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				

Source: Ready, Set, Charge California Guidelines p. 54

Fleet Charging and Management

Several manufacturers, including Aerovironment, ChargePoint, GE, and others, currently have or plan to offer PEV fleet charging software of varying levels of sophistication. For example, the Coulomb Network Fleet Manager provides status and location of PEVs 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.

Targets for PEV Fleets, Fleet Adoption Rates, and Strategies to Overcome Adoption Barriers

Surveys of major fleets in the tri-county area are ongoing annually through the Central Coast Clean Cities Coalition and provide data that local fleet managers can use to benchmark progress toward cleaner fleets. To advance PEV plans, Central Coast fleet operators may wish to consult these key resources:

- U.S. DOE Clean Cities EV fleet handbook is available at http://www.afdc.energy.gov/pdfs/pev_handbook.pdf
- U.S. DOE Clean Cities EV and Alternative Fuel Vehicle (AFV) case studies are available at http://www.afdc.energy.gov/case/
- American Public Works Association (APWA) fleet resources are available at http://classic.apwa.net/ResourceCenter/index.asp?Section=equipment&SectionName=Equipment+%26+Fleet+Management
- California Energy Commission (CEC) links to funded fleet initiatives and infrastructure initiatives are available at http://www.energy.ca.gov/drive/projects/electric.html

Current PEV Fleet Adoption on the Central Coast

Fleet adoption of PEVs on the Central Coast is modest as of late 2013. Surveys conducted on behalf of PCC (conducted by the Central Coast Clean Cities Coalition and the Community Environmental Council) found that a total of approximately 170 PEVs are currently deployed among major fleet operators responding to the survey, and the majority of these are low speed neighborhood electric vehicles at educational institutions. In fact, to our knowledge there are likely fewer than a dozen freeway capable EVs in Central Coast municipal fleets, with a handful in private fleets. (See the table on the following page.) There are very few major private fleet operators in the region, and the largest national entities – UPS, and the US Postal Service, FedEx – have not yet deployed PEVs in the region or announced plans to do so. However, these entities are testing PEVs in other regions and it is anticipated that national fleet deployment plans may be announced in the 2014-15 period based on the results of current testing with Medium Duty Vehicles from suppliers such as Smith Electric and Boulder Electric Vehicles. As part of its dialogue with stakeholders and the overall regional planning effort, PCC has assessed barriers to increased PEV fleet adoption and identified strategies to encourage adoption. These are articulated following the fleet table. Only larger public and private fleets with some Alt Fuel and/or PEV penetration were included in Table 19.

Table 19: Current PEV Fleet Adoption on the Central Coast

Fleet Operators	Vehicle Types (ICE)						Alt. Fuel Vehicles		
	Total Fleet	Two Wheel	Light-Duty	Truck /SUV	Bus/ Van	Other	Hybrids	PEV	CNG/ Biofuel
Higher Education									
UCSB - TSV	285		22	191			8	10	23
UCSB - DOV	60		7	34			1	7	9
Santa Barbara City College	47		6	29	12				4
Westmont College	91		27	46	6	12		63	
CalPoly SLO		72	22	220	96	53	2	57	1
Govt./Corp.									
City of Goleta	14	4	4	6			2		
City of Carpinteria	20	1	4	9	1	2	1	2	
City of Ventura	359	10	83	149	7	84	15	11	
City of San Luis Obispo	268	10	48	117	18	71	4		
City of Grover Beach	35		7	28					1
City of Arroyo Grande	78	2	50	10		10			
City of Oxnard	850		139	225			21		18
City of Thousand Oaks	244						55		12
City of Camarillo	80		4	44		25	7		
City of Moorpark	17		3	7	1	5	1		
City of Simi Valley	214				26				27
Metro. Trans. District (MTD)	136		27	3	106		18	20	
SB County	1,109	5	335	372	103				
SLO County									
Ventura County	1355		568	155	184	104	157	2	
SoCal Edison (Ventura/Santa Barbara Area)	309		191	175	56	78	12	1	
TOTAL	**5,571**	**104**	**711**	**1,477**	**270**	**252**	**287**	**173**	**1,683**

Source: Central Coast Clean Cities Coalition

EVs in the City of Santa Barbara's Fleet

The City of Santa Barbara has strongly embraced the electrification of transportation, with initiatives underway to phase in EVs in their 485-vehicle fleet, and to expand the public EV charger network. As in other municipalities, the first policy approach in the "loading order" for greener fleet management is to reduce fleet size through more effective sharing of pooled vehicles. This has the short-term effect of reducing the rate at which newer and cleaner vehicles enter the fleet, while producing the long-term effect of reducing greenhouse gases produced in both the manufacture of new vehicles and their use.

In 2012, the City purchased two Nissan Leafs through a lease-option purchase program and installed eight ChargePoint Level 2 charging stations to serve both fleet and public charging needs. The City is also considering the purchase of a plug-in hybrid for 2013, to enable longer-distance travel without recharging. With just 60 light-duty vehicles in the fleet, PEV penetration will be at 5 percent of LDVs once the third PEV is acquired and is expected to grow steadily from there. According to the fleet manager, acceptance of the vehicles has been good, and the low daily mileage duty cycle of most of the City's fleet vehicles are well-suited to the current range of BEVs such as the Leaf, which are rated at approximately 75 miles of all-electric range.

From the manufacturer's perspective, use of vehicles like the Leaf is a win/win for boosting consumer awareness and enthusiasm. The Santa Barbara fleet EVs are marked more prominently than regular consumer EVs, enhancing the City's green image and expanding awareness of the viability of EVs in fleet applications. In addition, many different City employees have the opportunity to use the fleet vehicles in a given year, and the driving characteristics of the PEV are typically a very pleasant surprise for new drivers, providing an attractive blend of quiet, smoothness, handling, acceleration, and the elusive "cool factor."

Because many City employees have the opportunity to enjoy multiple "ride and drive" experiences with EVs in a fleet placement, manufacturers are beginning to offer very special terms for EVs in public fleets, particularly during the model-year changeover period. Going forward, Santa Barbara and other public entities on the Central Coast may have access to increasingly attractive EV lease terms, as new lease terms are devised for very low-mileage duty cycles typical in some public fleet applications. Current lease prices of $199/month for a Nissan LEAF with the down payment covered through the $2,500 California rebate may pencil out well for fleet managers who analyze operating costs per mile and total cost of ownership. At this price point, it is likely that PEV acquisition will accelerate in many fleets, particularly as gas prices again rise beyond the $4/gallon mark, making it possible to finance much of the new PEV purchase out of gasoline savings alone, if a fleet EV is driven a typical 12,000 miles per year.

Unfortunately, for both the City of Santa Barbara and the City of Lompoc (the first two local cities to use EVs in their fleet), the EVs are only driving 2,000-4,000 miles per year, hindering payback. Lompoc employees don't take their EVs out of Lompoc, due to range anxiety, and Santa Barbara does not allow their EVs to leave the South Coast, limiting potential mileage. With the build out of public charging facilities, these cities should encourage employees to try longer trips, such as using public infrastructure at government buildings in Solvang or Santa Maria when attending regular meetings there.

Barriers to Adoption and Strategies to Address the Barriers

1. **Vehicle Cost Barriers:** Initial purchase price remains the primary obstacle to broader adoption of PEVs in fleets. However, fleet owners are more likely than individual consumers to consider the total cost of vehicle ownership. Therefore, efforts to address infrastructure, fueling, and vehicle costs in a holistic manner may prove more effective than targeting just one component of the PEV ecosystem.
2. **Cost Strategies:** Existing state and federal incentives that lower the initial purchase price are enhancing PEV attractiveness for fleet PEV deployment. In some regions, including the Bay Area, South Coast, and Monterey regions, the local Air Districts are providing additional rebates for PEVs in fleets, based on AB 2766 and other programs. Regional air districts in the Central Coast area may wish to consider a pilot program to incentive PEV fleet deployments through buy-down of either vehicles or associated infrastructure. In addition, pro-active outreach to fleets, as is already done through the Central Coast Clean Cities Coalition and other partners, is helping to keep fleet operators current on PEV total cost of ownership. Based on many common fleet duty cycles and recently announced special fleet leasing programs, the TCO of a lower-cost BEV, such as a Nissan Leaf and Mitsubishi i-MiEV, is significantly advantageous compared to the ICE equivalent. As this data become more widely shared, it is anticipated that PEV fleet adoption in fleets will pick up. It is also important to note that fleet turnover rates are lengthening, such that PEV purchase opportunities will be emerging incrementally over the coming years.
3. As PEV costs are reduced, and TCO advantages increase year over year, it is anticipated that fleet adoption in the light-duty segment will increase significantly. In addition, according to recent testimony by the UPS National Fleet Manager, the TCO on a PEV variant of the UPS medium duty cargo van is very close to level with ICE versions based on the current incentive structure. As additional scale economies are achieved in the coming two to three years, a cross-over point is likely to be reached, and PEV deployment in the MDV segment will likely increase significantly.
4. **Infrastructure and Fueling Cost Barriers**: Infrastructure and electric fueling costs can also pose barriers to adoption. For some companies, charging vehicles at night does not significantly increase peak electricity costs because the charging is occurring when other operations are closed or operating at reduced levels. However, for major delivery firms like UPS, peak charging time for PEVs–from about 7 PM to 4 AM–coincides with peak operations at warehouse and processing sites. As a result, new electricity infrastructure may be required, and capacity charges would likely increase. Also, outreach to local government fleets indicates that many of the buildings where vehicles are currently located are at or near electrical capacity – as a result, additional panel upgrades and/or new transformers may be required. Although there are incentives available for EVSE installation, these incentives do not always cover the costs of electrical upgrades.
5. **Infrastructure and Fueling Cost Reduction Strategies:** Infrastructure costs in some cases can be reduced if fleet chargers can be co-located with publicly accessible EVSE, where public charging revenue may be available during the day to offset capital and operating costs, while much fleet recharging would be done at night. In addition, battery-backed and solar-linked charging systems may provide additional revenue for

grid services (such as frequency regulation) or solar net metering. For these installations, the Self-Generation Incentive Program (SGIP) is available for batteries, while a variety of California solar incentives are available for solar PV. Time of use rates available from PG&E and Southern California Edison can substantially lower e-fueling costs. Finally, flexible leasing terms recently announced by ChargePoint are likely to be available for other EVSE vendors as well, which will make it possible for fleet operators to spread out EVSE payments over 5-8 years, thereby reducing or eliminating up-front expenditures. For private site owners, the 30 percent federal investment tax credit on EVSE may be available in future years, depending on Congressional action. In addition, some public entities with large procurements of qualifying equipment and vehicles may be able to participate in transactions where the value of the tax credit is reflected in the purchase price.

6. **Limited PEV Models and Resale Value Uncertainty.** Limited PEV options, particularly in the medium and heavy-duty categories, as well as pick-up trucks, bucket trucks, and other utility vehicles, restrict purchasing opportunities for fleet operators with diverse needs. Further, newer versions of vehicle models currently in use tend to be purchased to replace older models, and PEV equivalents are still limited. Uncertainty about PEV resale value is also a challenge for fleet operators who need to forecast total cost of ownership with high accuracy.
7. **Strategies to Address Limited PEV Models and Resale Value:** As a response to the issue of ambiguity regarding total cost of ownership, CALSTART is working on a total cost of ownership calculator to assist in determining cost when considering the purchase of PEVs. To more fully define operating cost, and to enhance operating revenue and resale value, PG&E has recently issued a Request for Proposals (RFP) to major automakers that calls for a demonstration fleet deployment that will develop new models for the integration of PEVs into Demand Response (DR) programs, whereby fleet operators could be provided discounts on energy costs or direct payments for fleets that agree to modulate charging in response to signals from the grid operator. Additionally, the PG&E pilot will work with automakers and fleet operators to assess the value of the battery when redeployed in a grid services configuration at the end of its useful vehicle life. This could enhance resale value of the vehicle or enable economic replacement of the battery.
8. **EVSE Availability and Charge Time.** The operational range of PEVs work well for many fleet applications. However, some have less predictable day-to-day routes and some operators may have concerns about vehicle range in a region without widespread EVSE availability. In fact, some local fleets limit the geographic area employees can drive EVs, which reduces electric mileage per year and hinders payback. There may also be concerns about the lengthy charging time of some PEVs if fleet vehicles are operated on a higher mileage basis.
9. **Strategies to Address EVSE Availability and Charging Time.** To address EVSE availability and charge time management issues, fleet operators have a range of EVSE options that can be carefully tailored to their needs based on specific duty cycles. For example, some fleets may be able to specify vehicles with smaller battery packs if, on fixed routes, they are able to deploy or co-locate either Level 2 or Fast Charge facilities that work for mid-day recharging. The savings on reduced battery needs could help pay

for the necessary infrastructure. Also, for vehicles that rarely need recharging during the day, fleet operators can deploy Level 1 charging, which works well for overnight charging scenarios. While Level 1 equipment typically costs almost as much to procure and install, in many cases it will not require the panel or transformer upgrades that a bank of Level 2 chargers often requires. In such situations, the cost savings can be dramatic.

10. **Accounting Practices**. The accounting practices of some fleets limit their ability to include fuel savings as part of their decision-making process for purchasing new vehicles. Therefore, their purchase decisions do not reflect effective amortization of the higher costs of PEVs through fuel savings. To address this challenge, fleet operators can be introduced to updated accounting practices where fuel cost, vehicle price, and maintenance cost are considered as part of a total cost of ownership platform, making it easier to develop a business case for the purchase of PEVs in a fleet.
11. **ADA Compliance**. Fleets interested in deploying PEVs may choose to make the associated EVSE publicly accessible. In this case, fleets will have to ensure that publicly available parking is compliant with ADA requirements. In some cases, this may increase the investment required significantly. To address this barrier, the Governor's Office of Planning and Research is working on an electric vehicle charging station accessibility guidelines document, available at http://opr.ca.gov/docs/PEV_Access_Guidelines.pdf.

EVs in Rental Fleets

Integration of PEVs in rental fleets is a high priority for PEV ecosystem development, as market exposure to PEVs can be greatly accelerated if a broad variety of PEVs is available via major rental companies. In the Central Coast, the primary PEV rental experience to date is with Enterprise. On a national basis, Enterprise has 200+ PEVs in service, about 35 of which are in Southern California, with several in the city of Thousand Oaks (Ventura County). EVs were available at the Santa Barbara location until recently, when they were discontinued due to low utilization. Available PEVs include Leafs, Teslas, and a few Volt or Prius PHEVs. Enterprise is in discussion with Tesla about securing additional vehicles. Approximately ten locations are served with Type 2 chargers as of the end of 2013.

The biggest challenge Enterprise has faced is utilization; occupancy for BEVs in particular is far below standard offerings, and the firm is unable to make up for this gap via additional rate surcharges. Most customers are reluctant to take a chance with range issues while driving a BEV and are not willing to pay a premium for the service. While market acceptance is improving, Enterprise would like to see it ramp up faster. According to a local Enterprise manager: "Range is the big show-stopper right now- they believe the range of a BEV is insufficient. However, many people are fine renting a PHEV as long as they don't have to plug it in. That said, people in the know like the HOV lane access of the PEVs. No doubt the sands are shifting, and I have every expectation that broader market acceptance will be here, whether in the form of BEV, PHEV, or even fuel cell form."

APPENDIX K:
COST FACTORS AND POLICY OPTIONS FOR MULTI-FAMILY DEVELOPMENT CHARGING

Overview

The challenge of installing PEV charging in multifamily residences -- including apartments and condominiums -- is a key obstacle to full market penetration of EVs. The problems of MDU charging include insufficient number of parking spaces, constrained electrical room capacity, expensive installation costs, and multiple EV charging station users. Since much of the Central Coast's urban population lives in some form of multi-unit residential building, EV owners in these buildings will need to find inexpensive and reliable ways to charge their EVs. The following discussion provides further detail on cost factors, MDU challenges from building owner and resident perspectives, and policy approaches adopted in Los Angeles, which can be considered by Central Coast stakeholders.

It should be noted that work on the MDU challenge in California has only just begun. The CEC has recently issued its first solicitation specifically targeting MDU issues. In addition, advisory documents have recently been developed by the California PEV Collaborative, available at http://www.evcollaborative.org/MuD. Given the resources now available via the PEV Collaborative, the discussion in this appendix is intended to summarize key opportunities for driving down costs through local policy approaches, especially mandated stub-outs and charger installations in new buildings and major remodels.

The City of Los Angeles was among the first municipality in California to begin tackling the MDU challenge, by adopting a Green Building Code mandating that all new single family and multifamily construction be equipped with the required electrical infrastructure and designated parking spaces to accommodate PEVs in the context of larger residential multi-family buildings. Of course, this initiative does not address existing housing stock. Therefore, in Los Angeles as on the Central Coast, property managers and homeowner association (HOA) boards must proceed on a voluntary basis until more robust legal requirements are in place, and cost factors must be addressed realistically.

Cost Range for Level 2 in MDU Contexts

Currently, EV charger installations in a multifamily building can range anywhere from $2,000 for a low- cost multifamily installation, to $10,000 or more for an apartment building requiring trenching to install a new conduit, a new circuit, and electric meter. One approach to reducing these costs is to carefully assess whether Level 1 (110 volt) charging may be adequate, as these equipment and installation costs are typically a fraction of the Level 2 requirement. This will be explored further in Phase II of the Central Coast plan development process, as level 1 charging installations are just now being deployed in California, and industry understanding of cost, energy management, and liability factors are still evolving.

Choosing Charging Levels in MDU Contexts

EV charging requirements are influenced by the type of EV (BEV vs. PHEV), daily distance driven, electricity prices, driving style, load, and conditions such as temperature and grade.

Battery charging times for the Nissan Leaf and Chevrolet Volt are indicated in Table 20 for illustrative purposes.

Table 20: Time to Fully Recharge EVs

Vehicle Model	Battery Capacity	Hours to Fully Charge from Empty	
		Level 1 (110/120V)	Level 2 (220/240V)
Nissan Leaf with 6.6 kW Charger	**24 kWh**	**10**	**4**
Chevrolet Volt	**16 kWh**	**10**	**4**

Source: Nissan, available at http://www.nissanusa.com/electric-cars/leaf/versions-specs/ and Chevrolet, available at http://www.chevrolet.com/volt/#technology

Drivers who are depleting the battery on a daily basis need to charge nightly. But if drivers deplete half of the battery per day, they may only need to charge at a slower Level 1 (110 volt) rate. Further, drivers charging at work and at businesses that offer EV charging may not need to charge as frequently. The combination of all of these factors will impact the feasibility of a Level 1 vs. Level 2 charging station. A Level 1 charging station will typically be more suitable for PHEVs and other vehicles with smaller battery sizes similar to the Chevrolet Volt, while a Level 2 charging station is typically more suitable for larger batteries, as in the Nissan Leaf. Level 1 charging typically may not require any new installation costs, as the charging device is portable, and a 110 outlet is often available in an existing parking lot or garage. Further, the liability for the charger equipment more clearly rests with the tenant insofar as the portable charger is his or her property as part of the vehicle.

Construction Constraints

Parking access considerations are a crucial determinant of charging station installation costs. Installations are typically less expensive for parking spaces located a short distance from the electrical panel, and more expensive for parking spaces located farther away. Running a line from the electrical panel to the charging station can be the most difficult step in assuring power delivery to an EV. The crux of the problem lies in whether or not there is an existing conduit from the panel to the parking space. If a conduit does not exist, the farther away the charger is from the panel, the more creative, and the more expensive, the solutions become.

In many cases, building electrical panels are fully utilized and do not have any room to add new circuits. This problem can be overcome by adding panel capacity. Adding more than 400 Amps will typically trigger a plan review, meaning the applicant will incur higher costs. In addition, electrical room space can be a limiting factor. In apartment buildings, panels are usually located in electrical rooms, which are also where electricity meters can be located. Adding another panel can be an issue for some buildings that have small electrical rooms. Additionally, if the building owner decides to meter a circuit separately (i.e. sub-metering), then a new meter would have to be provided.

Capital Cost Recovery

HOAs, building managers, and building owners often oppose installations because of upfront capital costs and concern about ongoing utilization rates, particularly if the original tenant or unit owner moves away. Thus, the potential to at least break even on the installation is a key issue. Estimates by the Luskin Center at UCLA project break-even monthly fixed costs under low cost ($3,600) and high cost ($11,600) installations, assuming a 7-year loan term, with and without financial incentives of $2,000 each toward the total charger project. The fixed cost includes a relatively low-priced Level 2 charging station ($1,500), a city permit ($100), and low ($2,000) or high ($10,000) installation costs.

Financing EV Charging Stations

Most charging station installations in multifamily buildings will be financed by some entity representing the building's ownership. For example, an HOA would finance the purchase and installation of a charging station in a condo, and a building owner would finance it in an apartment building. In both cases, the investing entity will pass costs onto users, and some entities might want to earn a profit. EV charging station users can pay a fixed cost to service the loan and pay for taxes. Payment can be made on a monthly basis, similar to the payment cycle for rental apartments and HOA fees, or it can be made incrementally during each EV charging session, with a fee assessed on a time-basis (e.g. by the second, minute or hour the EV is charging). Most HOAs are tax-exempt entities and would not typically seek a profit, but an apartment building managed by a real estate investment trust (REIT) may require a profit or break-even scenario. In many other circumstances, HOA dwellers with their own garages or deeded and immediately adjacent carports, the resident may be able to add an EV charging station without concern for HOAs.

Negotiation Factors

As representatives of a building's common spaces, and as forums for residents to voice private interests, many HOAs may be willing to facilitate EV parking access solutions to the greatest extent possible. Parking spaces are negotiable and have a price – it is simply a matter of what concessions each party is willing to make, and what prices are deemed acceptable. The transaction could be between individuals, or between the HOA and individuals. For example, EV owners desiring a specific parking space might be willing to pay for it, or swap spaces with the owner of the parking space in question, if acquiring the space lowers the total cost of installing charging stations. If several EV owners are interested in sharing a single space, the HOA, or even a new third-party entity, could purchase the space, and recover costs by charging EV charging station users. Opportunities to make "fair" transactions should be explored first in order to minimize EV charging station installation costs.

Electricity Cost Factors

To ensure fairness to other tenants, charging station users must pay for the electricity consumed to charge their EVs. Using low time-of-use (TOU) rates, average monthly electricity costs are roughly $30 for seven-hour bi-nightly charging and $75 per month for seven-hour nightly charging, assuming a 24kWh battery and a Level 2 charging station. Total monthly costs, including electricity and fixed costs could range from slightly more than $75 to more than $400 per month. Apartment owners and managers can pass on the costs in the form of

charges to users, but because of the transient nature of renters, and the small number of EV owners currently living, or wanting to live, in apartments, cost recovery within the tenancy of a particular apartment dweller will be challenging in many cases.

Requiring EVSE Installations at Point of Sale

Given the cost factors typically involved in a Level 2 installation scenario, the Luskin Center has proposed a mandate on multi-family building owners to upgrade their infrastructure at the time of sale, when a variety of other upgrades can be financed in a packaged approach. The applicable code language could emulate the existing Green Building Code, which applies only to certain types of new construction. This recommendation is considered a relatively bold and politically challenging approach.

The City of Los Angeles Mandated EV Charging Code Options

The City of Los Angeles Green Building Code (Chapter IX, Article 9, of the Los Angeles Municipal Code), adopted on December 14, 2010, mandates newly constructed "low-rise" (single family residences, duplexes, and townhouses) and "high-rise" residential buildings to be charging station- ready. The exact code language begins on the following page under the heading, "Mandatory Measure for Newly Constructed Buildings." An explanation of the code follows:

For low-rise buildings with private parking, either a 208/240 Volt 40 Amp outlet must be installed for each unit, or panel capacity and conduits for future installation of a 208/240 Volt 40 Amp outlet. All outlets must be located "adjacent to the parking area." For low-rise buildings with common parking, the following options are available:

- **A minimum number of 208/240 Volt 40 Amp outlets**, equal to 5 percent of the total number of parking spaces, to be located within the parking area; or
- **Panel capacity for the future installation of 208/240 Volt 40 Amp outlets**, equal to a minimum of 5 percent of the total number of parking spaces, with a conduit terminating in the parking area; or
- **Additional service capacity, space for future meters, and conduit for future installation** of electrical outlets, equal to 5 percent of the total number of parking spaces, with the conduits terminating in the parking area.

High-rise buildings are required to provide 208/240 Volt 40 Amp outlets equal to 5 percent of the total number of parking spaces, with the outlets located in the parking area.

Mandatory Measure for Newly Constructed Low-Rise Residential Buildings:
Section 99.04.106.6, Electric Vehicle Supply Wiring

1. For one- or two-family dwellings and townhouses, provide a minimum of:
   a. One 208/240 V 40-amp, grounded AC outlet, for each dwelling unit; or
   b. Panel capacity and conduit for the future installation of a 208/240 V 40-amp, grounded AC outlet, for each dwelling unit.
2. For other residential occupancies where there is a common parking area, provide one of the following:

a. A minimum number of 208/240 V amp, grounded AC outlets equal to 5 percent of the total number of parking spaces. The outlets shall be located within the parking area; or
b. Panel capacity and conduit for future installation of electrical outlets. The panel capacity and conduit size shall be designed to accommodate the future installation, and allow the simultaneous charging, of a minimum number of 208/240 V 40-amp, grounded AC outlets, that is equal to 5 percent of the total number of parking spaces. The conduit shall terminate within the parking area; or
c. Additional service capacity, space for future meters, and conduit for future installation of electrical outlets. The service capacity and conduit size shall be designed to accommodate the future installation, and allow the simultaneous charging, of a minimum number of 208/240 V 40-amp, grounded AC outlets, that is equal to 5 percent of the total number of parking spaces. The conduit shall terminate within the parking area.

When the application of the 5 percent results in a fractional space, round up to the next whole number.

Mandatory Measure for Newly Constructed Nonresidential and High-Rise Residential Buildings: Section 99.05.106.5.3.1, Electric Vehicle Supply Wiring

Provide a minimum number of 208/240 V 40-amp, grounded AC outlet(s), that is equal to 5 percent of the total number of parking spaces, rounded up to the next whole number. The outlet(s) shall be located in the parking area.

Developing Nearby Public Infrastructure

Apartment renters and residence owners (including live-aboard boat owners) who own EVs, but often do not have access to a dedicated parking space in the building, park curbside, or park in off-street lots, will have to think creatively about where to charge their vehicle. Allowing EV owners to use charging stations installed in public lots, or installed curbside, is one possible solution. Private lots, such as those belonging to schools, religious institutions, and businesses may present opportunities in particular locations. Building or property owners may be incentivized to install EV Charging Stations by collecting additional fees (above the cost of electricity) that would help pay for the EVSE over time.

APPENDIX L:
GUIDELINES FOR WORKPLACE CHARGING

This overview of workplace charging is designed to inform employers, building owners, facility managers, and other key stakeholders about a broad range of issues pertaining to EVs at the workplace. Because workplace charging is so essential to the growth of the EV ecosystem, many organizations are beginning to provide resources on this important topic. One very helpful resource is the California PEV Collaborative's case studies of 20 employers "Amping up California's Workplaces: 20 case studies on plug-in electric vehicle charging at work" which is available at http://www.pevcollaborative.org/workplace-charging

PCC has also drawn on materials made available by the Minnesota Pollution Control Agency, Advanced Energy of North Carolina, the Electric Power Research Institute, and EV Charging Pros, among others. A full list of resources on this and other EV issues is included at the end of this document.

As Electric Vehicles come to the market in ever-greater numbers, EV drivers will increasingly need and expect to recharge at work. While it is expected that the majority of charging will continue to occur at home at night -- when it is most convenient and affordable, the importance of workplace charging should not be underestimated. Individuals especially dependent on workplace charging will include drivers of BEVs and PHEVs with smaller-capacity batteries, employees who may not have ready access to home charging, corporate EV fleet users, and visitors who need to recharge to return to their destination or continue on their journey. Companies that provide charging are considered "leading edge" today, but soon the emphasis may shift, so that workplaces without charging resources will be considered "behind the times."

Workplace charging also plays an important role in the overall public charging ecosystem, and in the public perception of EVs as a reliable and convenient mode of transport. The EV Project – a federally funded large-scale EV charging infrastructure project (led by Nissan and EcoTality) has demonstrated that the percentage of EV owners charging their vehicles outside the home grows as more publicly accessible charging becomes available. In other words, as more charging becomes available, more "electric miles" replace gasoline miles. Workplace charging can be an important component of the overall public charging network by providing additional "opportunity charging" for drivers who are running errands and need to give their EV a quick range-extending charge.

Research strongly supports the need for workplace charging opportunities. EPRI estimated that 54 percent of non-residential parking occurs at the workplace -- where vehicle dwell time is typically between four to eight hours. This extended period can be an ideal time to provide EV owners with an extension in range. Workplace charging can typically provide EV owners an extra 15 – 70 miles of range depending on the charging infrastructure available. This matches well with the characteristics of typical commuters today, of whom 90 percent drive less than 40 miles one-way to work.

Getting Started

Successful efforts to increase workplace charging depend on EV drivers, their employers, and building owners being fully informed of the key program and infrastructure design issues involved. With this knowledge, workplace charging programs can pay for themselves over time, and be an effective marketing tool for a business or a building owner to attract and retain their highest value employees, tenants, and customers. The following guideline in Table 21 provides a summary of the initial issues that must be considered in developing an effective workplace charging program. Each of these issues will be considered in further detail below.

Table 21: Guidelines for Workplace Charging

WORKPLACE CHARGING ISSUES AND ACTION ITEMS
1. Survey employees' interest in a workplace-charging program.
2. Discuss survey findings and EV charging needs amongst employees and key decision-makers: supervisors, building owner/manager, facilities technicians, and legal counsel.
3. Examine EV charging equipment options and compare the benefits and costs (e.g. Level 1, Level II, and Fast Charging).
4. Decide who will own the EV charging equipment. It could be the company, the building/parking lot owner, or a third party EV service provider.
5. Identify incentives an investment sources for workplace EV charging infrastructure.
6. Create an EV charging policy addressing workplace charging. Issues to be addressed include who should get priority access to the chargers, when they will be accessible, how much charging will cost, and who will oversee ongoing operations and maintenance.
7. Contract with a certified electrician or EV consultant to determine ideal location(s), deal with local permitting, and install the equipment in an accessible location.
8. Install signage, alert employees and start charging!

Source: Electric Power Research Institute

Workplace Charging Benefits for Employers and Building Owners

The provision of workplace charging offers significant benefits for both employers and their current and future employees, visitors, and customers. Today, the provision of EV charging helps to differentiate a workplace as environmentally friendly, socially responsible, and technologically cutting-edge. As many workplaces begin to deploy EV charging infrastructure, EV charging may come to be seen as expected, just as a well-lit visitor parking lot is now considered essential to a welcoming and secure workplace. For the immediate future, however, workplace charging hosts can gain comparative advantage and enjoy these benefits as part of the EV vanguard:

- **Employee attraction & retention** - Many employees now or in the future will be driving EVs to make a personal contribution to environmental sustainability and energy

security, and to enjoy the benefits and cost savings of electric drive. By installing EV chargers, employers can help retain current employees and attract new ones by staying on the leading edge of technological development and social responsibility.

- **Publicity & green credentials -** Showing leadership in supporting cutting-edge, clean transportation can raise the environmental profile and positive public perception of a business. In some construction and retrofit scenarios, LEED points are available for the installation of EV charging equipment. By deploying chargers in visible locations, a workplace also creates immediate awareness and "green curb appeal" for the organization and property. This awareness can be extended through promotional and marketing materials. In combination with solar installations, businesses can go even further in showcasing the coming era of "fossil-free" transportation and clean energy.
- **Fleet cost savings** - Going beyond EV charging for employees, a business can realize cost savings by transition its own fleet of company cars to EV and charging them at the workplace. Studies show significant operating savings potential for EVs from both fuel savings and reduced service costs, leading to a substantial reduction in fleet total cost of ownership (TCO).
- **Triple Bottom Line Financial Reporting** – Triple bottom line (TBL) performance metrics -- reflecting people, planet, and profit -- are being used to communicate the economic, ecological, and social success factors of a business, government, or nonprofit organization. With the ratification of the United Nations TBL standard accounting practices in 2007, and ongoing deployment of carbon accounting measures in California and nationwide, many organizations with a corporate social responsibility (CSR) initiative or specific obligations under AB 32 will need to report their greenhouse gas reduction results. EV charging facilities will encourage more "carbon-free commuting" and EVSE software can quickly and simply report the results in tons of GHG reduction.

Workplace EV Charging Benefits for EV Owners

- **Range security** - The opportunity to charge at work helps EV drivers to achieve "range security." Knowing that they will be able to have the full range of the EV when they leave work is important -- and in some instances critical – for those faced with long commutes or a lack of residential charging.
- **Range extensions** – For drivers of PHEVs, workplace charging can double daily "all electric" driving range – enabling extended driving before having to turn on the gas generator.
- **Preheating/cooling** - Using workplace charging can enable EV owners to preheat or pre-cool the car without draining the battery.
- **Increased incentive to purchase an EV** – The availability of workplace charging helps make the EV purchase decision easier – especially for BEV owners with longer commutes.

The Towbes Group Embraces EV Charging

The Towbes Group is an integrated real estate investment, development, and property management company with headquarters in Santa Barbara. Towbes has developed 6,000 residential units and 1.4 million square feet of commercial properties primarily in Santa Barbara, Ventura and San Luis Obispo counties, from Westlake Village to Santa Maria. The company also manages more than 2 million square feet of real estate. As part of its broad

commitment to sustainability, Towbes is embracing EV charging as an essential aspect of its current and future development program.

Towbes has installed two ChargePoint Level 2 charging stations at its Ralston Courtyards apartment complex in Ventura. These include both 110 volt and 240 volt connections, suitable for charging both regular EVs with a J1772 connection, and (via the 110 connection) the increasingly popular electric scooters, e-bikes, neighborhood EVs (NEVs), and legacy EVs such as the 1990's version of the Toyota RAV 4 EV that are still on the roads. The initial ChargePoint stations were purchased without grant funds and have been in service since late 2010.

In addition, Towbes will soon be installing EV chargers at the Fairview Business Center in Goleta near the 101 corridor, using workplace charging grant funds received obtained by EV Connect from the California Energy Commission. Two level 2 stations will be installed, with additional conduit and power infrastructure to expand to four stations. EV Connect will manage the network operation and installation work.

Towbes is also installing EV chargers at Riviera Park – an eight-acre high-end office property in the Santa Barbara Riviera on Alameda Padre Serra, with tenants in the film, architecture, development, and engineering sectors. Riviera includes more than 90,000 square feet and will initially have two EV charging stations with potential for six total. Another project now in development is a high-end apartment complex known as Willow Springs Phase 2 in Goleta, across from the 230,000 square foot Castilian Technical Center. The exact specifications of this project have not yet been determined, but two to four initial charging stations are under consideration. In addition, integration of solar with EV charging on the planned carport will be considered.

As with most EV charging installations, the Towbes Group has experienced large discrepancies in cost. Average installation costs in a site vary widely on a per unit basis depending on how many chargers are being installed (with costs typically falling with more units per site.) Towbes currently reports installation cost factors in the range of $4,000 to $5,000 per charger at the least expensive sites, up to $8,000 per charger at more costly sites, with distance to the electrical panel and trenching or boring requirements being main cost drivers.

Going forward, Towbes is also considering options with NRG, a large energy company that has entered the California market, and is developing 10,000 so-called "make ready" sites that provide the power infrastructure needed for installing an EV charging station. However, no agreements have been signed as of late 2013. Under the NRG program, site hosts must identify an individual EV charging network subscriber to NRG's "EV Go" monthly charging program before they will install an actual charging station. The charging station must then be reserved for the use of that subscriber, not for general public use. If no subscriber is identified for that site within two years of the completion of the make-ready work, then the site host may contract (at their own expense) with another EV charging company to install a charging station at that site. Towbes is considering the EV Go program – or alternatives such as Powertree – for up to twelve residential properties.

A key operational objective for Towbes is to begin standardizing on one back-end network for network management and reporting. Thus far, Towbes has used the ChargePoint system, which is available on some but not all brands of chargers. NRG has reportedly opted in to

ChargePoint recently, as well as several other EV charger manufacturers. However, an expected charging industry shake-out may affect back-end system issues, so the Towbes Group is monitoring the situation carefully before making further system management commitments.

Towbes is not merely looking inward at its current office and residential client needs for EV charging. It is also explicitly looking to help build out the broader Central Coast charging network as a service for EV drivers who may not be lessees or residents in its buildings. According to Andrew Lemert, the Information Technology Director at Towbes: "It's our perception that the only way to ensure the success of EVs is to build out the region's charging network. Towbes properties have the perfect span across the 101 corridor to help build out this system. As we have these stations available, you are going to see people use it. We are seeing a lot of EVs already, and we want to accelerate that as part of our overall commitment to the environment."

Planning and Executing a Workplace EV Charging Program

Implementing EV workplace charging is easiest when the employer is in full control of their entire campus. Singular control of the parking area, building, and electrical service streamlines decision-making and cost allocation. However, many employers confront more complex ownership and management scenarios that may involve a building that is owned by one entity, maintained by another entity, and with yet another entity operating the parking facility. For these more complex scenarios, the guidelines below will have to be modified to fit the specific ownership situation. One key to an effective program launch is to ensure the comprehensive education and engagement of all the relevant parties at the outset of the planning process.

Successful efforts will depend on both employer and employee engagement. Most of the workplaces that now offer EV charging for their employees began as an initiative of an existing or prospective EV driver, "evangelizing" the benefits of EV, ultimately leading to a top-level decision to provide workplace charging. In small organizations, informal conversation between colleagues is often enough to get the ball rolling. Medium and large-sized businesses may require a more formal process, and more complex ownership scenarios will typically require the convening of a management level designee, the building owner (if different from the employer), parking lot operator (if necessary), facilities operation staff, human resources, and legal counsel. Together, this team will need to assess employee interest in EV charging as a first step.

Evaluating Interest in Workplace EV Charging

To "right size" an EV workplace charging effort, a survey will help determine both short- and longer-term interest in owning EVs -- and the need for charging options at the workplace. Potential questions include:

- Do you own an electric vehicle?
- Is your vehicle a BEV or PHEV, and what is its "all electric" range?
- What is your commute length (one way)?
- How often do you drive your EV to work?
- Would the option to charge your car at work be desirable?

- How much time would you expect to charge your EV at work, assuming a Level 2 charger?
- Are you considering purchase or lease of an electric vehicle in the future?
- How soon do you plan on buying or leasing your next vehicle (any type)?
- If workplace charging were an option, would you be willing to pay for the service?

Company decision-makers should evaluate results and determine the potential number of charging stations that might be needed. EV ownership is expected to grow rapidly over the coming decade as production of EVs ramps up significantly, so implementing a workplace charging program should be done deliberately and with an eye for potential expansion in the future. For example, Google has a near-term goal that 5 percent of their employee parking spots will be equipped with EV charging.

For employers who do not own their buildings or control their parking facility, the parking operator and building management must be engaged. Lease renewals are often a good time to address these issues. At the U.S. EPA's San Francisco office, the installation of EV chargers was negotiated as part of the process of extending the agency's lease. As a result, EPA employees now have access to a pair of Level 2 charging stations by Coulomb and Eaton.

Santa Barbara's Workplace and Public Charging Program

The City of Santa Barbara is a regional leader in EV charging, with Mayor Helene Schneider and the City Council supporting the installation of eight chargers in four locations, which became operational in April 2012. The City plans on expanding the network as demand grows in future years. With assistance from the Community Environmental Council, the City was able to take advantage of grants associated with the ChargePoint program, which covered the full cost of both hardware and installation via grants from the California Energy Commission, the federal Department of Energy and the Santa Barbara County Air Pollution Control District. To ensure that installation costs could be fully covered by the available grant funds, the City picked locations that had adequate power and conduit nearby, with a very low cost of $25,000 for installation of the eight chargers.

Each location has two Level 2 chargers (some also have Level 1 availability) and include two large covered downtown lots on Anacapa Street, where parking is free for 75 minutes, then $1.50/hour; a free lot on Helena Street, managed by the City's Parking Division; as well as a lot at the harbor that charges $2/hour. EV drivers must pay these same parking fees as other drivers, plus energy costs of $1 per hour of charging. According to a recently adopted municipal ordinance, if EVs are not actively charging, they can be ticketed. However, this policy has not yet been actively enforced. Currently, downtown lots are experiencing an average of three to four charge sessions per day, while the waterfront lot has much less utilization.

The City has assessed their parking lots to find an appropriate DC Fast Charging site. The lowest cost site is at the Amtrak depot, but its historic site designation has created additional challenges. New Level Two locations are also being scouted at the City's commuter lots -- on Castillo Street and on the corner of Cota and Santa Barbara. However, power constraints may make installations impractical in the near-term. At this point, the City is looking primarily to private site owners to further expand Santa Barbara's charging network. As a member of the PCC regional EV Coordinating Council, the City will be cooperating in efforts to get the word

about its own positive experiences with EV charging and EVs in the City fleet, and to assist in identification of viable sites for future EV charging network growth.

UC Santa Barbara Charging Stations

UCSB has installed EV charging stations in Parking Structures 10, 18, and 22 on the UCSB campus, sufficient to charge a total of 12 EVs concurrently. Two, dual port stations are available just inside the main entrance to each parking structure. The easiest way to use the charging stations is with a ChargePoint *ChargePass* card, available at www.ChargePoint.net, though users can also call a toll-free number or download the ChargePoint App to a smartphone (free). In addition to activation through ChargePoint, a valid UCSB parking permit is required to park on campus. The parking permit dispenser closest to the charging station will vend an electric vehicle charging station permit at the rate of $1 per hour over and above the cost of any UCSB parking fees. Users who already have a valid UCSB parking permit or in-vehicle parking meter must purchase and display a short-term "EV Power Only" permit, available near the EV Charging Stations, which cost $1 per hour. Recently UCSB also launched a program for monthly EV passes, which may be more convenient and affordable for regular EV commuters. EVs must be actively charging to use the charging spaces – and are currently available on a first-come, first-served basis. If demand outpaces supply, the University is considering allocating some stations on a reservation basis.

The University's EV charging stations were with funding from the U.S. Department of Energy, California Energy Commission, Santa Barbara Air Pollution Control District, and the UCSB. The Green Initiative Fund (TGIF). One additional EV charging station is in the planning states in Parking Lot 22, as part of the Student Resource Building solar array project. For more information about the EV charging at UCSB, Mail-to at TAP@tps.ucsb.edu or call 805-893-5475.

While the City of Santa Barbara and UCSB operate the largest networks of charging stations in the region, many other businesses also provide charging. As of late 2013, there were at least 50 Level 2 charging stations in the greater Santa Barbara area (approximately 200,000 inhabitants), which gives Santa Barbara the distinction of having some of the most public charging stations per capita in the nation. These stations are located at hotels, workplaces, shopping centers, beaches, parks, and other destinations.

Identifying Charging Equipment Needs and Charging Levels

Determining what type of charging option to provide is critical to meeting driver needs. Factors such as EVSE system cost, electricity needs, potential electric supply upgrades, EVSE security, and maintenance will influence decisions. Survey results will inform decisions on charging needs. Where specific survey data is not available, national data may be useful. According to the US Department of Transportation *Omnibus Household Survey* the average commuter travels approximately 15 miles one way to work. Two out of three commuters (68 percent) reported a one-way commute of 15 miles or less, 22 percent traveled between 16 and 30 miles and 11 percent traveled more than 30 miles.

Expansion of Level 2 charging (providing 8-20 miles per hour of EV range) is a preference that many EV owners share. Level 2 EVSE at the workplace provides robust range security and can enable one EVSE unit to serve multiple vehicles through the day if procedures are in place for owners to move cords between adjacent parking slots, and/or to swap vehicle locations at

lunch or break times. With a host of popular EV smart phone apps, users can be notified when their EV is charged up.

While Level 2 charging is often the preferred solution, Level 1 often has significant cost advantages. Given the long time periods that many EV owners are parked at work, and the significant charge remaining on the batteries of short-haul commuters, Level 1 charging -- providing 3-5 miles per hour of EV range -- can be an excellent workplace charging solution. Implementing Level I charging at the workplace is a viable entry point for companies that want to get a feel for the technology and how it works before investing resources in faster charging solutions.

A Level 1 EVSE can be as simple as a three-pronged extension cord plugged into a standard grounded 110 outlet, utilizing the standard Level 1 portable charging device that comes with all EVs. Level 1 charging can be the easiest and most cost-effective way to rapidly expand EVSE infrastructure. Because of its simplicity and low costs, analysts predict in 2017 that 2.9 million of the total 4.1 million charging stations in the U.S. will be the Level 1 type. However, there a range of issues that must be taken into account by site hosts before moving toward the Level 1 solution.

Level 1 charging equipment solutions ranges widely in cost from the cost of an extension cord where adequate grounded outlets already exist, to $1,000+ per space for new conduit and electrical upgrades, depending on the power situation at the workplace. At the low end of the scale, a workplace can provide access to a three-pronged plug and the driver can use the charging cord set that comes standard with every vehicle. Alternatively, a workplace can procure a dedicated Level 1 EVSE with a J1772 connector for approximately $500, as is available from Clipper Creek. These devices can be either mounted on the wall or attached to a light pole for easy installation in the parking environment. However, use of plugs rather than J1772 connectors introduces greater hazards for the driver and potential liabilities for the site host. Furthermore, much of the cost advantage of the Level 1 installation can be eliminated if a J1772 charging station with a payment system is installed.

Level One Payment Systems

One of the impediments to wider use of Level One charging is that lower-cost "dumb" EV chargers do not have point-of-purchase transaction systems (such as credit card billing). However, IRS rules may require employers to track EV charging as a benefit. Further, many companies do not want to provide free charging, even at low-cost EV rates. To find a workaround to this problem, a company called Liberty Access Technologies has introduced a relatively inexpensive add-on keypad and customer code generator that enables site hosts to control access to "dumb" chargers or charging outlets, without paying the more costly network access fees imposed by some EVSE vendors. The charge authorization code can be issued by the site host or purchased from a payment kiosk or a mobile payment system via a mobile phone and credit card payment.

Each code is unique and cannot be reused once it has expired, protecting the lot owner and the consumer from potential fraud. Codes can be issued for periods ranging from several minutes to several months. A credit-card transaction fee is charged on a per transaction basis. Charging fees can also be directly debited from an employee's expense account. One Liberty data system provides access control for up to ten Level One or Level Two chargers, enabling

use of the far cheaper "dumb" chargers now on the market from companies like Eaton, Clipper Creek, AeroVironment, Leviton, and many others, available at www.libertyplugins.com.

Power Availability

Another significant consideration for both Level 1 and Level 2 charging is power availability. Most Level 1 charging equipment requires that a 15-amp dedicated circuit breaker be installed in the electrical panel to support the equipment. However, if the workplace has determined via an employee survey that there is a need for multiple Level 1 stations, additional power supply may be required to support multiple, simultaneous charging sessions. In some environments, a workplace might need to install a dedicated 120/240-volt electrical panel, with a service rating of 120 to 200 amps to support the projected long-term demand for Level 1 charging. In addition, the location of the power room and distance relative to the proposed charging locations is critical to budgeting for a workplace charging installation. Additional cost considerations involve the distance of conduit requirements, the type of cable to be used to bring power to the locations, and possible cutting, trenching, and replacement of sidewalks and pavement.

Using Level 1 as a steppingstone, an employer can gain experience about how their employees are using workplace charging, gauge their satisfaction with Level 1 charging, and then make an informed choice to move (or not) to faster charging options.

Hardware Cost Factors and Available Tax Credits

Level 2 charging equipment has a wider range of costs, from $500 to $6,000 for the equipment (plus $1,500 to $5,000 or more for installation) depending on the physical layout of the parking area, the existing electric infrastructure, and the type of equipment purchased. The higher cost of some Level 2 chargers is typically due to the inclusion of support for credit card billing, as well as network charging software. Network software enables a variety of access protocols and flexible pricing for the units (e.g. differentiated costs for network subscribers, tenants, or drive-up "opportunity charging"), and can provide reservation features and more robust reporting functions.

There are also many different form factors available for Level 2 equipment -- from wall and bollard mounts to units with retractable cords. Some EV charging units are also available in dual port stations, which provide the ability to charge two vehicles simultaneously from a single device. Of course, Level 2 EVSE require a higher level of dedicated power than Level 1. Generally, a dedicated 40-amp circuit breaker is required for each charger in the electrical panel. If a dual charger is being considered, then 80 amps of available power and two dedicated breakers must be installed.

At the end of 2013, the Investment Tax Credit for EV charging equipment expires, with 30 percent of the purchase price available as a tax credit. The specifics of the rebate and applicability to your tax situation should be assessed with a qualified tax professional or accountant. In certain circumstances, nonprofit or public organizations may be able to work with a financial intermediary to monetize some of the credit, though this is not always feasible.

Case Study: Workplace EV Charging Deployment at Palo Alto Research Center (PARC)

The Palo Alto Research Center (PARC) is a research and development organization made famous when Steve Jobs commercialized their pioneering designs for the computer mouse and graphic user interface. PARC recently decided to install EV charging on their property as a sign of their ongoing commitment to "the next big thing" – in this case, the EV era. With a long-term lease on their facility, PARC decided to take a long-term view of the development of their charging infrastructure.

After hiring an EV consultant to help them through the process, they first undertook an employee survey. The results indicated that their existing EV drivers all had relatively short commutes. Further, PARC discovered that the addition of charging infrastructure at the workplace would positively influence 53 percent of their employees to consider an EV when they were ready to purchase their next vehicle. Next, the PARC consultants assessed their power infrastructure. Based on information from the two surveys, they decided to install four Level 2 chargers in the visitor parking lot, with plans to scale the infrastructure to support 16 Level 2 EVSE over the next five years. In addition, PARC decided to install eight Level 1 chargers in a separate employee only parking lot – with sufficient power capacity to support an eventual deployment of 16 Level 1 chargers.

Given that their current power infrastructure could not support their long-term plans, PARC designed a three phased project. First, they upgraded their electrical service and installed a dedicated electrical panel in each of their parking lots to support their vision for long-term EVSE deployment. Second, they chose equipment from two different EVSE vendors matching their needs for L1 charging for their employees -- and L2 charging for visitors and employees with longer commutes. Finally, they installed the initial equipment and now have the capacity to increase the number of EV charging stations as their needs grow without replacing their utility panels. The project budget was $100,000, with over 60 percent of the costs being dedicated to upgrading power infrastructure. PARC made this unusually large commitment due to the intention of so many employees to become EV owners, and their corporate commitment to technological innovation, sustainability, and triple bottom line results.

EV Charging Equipment Options – Information and Resources

Decision makers looking at charging options can use online resources to assess the growing offerings of EVSE manufacturers and service providers. One of the most extensive listings of EV charging equipment can be found at Plug-In America, available at http://www.pluginamerica.org/accessories. Another strong listing is Plug-In Recharge, available at http://www.pluginrecharge.com/p/evse-vendors.html

There are a growing number of vendors that sell EVSE equipment and offer turn-key installation and ongoing service. Some of these vendors and network operators require users who purchase their equipment to subscribe to a charging service and to make payment via credit card or radio-frequency identification devices which control access to the EVSE and enable the owner to collect usage data. Charging can also be set up to be free for all or some users. The EVSE vendor typically shares in the revenue generated by the EVSE and charges service fees for managing payment transactions, maintenance and troubleshooting services for the EVSE.

Fast Charging (sometimes called Level 3) is less likely to be a good match for most workplace situations at this time due to the high equipment and installation cost. However, like most EV equipment, hardware cost is declining rapidly, and more EVs will likely be shipping with Fast Charging options (either the Japanese Chademo connector standard or the American and European SAE Combo 2 standard. If a workplace is located on a property with multiple buildings or a very large number of EV tenants, it might be feasible to provide a L3 solution, which could permit a large number of drivers to charge their vehicles throughout the day. (Google is planning a Level 3 installation, for example.) Currently, Level 3 costs are in the range of $20,000 - $40,000 for hardware, and $15,000 - $30,000 for installation.

EVSE Installation Budgeting – Factors to Consider

Itemized costs for workplace EVSE will vary for each site. Factors such as trenching, new electrical circuits, surface refurbishment, panel upgrades, and permitting will play a role. In some locales, there may be state or federal grant or incentive programs to help cover the cost of workplace charging. A typical budget might include the following line items:

- Material/Incidentals
- Equipment Rental (trencher for conduit)
- Sidewalk Demolition/Repair
- Labor (in-house)
- Labor (outside)
- EVSE (charging station)
- Incentives (if available to offset costs)
- Optional EVSE equipment (e.g. Radio Frequency Identification card reader)
- Signage and/or Paint

Company Workplace Charging Policies

It is important to develop clear internal company policy about workplace EV charging. The California PEV Collaborative has issued an excellent compilation of 20 case studies of California businesses that offer charging, referred to in the intro of this section and available at http://www.pevcollaborative.org/workplace-charging. Issues that should be considered follow.

Access to Charger-Equipped Parking

Signage should clearly indicate that the EVSE parking space(s) are only to be occupied by EVs charging their vehicles. Access privileges can be extended to both employees and visitors, at the discretion of the employer. A policy regarding time limits per car may need to be defined if there is more demand than supply of charging. For more information about site signage requirements, please see Section I on *EV-Related Signage Guidelines* in the Appendix of this document. Additional information can be found in Ready, Set, Charge California document available at http://www.baclimate.org/images/stories/actionareas/ev/guidelines/readysetcharge_evguidelines.pdf.

Registration and Liability Forms

Some workplace charging programs require users to register to use the equipment and sign a standard waiver of liability. A registration form could include language requiring vehicle owners

to agree that the business is not responsible for any costs related to vehicle purchase or repairs, nor for any damage to the vehicle while parked at the charging station. It could also provide a specific timeframe within which the business would be obligated to correct maintenance issues with the charging stations upon notice of the problem.

Time Restrictions on EVSE Access

Employers must decide whether the EVSE can be used outside of normal business operating hours. A company may also decide to put the locations of the chargers on charging network maps, such as those operated by the Department of Energy or EV Charging News. These resources will make EV charger information available to the general public and enable a potential revenue flow for charging outside of business hours.

Equipment Security

Level 1 charging often involves connectors and cables owned by the EV driver. Some of these cables can cost as much as $600, so it will be important to create as secure an environment as possible to prevent vandalism and theft. A commercial building in Silicon Valley with both workplace and public retail tenants has taken the step to enclose the workplace-only charging units inside a fenced off area, providing a key to authorized drivers to unlock the equipment. This measure has effectively segregated the equipment from the public, while giving authorized drivers access. Other workplaces report little if any interference with driver-supplied charging equipment.

Managing Access Following Complete Charging:

Employers must also decide what policies should govern EV drivers once EVs are fully charged. Must employees move their vehicles to enable another EV to use the charger? Many companies are asking drivers to sign an "EV Drivers' Code of Conduct" that includes instructions on how to share spaces and notify other EV users that the spot is available. For example, most EV's have easily readable dashboard lights that can be seen by anyone looking at the vehicle to indicate if the vehicle is currently charging. With appropriate protocols, some workplaces have policies that permit other drivers to move the charging device from one vehicle to another when a complete charge is indicated. Other policies call for notification via smartphone app, while leaving the responsibility for decoupling the charger to the original driver.

Auto manufacturers are also educating new EV drivers on standard "charging etiquette" For example, the Ford Motor Company has recently produced EV Etiquette documents, available at http://blog.ford.ca/2013/01/04/ev-etiquette-a-whole-new-ballgame. Many drivers also use timecards that can be displayed in vehicle windows indicating when the charger might be disconnected and used by a vehicle in the adjoining spot, as illustrated here: http://blog.ford.ca/wp-content/blogs.dir/1/files/2012/12/Ford-EV-Etiquette-Plug-In-Card.pdf.

Generally, EV drivers understand that they are not parking and charging their vehicles in a spot for the full day, that they are actually occupying an "alternative fueling station" and are ready and able to calculate the time required to charge their vehicles and make arrangements in their schedule to move their vehicles when their charging sessions are over. A growing set of smart phone apps may enable EV drivers to plan, monitor, and schedule the charging of their vehicle. While it is up to the workplace to determine whether they want to limit car

switching when charging is completed these applications often include reservation systems so cars can be scheduled and moved by the drivers as necessary. Ideally, the charging spot should be used as efficiently as possible so that any vehicle in the spot is actually charging up.

Charging Money for Charging EVs – Policy Options for Employers

Many EV workplace charging programs are free for employees. Since the number of EVs on the streets today is relatively small, this can be an affordable approach to initially incentivize employees to make a clean transportation choice. As the penetration of EVs expands, providing free charging may have to be reconsidered. Capital and operational costs for EV charging can be recovered over time through a charge-per-use or setting a monthly/yearly subscription rate. Level 2 charging equipment usually includes management software that allows workplaces to set the fee for a kWh of energy, a pre-defined length of a charging session, or to allow access to the unit for no fee during certain hours of the day. In the largest survey to date, the California Center for Sustainable Energy (CCSE) and the California Air Resources Board (ARB) found that California EV owners are willing to pay 40 percent – 70 percent more for public and workplace charging compared to standard residential electricity rates.

The cost of the electricity used to charge a single EV is minimal, comparable to per employee costs for coffee or snacks in a break room. For example, the energy cost per kilowatt hour (kWh) in the United States as reported by the Bureau of Labor statistics is .12 cents, in Los Angeles it is .20 cents. A Nissan LEAF goes approximately 3.5 miles per kWh of energy used. In order to obtain 20 miles of range (longer than the typical one-way commute in California) the Leaf would require 5.7 kWh of electricity, which would cost .68 cents at the national average electrical rate and up to $1.14 in Southern California Edison (SCE) territory. For comparison, a vehicle with an internal combustion engine might consume between $2.00 and $5.00 in gasoline to drive 20 miles. Given the 3.3 kWh charging unit in the LEAF, it would take close to two hours of charging to receive 20 miles of range in the battery. For an employee in SCE territory who utilizes workplace charging for five days/week, the total charge for energy would be $5.70 per week, for a 4-week working month the cost of energy would be $22.40 and a for 50 weeks a year the employee's vehicle would consume $285 worth of energy.

It should be noted that if a company decides to make EV charging free for its employees, some legal experts think that it could be considered a reportable employee fringe benefit. Most Level 2 chargers include management reporting capabilities can provide individual statistics for each vehicle that has charged, including the time to charge and the amount of energy consumed. These reports can be used to provide information for employee benefit reporting.

Some companies have decided not to burden themselves with tracking individual vehicle energy consumption and instead have added an electric vehicle-charging component into an Employee Alternative Transportation initiative. Under this type of program, an individual employee is not charged directly for the energy their vehicle consumes, however a taxable benefit of $30 per month (or more as appropriate) is added to their benefit package. In either scenario, the cost of energy for an individual vehicle is relatively small. Given that EV charging may be a tax liability to your employees and require an employer reporting mechanism, consulting a tax attorney or advisor is recommended.

EV Charging in the City of Ventura

The City of Ventura leads the Central Coast in the number of public EV charging stations installed, with 14 installed as of early 2013, of which 12 are available to the public and two are reserved for City fleet use only. Locations include the beachfront parking structure, downtown, and City Hall. As in the case of Santa Barbara, the City was able to take advantage of the ChargePoint grant program, which included California Energy Commission and federal Department of Energy funding for both hardware and some installation costs. Additional installation funding was provided by the Ventura County Air Pollution Control District (for the Metrolink project). Installation was done by Clean Fuel Connection and ABM, two companies certified by ChargePoint to undertake installs of their equipment.

The City's robust charging program has the full support of the Mayor and City Council, which is promoting EVs as part of an ambitious Climate Action Plan, and green initiatives throughout the transportation sector. Future charging station installations are being considered for the Community Park and Aquatic Center areas. The City's average installation cost ranged from $7,500 to $10,000 per station for the installation alone. Therefore, additional grants will be sought to cover future network expansion.

As part of its EV commitment, the City also purchased three Prius Plug-in Hybrid Electric Vehicles (PHEVs), which have a 12-mile all-electric range, and very high-MPG ratings under regular combustion power. They also continue to operate a model year 2000 Toyota RAV 4 EV, which has proven very reliable. The Prius PHEVs were purchased with federal Recovery Act stimulus funds.

The City recognizes that its position on the 101 corridor between Los Angeles and San Francisco is a key strategic location for EV charging, and the City is cooperating with NRG and other stakeholders to identify appropriate locations for future EV Fast Charging.

EVSE Siting at a Workplace Location

The workplace charger siting process should begin with the electrical contractor performing the initial site inspection. The contractor can pinpoint existing power supply options and upgrade requirements and identify charging spots closest to the existing electrical infrastructure. Attention to ADA requirements is important at this point, especially since ADA compliance requirements are subject to local interpretation. The guidelines are available at http://www.baclimate.org/images/stories/actionareas/ev/guidelines/readysetcharge_evguidelines.pdf and should be consulted for a full discussion of ADA issues. Many municipalities and local ordinances require that the first in a series of charging stations be accessible and use the ADA standard as their permitting guideline. Building an accessible EVSE spot also includes making sure that wheelchair users are able to access the charging station and cables and outlets are installed at accessible heights.

Aside from following ADA and National Electric Code guidelines on installation, safety considerations should also include efforts to reduce the potential of people tripping over EVSE cords, proper and sufficient lighting, potential shelter from weather, general personal/property security, clearly visible signage, and sufficient barriers to prevent a car from colliding with the EVSE.

For more information about where a charging station should be installed, ADA and site signage requirements please see the following sections of the Appendix to this document: Section C -

Charger Installation Guidance for Commercial and Multi-Family Installations, Section H - *Guidelines for Accessibility and ADA Compliance* and Section I - *EV-Related Signage Guidelines*. Additional information can be found in Ready, Set, Charge California document available at http://www.baclimate.org/impact/evguidelines.html.

EVSE Installers and Contractors

A certified electrician should carry out EV charger installations. When hiring a contractor to install EVSE at a workplace, select one who is familiar with the National Electric Code Guidelines found in NEC Article 625, the specific guidelines for EV charging equipment and installation. Be sure to have key decision makers and key employees that will use the EVSE walk through the parking area with the certified electrician/contractor prior to beginning the installation. The electrician or general contractor will likely be the point person in coordinating local permitting, inspections, utility upgrades (if needed), equipment purchasing and installation of the EVSE. After installation, the electrician should walk through the EVSE and its operation with the owner of the equipment.

With the growing interest in EVs, targeted training and certification programs for EVSE installations are expanding. For example, UL (formerly Underwriters Laboratories) now offers an online and hands-on program to familiarize technicians and safety inspectors with a wide range of electric vehicle products and technologies, including Section 625 of the National Electrical Code. The national electrical industry also has created the Electrical Vehicle Infrastructure Training Program (EVITP) to train and certify EV equipment installers. This has become the leading training program for EV charger installation – with co-sponsorship by the National Electrical Contractors Association (NECA) and the International Brotherhood of Electrical Workers (IBEW).

Utility Notification Processes

It is important to notify the local utility when Level 2 charging infrastructure is being installed. Business locations for EV charging infrastructure generally have robust electric service -- so that the addition of the first one or two Level 2 EVSE will not likely impact the local electrical distribution network and equipment. However, additional chargers on a single transformer may require an upgrade, and it is important for utilities to track each new installation as it occurs for system planning purposes.

Utilities also offer special EV charging rates. Typically, these rates have been established to incentivize drivers to charge their vehicles during off-peak times when electricity consumption is lowest (e.g. overnight). However, some rate incentives may apply during portions of the daytime hours as well, particularly during morning hours.

Charger Signage

EV charger signage must clearly show that the parking spot is only to be used by an EV. One emerging practice is to choose the signs indicating EV charging in a green rather than blue color. Blue is often associated with ADA parking spots and some drivers of traditional vehicles often think that those spots are available for them to use. This helps alleviate a phenomenon which EV owners refer to as "getting ICE'd" when they come to a public charging station spot only to find an Internal Combustion Engine (ICE) parked there. The cost of signs will typically range between $15 – $80, plus installation.

It can also be useful to paint the pavement of the parking space to provide further visual guidance for the EV charging space. The main consideration in painting the space is to use a high contrast color, so the information on the pavement is easily readable. For more information about site signage requirements please see Section I - *EV-Related Signage Guidelines* in the Appendix of this document. Additional information can be found in *Ready, Set, Charge California!*,available at http://www.baclimate.org/images/stories/actionareas/ev/guidelines/readysetcharge_evguidelines.pdf

EV Chargers and Renewable Energy

A unique benefit of driving electric is the capability to power them with clean, locally-produced solar or wind power. Use of renewable, green sources of electricity to power EVs is encouraged to prevent pollution from energy generation and to promote a robust local low-carbon energy economy. Installing a solar array adjacent to a plug-in charging station demonstrates that natural energy from the sun can be used to power vehicles. Solar power typically flows into the grid with a separate meter tracking how much electricity has been generated -- offsetting the grid power that is supplied to EVs through the EV charger.

The cost of a solar power is on a steep decline – such that some systems may be installed with no upfront investment by a financing mechanism known as a Solar Power Purchase Agreement (PPA). For example, a 2kW solar installation provides savings sufficient to power an EV for 10,000 miles per year – year after year -- with a one-time cost of approximately $6000 after incentives. Through a PPA, businesses also have the opportunity to own the asset by investing their own capital, or to enter into a PPA agreement whereby an energy company such as Solar City would own the asset but pass on some of the energy cost savings to the host business.

Sample Checklist for Workplace Charging

Establishing a workplace charging initiative can be a straightforward process for most organizations. It requires an executive to put together a team of key stakeholders to assess options and decide key issues. The following checklist references the major steps and components of the process.

1. **Determine employer/employee interest** in an EV charging program, including strategic drivers and potential for short-term and long-term utilization.
2. **Assess the concerns of property owners** and landlords.
3. **Have a certified electrician evaluate the power infrastructure** and upgrade options.
4. **Confirm utility rates, local permit requirements and operating revenue and expense**.
5. **Determine site plans** for EVSE infrastructure design.
6. **Select appropriate EVSE vendors** and equipment.
7. **Develop internal policies and programs** for EV drivers.
8. **Build-out site infrastructure**, including permits, power, charger installation, and signage.
9. **Turn on charging infrastructure and orient users** to charging policies and procedures.

APPENDIX M:
GRID INTEGRATION ISSUES

Much attention has been paid to the potential impacts of Electric Vehicles on the utility grid, with initial concerns being expressed by some utility analysts that EVs could produce significant strain on transmission or distribution infrastructure, or even require new generation facilities once a significant share of new vehicles sold are electric. Most recently, the slow and gradual introduction of EVs into the marketplace, combined with more than twenty years of study of the issues (dating back to the first wave of EV penetration in the 1990's) have mitigated many of the most urgent concerns on the part of utilities, the California Independent System Operator (CAISO), and the California Public Utilities Commission (CPUC). In fact, Southern California Edison recently issued a white paper stating that grid impacts have been much smaller than they anticipated, much of this due to the fact that many EV owners that travel less than 50 miles per day are using Level 1 charging, and also that randomized start times of charging sessions help lessen grid impacts. Of the nearly 400 circuit upgrades SCE made in the past 2 years, only 1 percent was because of additional power demands from EVs.

To ensure that grid impact mitigation receives the attention it deserves, however, the California Energy Commission has instructed local EV councils to include grid impacts in their EV ecosystem planning process, and to encourage local stakeholders to work with utilities to ensure that notification protocols are in place regarding EV charging installations, so that utilities can plan for impacts on transformers and other infrastructure. The following discussion of grid impacts is intended to provide local public officials and EV stakeholders with an understanding of the issues at stake, and to identify needed policies and procedures for EV-to-grid interface.

Analysis of Potential Grid Impacts

To understand potential EV impacts on the grid, it is important to define essential terms. The grid is a collection of power plants and transmission and distribution facilities that produces and delivers electricity to end users. It must do so in real time, because electricity has not historically been able to be stored in significant quantities at reasonable cost. Power plants on the grid fall into two basic categories. Baseload facilities, such as large coal, nuclear or geothermal plants, are designed to operate continuously and at low cost. Peaking power plants, which operate only when demand is highest, are often fired with natural gas, and are typically more costly to operate. Wind and solar resources are intermittent, while hydro can be scheduled for use during peak times. Because of the structure of the grid, the cost of electricity and the emissions associated with generation will vary with demand and power plant availability. Charging an electric vehicle requires the grid to respond by providing more electricity. A key consideration for understanding the cost and emissions implications of plug-in vehicles is how the grid system responds to the additional demand.

Vehicle recharging will impact the grid in both the immediate and long term. In the near term, recharging vehicles will require additional electricity to be generated. However, it will take a very large number of plug-in vehicles in a region before power plants are operated differently or new ones are needed. For example, adding 1 million PHEVs in California (out of 26 million

vehicles) only increases total electricity consumption in the state by approximately 1 percent. If that increase occurs off-peak, no new capacity is likely needed, according to researchers at the University of California at Davis.[16]

The degree of the negative local grid impact depends on EV penetration, the current condition of local distribution infrastructure, and strategies to manage additional load. Fortunately, both PG&E and SCE have taken a national leadership role in implementing pilot projects and assessments to understand EV usage patterns and how tools such as smart meter, EV tariffs and incentives can focus charging during periods of lower demand, and otherwise mitigate grid impacts. The following narrative reviews key strategies for minimizing potential for negative grid impacts, focusing on 1) transformer impacts; 2) pricing and incentives; 3) utility notification in the planning process; and 4) energy storage and renewable power integration with fast charging infrastructure.

Plans to Minimize Effects of Charging on Peak Loads

Research conducted by the EPRI found that aggregate EV demand will not require substantial new generation at either the national or state level, even with aggressive estimates of PEV penetration. This is due in large part to the fact that more than 40 percent of the nation's electric generating capacity sits idle or operates at reduced loads overnight and could accommodate tens of millions of PEVs without requiring new plants. This research also concludes that utilities could better utilize their power-generating assets by allowing for more efficient operation and gaining a new market for off-peak power that now sits idle.[17] The additional 1.8 million PEVs by the late 2020's are expected to increase California's electric system load demand by 4.6 terawatt hours (TW-hrs.). If most of this additional demand is supplied by off-peak power, it is likely that PEVs would not create an adverse impact on California's supply of available electric power within the 2020 timeframe, as projected in the staff white paper entitled: *Light-Duty Vehicle Electrification in California: Potential Barriers and Opportunities,* Policy and Planning Division, CPUC, May 2009. These grid impacts are summarized in Table 22 as a function of EV penetration scenarios.

[16] Christopher Yang and Ryan McCarthy, *Electricity Grid Impacts of Plug-in Electric Vehicle Charging,* UC Davis, June 2009, p. 16.

[17] *Driving the Solution: The Plug-In Hybrid Vehicle,* Lucy Sanna EPRI Journal, 2005.

Table 22: Grid Impacts of California EV Penetration Scenarios

EVs in 2020	GWh/yr.	GWh/Yr. % increase	Peak Load MW	Peak Load MW % increase
3,000 BEVs 58,000 PHEVs	202	0.1%	10	0.01%
33,000 BEVs 312,000 PHEVs	1,136	0.3%	56	0.08%
455,000 BEVs 2,500,000 PHEVs	9,645	3.0%	47 4	0.64%

Source: Electric Power Research Institute

The upper estimate for EV impact on the grid is a 3 percent increase in electricity generation and a 0.64 percent increase in peak demand. Each million PEVs would add 2.4-4 TWh of consumption, at a cost to consumers of $0.24 - $1.2 billion. The results of this study demonstrated that EVs can provide more efficient use of utility assets and therefore potentially lower rates.

In the 2013-2020 planning horizon, utility analysis indicates that potential for negative grid impacts are minimal and are limited primarily to the possibility of clustering of PEVs in neighborhoods with limited power infrastructure. For instance, a CPUC report cited a Southern California Edison (SCE) analysis that shows that additional peak demand (around 7 pm) could be substantial if a large number of PEV customers plug in and charge immediately upon returning home from work. The CPUC staff found that in the extreme worst case "uncontrolled scenario" for 2020 could occur if 3 million PEVs were plugged in simultaneously. This added energy load would be 5,400 MW if a 120 V connection is used and 19,800 MW for 220V outlets. However, tariff structures have been designed to prevent this scenario, and smart meters are being deployed that have the capability to phase in the introduction of charging at night so as to prevent sudden peaks. Additional information on time-of-use rates is provided below. An additional strategy for reducing peak load impacts is solar and fixed energy storage integration with EV battery charging, which is discussed in depth at the end of this section of the Appendix.

EV Related Utility and Grid Upgrades

One of the largest concern of utilities is related to local distribution equipment (at the individual residential block level), particularly local transformers. EVs can contribute to degradation of transformers – and even failure -- if several neighbors recharge simultaneously during peak demand periods. To avoid this and ensure that upgrades are made in advance of possible failures, utilities have worked closely with auto dealers to ensure that they are notified at the time of purchase so that they can track their likely charge location and plan for upgrades accordingly. Currently, PG&E and SCE estimate that they are being notified regarding approximately 90 percent of PEV purchases. Additional outreach is being undertaken by PCC to ensure that local public authorities are aware of the importance of notification protocols that can capture additional installations of PEV chargers that may not have been in the dealer to utility notification chain. Specifically, notification protocols will be highlighted in three

stakeholder workshops held in each of the three PCC Counties, and are highlighted in our informational materials and checklists for local government staff.

PEVs are likely to be concentrated in particular neighborhoods, where 25 kVA transformers may already be stressed due to operating with narrow margins. Each transformer typically serves five to fifteen households. In an uncontrolled charging scenario, peak loads might occur at around 5:00-7:00 p.m. If all the vehicles were BEVs, then the peak load would be about 1400 – 6000 watts per vehicle on average, depending on Level 1 or Level 2 charging rates. Early model PEVs are typically charging at 3.3kW while newer vehicles are in the range of 3.3 – 6.6kW, with Teslas drawing up to 18kW via high-rate (70 amp) AC charging. PEV charging represents a significant power draw for most homes. A Level 2 charger operating at 220 V on a 15-amp circuit is expected to draw 3.3 kilowatts of power at the peak of its charging rate, a load that is equivalent to between 50-100 percent of the average load in a typical home. Distribution system impacts including transformer stress could occur due to clusters of EVs increasing loading beyond transformer capacity. Therefore, incentivizing customers to charge when load is low is important. Both PG&E and SCE have initiated rate designs and "demand response" options (that enable users to interrupt charging briefly in return for lower tariffs) that will mitigate these issues.

According to a study by the University of California, Berkeley, the current California grid is capable of handling a significant number of PEVs, as long as utilities policies promote off-peak charging. (DeForest, N., et al., "Impact of Widespread Electric Vehicle Adoption on the Electrical Utility Business – Threats and Opportunities," University of California, Berkeley, August 2009, pp. 13-16, available online at: http://cet.berkeley.edu/dl/Utilities_Final_8-31-09.pdf.)

Time of Use Tariffs: Time of use (TOU) tariffs enable utilities to charge higher rates during times of peak demand and lower rates during off-peak hours, thereby reducing system peaks and the corresponding investment to provide peak capacity. Smart meters and smart charging technologies can work in tandem to track daily usage patterns and ensure that charging is concentrated in the off-peak, when surplus electricity is available for less, and when renewable power may be available in surplus. (Currently much of California's wind energy is sent out of state at night for very low or "negative" prices, i.e., the state is paying other utilities to take the power because we do not have any use for it.) Concentrating EV charging during times of surplus renewable power generation can reduce the effective carbon intensity of EV charging and make strong economic sense for California rate payers and utilities. The time of use tariffs available now typically fall into one of these categories:

- Whole-house Time of Use with a single meter – this time of use (TOU) rate has both the house and the PEV on the same rate with one meter. This rate encourages consumption during off-peak while avoiding costs associated with a second meter. To take advantage of this rate, customers must also maximize the amount of electricity consumed during off-peak hours. This rate is very advantageous for EV and solar owners, as they can charge their EV overnight at low super off peak rates and have their solar feed power back to the grid and be credited at on peak rates, which are often 2-4 times higher than the super off-peak rate.
- Fixed fee or fixed fee off-peak – this rate requires EV owners to pay a flat monthly fee for unlimited charging (although the time could be restricted to off-peak charging).

Though this rate is easy to use for both the utility and the customer and doesn't require the use of a second meter, the rate would need to be structured to provide significant off-peak discounts to encourage off-peak usage.

- Two-meter house with high-differential pricing – this rate has the house and the PEV on different rates with one meter for the house usage and another meter for the PEV consumption. This encourages electricity consumption during off-peak hours for the PEV with a TOU rate and allows the house to be on a normal residential rate, such as a flat rate. The primary requirement to achieve lower bills on this type of rate is that customers need to adjust just their charging times to maximize the amount of electricity consumed during off-peak. The disadvantage of this rate structure is the need and costs associated with installing a second meter, which can require an investment of several hundred dollars or more.
- Sub-metering off PEV charging circuit with high-differential pricing – This rate is similar to the two-meter house rate, except the PEV charging circuit is sub-metered and simply subtracted from main meter use. The advantages of this rate are that it is appropriate for multi-unit dwellings, potentially less expensive, and allows for differential pricing. However, these rates are experimental at this time, and it is not clear when they might become available.
- Demand response (can be combined with options above) – Demand response programs enable the utility to enter into a contract with a user or an aggregator of PEV and other controllable loads to directly control the rate of charge to PEV during peak periods, and/or to provide financial incentives for temporarily reduced rates of charging. This feature may be especially useful for local grids near 100 percent capacity and for providing other grid services to the utility. To ensure consumer acceptance of this approach, PEV drivers must be able to charge to the desired level when needed.

Utility Incentives for Time of Use Charging

Table 23 describes the current SCE program of EVSE incentives and special PEV rates.

Table 23: Guidelines for Workplace Charging

Pilot Program	Incentive Type	PEV Rate
EV Discount Rate	Two time of use (TOU) discount rates are available for PEV, NEV and golf cart charging	The first rate provides discount of 8.1 ¢/kWh for off-peak summer; 9.2 ¢/kWh for off-peak winter. The second rate provides discounts for off-peak and super off-peak as well as a peak time rebate

Source: Southern California Edison, "Rate Information – Residential Rates," available online at http://www.sce.com/CustomerService/rates/residential/electric-vehicles.htm

Utility Notification of EV Charger Installations

With encouragement from the California Public Utilities Commission, PG&E and SCE have joined together to develop a guidance document for PEV notification designed to help utilities

evaluate if the local distribution system is adequate to serve PEV charging needs. In their report, PG&E and SCE identified the following requirements for EVSE installation notification.[18]

- **Comprehensiveness**: To ensure grid reliability, safety and stability, the two utilities request notification for charging locations for both new and used PEVs. Currently, PG&E estimates it has captured 80 percent of new PEVs sold in the service territory using existing notification processes. However, the utilities are attempting to achieve closer to 100 percent notification.
- **Granularity**: The location information should be as specific as possible, ideally with a street- level address as opposed to a zip code or city block. The data should also include charging levels (Level 1 vs. Level 2) to evaluate potential demand and impact on circuits. Currently, OEMs are sharing notification data at the street address level. Where there are dropouts in this process, local government permitting authorities are urged to notify the utilities regarding new EVSE installations.
- **Notification Timeframe**: Utilities prefer notification of new EVSE prior to installation, and notification protocols have been established between utilities and dealers.
- **Cost and Scalability**: As the PEV market grows, PG&E and SCE have expressed concern about the amount of manual activities required to collect data regarding regional EV deployment. Discussion with auto OEMs are ongoing regarding process streamlining and data collection cost reduction.

Current reporting protocols include the following: GM's regional manager for California provides data to the two major utilities on a biweekly basis; Nissan shares data quarterly through its third-party analytics firm, Oceanus; ECOtality (now acquired by Car Charging Group) provides the utilities weekly reports on its Level 2 charger installations. Individual customers also contact the utilities by phone or via its on-line PEV reporting tool to schedule a service appointment or discuss the EV rate options. Through recent legislation, SB 859, utilities are also able to get data for vehicles registered with the State of California directly from the Department of Motor Vehicles (DMV). As noted above, PCC is actively outreaching to local government to increase awareness and participation in notification protocols based on permitting activity for EV chargers.

Ensuring Intercommunication Between Charging Infrastructure and PEVs for Grid Interactions

It appears that in the next few years, utilities will be able to avoid transformer overloading as a result of local PEV clustering. However, long-term challenges could be created by high levels of PEV adoption. It will be important for utilities to work proactively with auto OEMs and other energy system intermediaries such as energy storage and demand response aggregators and EVSE network operators to further develop protocols for "load shedding" of PEV charging as these loads grow over the coming years. To begin this process, the California ISO in collaboration with the CPUC and the CEC, has convened a Vehicle-to-Grid Working Group and a V2G Strategic Roadmap development process in response to a request from the Office of Governor Brown. PCC has been represented in this process through its partnership with EV

18 See Southern California Edison Company, "Joint IOU assessment report for PEV notification," December 2011, p. 14, available online at: http://docs.cpuc.ca.gov/efile/REPORT/156710.pdf.)

Communities Alliance. At this time, no concrete measures to promote accelerated work on vehicle to grid communications have been identified by utility or regulatory bodies that are actionable at the local or regional level. However, as part of its own efforts to encourage awareness of the issues involved, PCC is requesting information from vendors on V2G communication protocols to ensure that local stakeholders are aware of the issues and opportunities for future EV and charger network participation in energy service markets. In addition, PCC is pro-actively outreaching to vendors of battery-backed chargers to ensure that these technologies are fully considered by stakeholders so as to minimize utility demand charges in future installations, and to provide a pathway forward for grid services revenue development as vehicle-to-grid communication protocols are deployed by OEMs and commercial V2G ecosystems begin to emerge.

PEV Charging and Battery-Backed Fast Chargers

To date, nearly all of the charging in California has been in the form of Level 1 and Level 2 charging. However, public agencies and EVSE network providers have announced plans for the installation of approximately 300+ Fast Chargers across the state in the 2013-2014 period, including a number (yet to be determined) along the 101 corridor in the Central Coast. However, Fast Chargers are not only costly to procure and install, they can be extremely costly to operate due to their impact on local utility infrastructure. While tariffs vary, many commercial site hosts will find that Fast Charge electricity loads have dramatic impacts on their bill, reflecting utility costs to deliver the high-power output to Fast Chargers that utilize 480 volt three-phase DC power. (Note that an emerging class of Fast Chargers, discussed below, can operate with 208-volt single phase power which pull less than 20 kW from the grid, which typically falls below a special utility surcharge for peak usage, known as a "demand charge.")

A utility demand charge represents the peak power used during a monthly billing cycle and is measured in kilowatts (kW). Demand charges vary by utility from near zero to as much as $26 per kW. Commercial utility rate plans vary considerably, and the least-cost approach for any given installation will vary based on the site host's base load and the intensity of utilization of the Fast Charger. Thus, the first decision facing the site host is whether to adopt a lower base tariff with a higher demand charge – or a higher tariff with no demand charge for extra peak usage. To illustrate the tradeoff, below is an example of PG&E's A-10 commercial tariff and a calculation of the monthly bill based on a 50kW Fast Charger with an average utilization of four charges per day. This charging scenario assumes a single charge based on a Nissan Leaf charging from a nearly empty battery to 80 percent of the battery's 24 kWh capacity. (Fast Chargers typically shut down their charging at the 80 percent level because the last 20 percent of energy transfer must proceed very slowly in order to limit battery degradation.) Demand charges are identified by PG&E as the "Total Demand Rates" in the example below. Note that the summer rate is more than double the winter rate, which is typical for California utilities. This reflects the reality that summer air conditioning loads require expensive generation resources to meet demand peaks on the hottest days. Figure 16 shows the PG&E Rate Schedule A-10, which is used to calculate the demand charges for a medium general demand metered service. A simplified presentation of the rate structure is shown in Figure 17.

Figure 16: PG &E Electricity Rates: Schedule A-10

ELECTRIC SCHEDULE A-10 Sheet 3

MEDIUM GENERAL DEMAND-METERED SERVICE

RATES: Standard Non-Time-of-Use Rate

Table A

TOTAL RATES

	Secondary Voltage	Primary Voltage	Transmission Voltage
Total Customer/Meter Charge Rates			
Customer Charge ($ per meter per day)	$4.59959	$4.59959	$4.59959
Optional Meter Data Access Charge ($ per meter per day)	$0.98563	$0.98563	$0.98563
Total Demand Rates ($ per kW)			
Summer	$12.12 (R)	$11.35 (R)	$7.43 (R)
Winter	$5.63	$5.84	$4.13
Total Energy Rates ($ per kWh)			
Summer	$0.13741 (R)	$0.12857 (R)	$0.10452 (R)
Winter	$0.10257 (R)	$0.09835 (R)	$0.08604 (R)

Total bundled service charges shown on customers' bills are unbundled according to the component rates shown below.

Source: PG&E

Figure 17: Fast Charge Demand Charge Calculation
Rate Scenario: PG&E A-10

Meter Charge per month: $137.99

Demand Charge (kW) per month:

Summer: $607.50

Winter: $281.50

Energy Charge (kWh) per month:

Summer: $313.98

Winter: $234.11

Total cost per month (@ four sessions per day):

Summer: $1,059.47

Winter: $653.60

Assumptions

- Four charge sessions per day for 30 days/mo.
- 50kW Fast Charger

Source: PG&E

LinGiven that the demand charge under the PG&E A-10 rate plan is quite high, it is likely that the station owner will opt to use a rate plan such as A-1, which includes a much more expensive energy charge (measured in kilowatt hours or kWh), but zero demand charge (measured in kW). In this example, the A-1 rate is approximately twenty cents per kWh (0.20495) – vs. approximately thirteen cents for the A-10 rate (based on a summertime comparison). SCE does not have an equivalent to the A-1 rate. Thus, demand charges in SCE are much higher, and may require more aggressive mitigation strategies, such as battery-backed Fast Chargers. Using the same assumption of four charges per day in the summer, shown in Table 24 is an illustration of the monthly DCFC energy cost with the two major California utilities in the Central Coast.

Table 24: Monthly DC Fast Charger Costs on the Central Coast

Utility	Tariff	kW charge	Monthly Cost
PG&E	A-1[19]	None	$487
SCE	TOU EV-4[20]	$12.18	$1,131[21]

Source: PG&E and SCE

The demand charges can be prohibitively costly for site owners when DCFC utilization is relatively infrequent. For example, when a Fast Charger is utilized only once in a summer month, as in the example below (under a Southern California Edison (SCE) TOU EV-4 rate tariff), the demand charge will be a substantial portion of the overall bill – approximately $609 ($12.18 x 50kW). (The 50kW power draw during a charge session is an approximation and may vary somewhat depending on equipment.) If the charger is used four times per day over the course of 30 days, the cost of energy would be $9.42 per session in the summer rate period ($1,131 per month for a total of 120 sessions). As noted above, **s**ummer costs are significantly higher than winter, and both winter and summer seasons should be taken into account when setting rates across the whole year (there are no fall or spring rate variations). During winter, under the SCE TOU EV-4 rate, the cost per session is $7.90. Please note that the examples above have been calculated based on the most common installation scenario, wherein the Fast Charger is established on its own utility service and meter. This configuration enables the site host and station owner to achieve full control of operating costs and to clearly delineate the contribution of the Fast Charger to the total site owner's electricity costs.

208 Volt Fast Chargers: There is also a growing market for 208-volt DCFCs that reduce power usage below the threshold of 19kW, which is the trigger for California utility demand charges. Moreover, the 208-volt DCFCs that do *not* include battery back-up are less costly in initial purchase price, in ongoing energy costs, and in installation. They also have reduced requirements for heavy-duty conduit and wire, step-up transformers, and other costly

19 Pacific Gas & Electric, 2012. Electric Schedules, available at http://www.pge.com/tariffs/ERS.SHTML#ERS

20 Southern California Edison, 2012. Regulatory Information- SCE Tariff Books, available at http://www.sce.com/AboutSCE/Regulatory/tariffbooks/ratespricing/businessrates.htm

21 Based on two on-peak (12pm to 9pm) and two off-peak charges (all other times).

electrical components. Those with battery back-up are far more expensive but have additional revenue scenarios. An example of a battery backed 208-volt fast charger is shown in Figure 18.

Figure 18: RAPIDAS / Kanematsu 208-volt Battery Backed Fast Charger on Portland's "Electric Avenue[22]

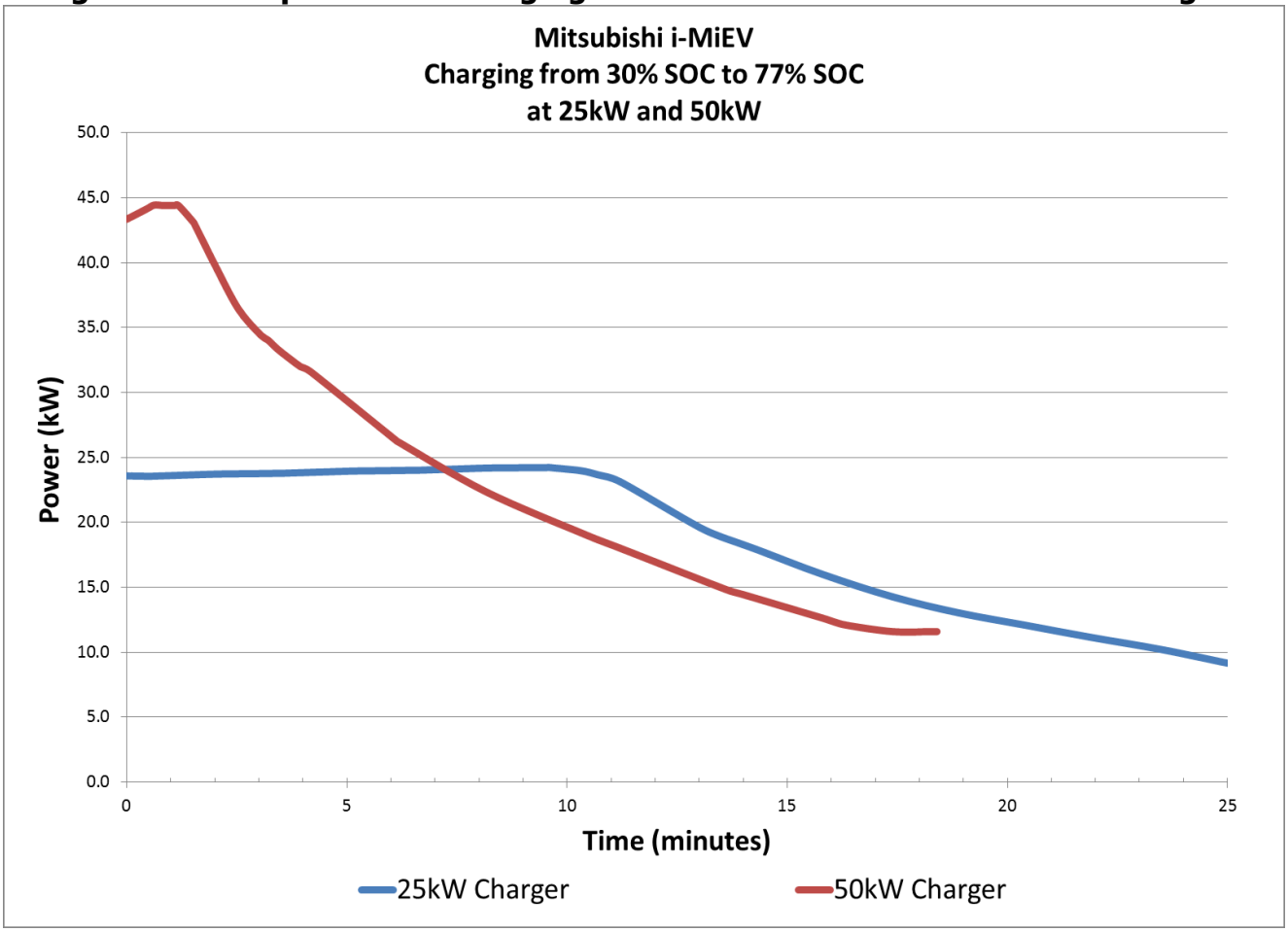
Photo Credit: Courtesy of Kanematsu – EV Collective

Proponents of the 208-volt chargers note that the reduction in charging time is not proportionate to the reduction in rated voltage. Because of battery physical properties, the initial high charging rates of the 50 kW units cannot be maintained throughout the charging session. Thus, the 50-kW initial speed advantage in charging is sustained only for approximately the first ten minutes of the charging session, after which it falls to a lower charge rate comparable to the 20-kW unit, as noted in Figure 19 below. Therefore, while the theoretical difference in charging time can be 100 percent or more, the actual difference for drivers in many real-world charging scenarios is likely to be as little as 25 percent, or an extra ten minutes on a typical 30 percent state-of-charge (SOC) to 80 percent SOC charging scenario.

Shown in Figure 16, a Mitsubishi "i" at a 30 percent SOC can be recharged to 77 percent SOC in 18 minutes with the 50kW unit vs. 25 minutes with the 25kW unit. There is no doubt that BEV drivers will prefer the faster charge times in circumstances of serious time constraint, but in many real-world use scenarios, the longer wait times may not be a significant inconvenience.

22 JFE is available at http://www.jfe-eng.co.jp/en/en_release/news_e11041e.html

Figure 19: Comparison of Charging Rates between 25kW and 50kW Chargers



Source: Study Conducted by Larry Butkovich, GM of EV Systems for Fuji Electric

Innovative strategies for deploying Fast Chargers in cost-effective and environmentally smart configurations are emerging in leading EV-ready communities around the globe. California is positioned to be a leader in this trend by taking bold action to accelerate the number and diversity of pilot projects that interconnect EVs, new charging technologies, solar PV, and fixed battery storage. By integrating these technologies into "smart micro-grids," charging hosts and EV network operators can:

- Reduce the operating costs of DC Fast Charging
- Advance new "green fueling" options for EVs
- Provide enhanced back-up power systems for nearby buildings
- Reduce facility energy costs
- Build a foundation for future grid services revenue flow to energy storage and EV owners.

PEV Charging and Solar PV Integration

To address the challenges of demand charges and develop greener fueling options for EVs, the co-location of solar PV, battery storage, and Fast Charging (along with Level 2 charging) is emerging as an attractive strategy. Through this co-located approach, site hosts can stay below the demand charge trigger point of 20kW of power demand from the local utility and

lower energy costs over time. Additionally, co-located PV adds a special dimension to the EV experience: it affirms the transition now underway from "black" energy (based on dirty and largely imported fossil fuels) to "green" energy, sourced from secure, local, clean, and renewable resources.

To effectively deploy Fast Charging, PV, and battery storage, it is important to define two terms that are used interchangeably in ordinary conversation, but which denote very different phenomena in the world of the electric grid: *power* and *energy.* Energy represents the amount of electricity used over a given period of time and is generally measured in *kilowatt-hours (kWh).* Power is an instantaneous measure of the level of electricity output and is measured in *kilowatts* (kW). To calculate kilowatt-hours, a unit of power (e.g., one kilowatt) is multiplied by a unit of time (e.g., one hour) to produce (in this case) one kilowatt-hour.

For purposes of billing and crediting energy use to rate payers, utilities determine the amount of power consumed by measuring the average power over an interval of time, typically 15-minutes for commercial customers. Some utility tariffs allow commercial customers with less than 20 kW of peak power requirement (measured over the interval of time) to avoid demand charges. As discussed above, demand charges reflect the peak power level (e.g., 21 kW or greater) a customer consumed during the billing period. Demand Charge tariffs also vary significantly by season and are highest in the summer. The *energy charge* is based on a more familiar calculation. If a customer uses an average of 3 kW per hour for four hours, this equates to using 1 kW per hour for twelve hours: both are 12 kWh, or 12 kilowatt-hours of energy. Thus, for larger commercial and industrial customers, the total monthly charge for electricity is based on multiplying energy consumption (based on a 15-minute utilization average) x the energy rate (i.e. $/kWh), with an additional surcharge for peak power. By understanding the potential impact of utility Demand Charges, site hosts will be better equipped to evaluate the business case for co-locating battery storage with a DC Fast Charger. DC Fast Chargers without storage require peak power levels of 50 to 60 kW. This level of power draw will permanently alter the charging host's power bill. While tariffs for demand charges vary by utility, a realistic billing scenario shown in Table 25 using PG&E's tariff demonstrates the impact of operating a Fast Charger with and without battery back-up.

Table 25: Assessing the Cost Impact of Battery Storage on Fast Charging

Context	**PG&E A10 Tariff**			
Meter Charge	$4.60	Per day		
Demand Charge (kW)				
Summer	$12.12	May - Oct		
Winter	$5.63	Nov - April		
Energy Charge (kWh)				
Summer	$0.14	May - Oct		
Winter	$0.10	Nov - April		
	No Storage	**With 24 kWh Storage**		
Meter Charge	$137.99	$137.99	Based on 30 days	
Demand Charge (kW)				
Summer	$595.35	$0.00	Based on 49kW DCFC	
Winter	$275.87	$0.00		
Energy Charge (kWh)	KWh Cost per session based on full 19kWh battery			
Summer	$2.62	$2.69		
Winter	$1.95	$2.01		
	No Storage		**With 24 kWh Storage**	
Total cost / year	2 sessions/day	4 sessions/day	2 sessions/day	4 sessions/ day
Summer	$5,341.98	$6,283.92	$1,798.14	$2,786.34
Winter	$3,185.46	$3,887.82	$723.42	$1,446.78
Yearly Total	**$8,527.44**	**$10,171.74**	**$2,521.56**	**$4,233.12**

Source: PG&E

This billing scenario demonstrates the economic benefit of establishing a "separate service" account with the utility for a battery-backed Fast Charger that can charge itself at 19 kW (below the demand charge threshold) and discharge into the vehicle battery at full power when needed. Vehicle charging for a battery-backed Fast Charger *combines* the stored energy from the charger battery and additional grid power while drawing *less than 20 kW from the grid at all times.* Optimally, a battery-backed Fast Charger will also have the capability to provide back-up power to nearby buildings and facilities, likewise reducing the utility-supplied power below demand charge triggers.

Only a careful analysis of likely costs at a specific location – and the projected frequency of EV charge sessions – can ensure the avoidance of all (or nearly all) demand charges. Fast Charge owners and site hosts must weigh the higher capital costs associated with battery-equipped Fast Chargers vs. the demand charge mitigation over a realistic timeframe for equipment amortization. Also, buyers should be aware that battery prices are projected to drop over the

next five to ten years by as much as 50 percent or more from their current cost of approximately $500 per kilowatt of energy storage in a fully configured system.

Notwithstanding these high up-front costs, EVSE network operators and vendors – including NRG, Kanematsu/EV Collective, AeroVironment, Energy Vault, and Green Charge Networks, among others -- are beginning to deploy battery-backed chargers because of their potential to generate superior cost savings and revenue enhancement over time, while minimizing grid impacts.

Residential Renewable Energy and PEV Charging

Grid impacts can also be reduced by encouraging distributed renewable energy deployment linked to EV charging in both commercial and residential locations, and in both single family and multi-family residential settings. It should be emphasized, however, that grid tied solar panels can only be considered an informal "carbon offset" for driving, since the electrons that actually power the charger will come from a grid mix of electricity rather than directly from the solar panel – unless there is an inverter and an energy storage resource that makes a direct connection possible. To facilitate such direct connections, both AeroVironment and Solar City (in collaboration with Tesla) are producing battery/inverter combinations that can make a direct connection possible between residential solar and EV charging. These units also have the important advantage of enabling "islanding" in the event of a grid outage, so that the solar power can be routed to back up home electric appliances, whereas a conventional grid-tied solar installation is not useable in a blackout.

Residential solar installations are frequently deployed as Power Purchase Agreements (PPA), which is a leasing arrangement whereby the solar company or financier retains ownership of the solar installation for a period of time, and the site host gains some of the energy savings on their monthly utility bill. Alternatively, some of this savings is used to finance the eventual purchase of the underlying solar asset. This enables solar site hosts to put very little or zero money down. In a solar installation with a direct link to EV charging, the solar resource can be valued at the replacement value of the energy that would be otherwise procured in the form of gasoline or at the utility retail rate. This can significantly speed up the return on investment in solar compared to a solar install that is only being compensated at the utility "net metered" tariff, which is often not very favorable to the residential solar customer.

Solar and EV charger partnerships are also coming into the marketplace. For example, Solar City has partnered with EV-charger maker Clipper Creek for a package that provides a discounted charger for customers who buy or lease a solar power system. The company, which was founded by Elon Musk, who is also co-founder and Chairman of Tesla Motors, says the average San Francisco Bay Area resident would pay about $107 per month to power an EV with electricity from a photovoltaic system. That compares with $230 per month to fuel a comparably sized gas-powered car, based on $3.65 per gallon of gas. Solar City indicates that most of the company's residential customers in its 12-state service area choose to lease 2-kilowatt system for about $54 per month, usually for a 20-year term. The deal with Clipper Creek will provide a 240-volt Level II EV charger and installation for an additional $1,500.

In addition to the Solar City / Tesla connection, Sun Power is entering into a marketing partnership with Ford Motor Company, which will tie EV chargers and home solar systems together in a package. Ford's partnership with SunPower will provide customers with a 2.5-

kilowatt rooftop solar system to power chargers for the Focus Electric and C-Max plug-in hybrid. Ford indicates that the system will cost about $10,000 before rebates and will be available through dealers in the initial markets for the two EVs. A household with a $200 monthly electric bill can expect to earn back the cost of the solar system in five years or less after rebates and tax credits are applied.

At the commercial level, solar/charger/battery integration becomes a more complex calculation, because building valuations and owner/agent relationships are more complex, and the effect on utility bills and opportunities for participation in utility programs, such as Demand Response, require much more elaborate calculation. However, some companies are seeking to simplify the situation with a turn-key approach that integrates solar, battery storage, and EV charging. For example, Powertree, a San Francisco based company, has a new offering that provides an Eaton Level 2 AC charger, functioning at 80 amps, with flexible support for higher-rate charging (from 3.3 kWh all the way to the 20 kWh rate possible with a dual cordset, high-rate AC Level 2 connection package from Tesla.)

Powertree provides an integrated solar, grid-tied energy storage and EV subscription network offering that can be structured in the form of a Power Purchase Agreement (PPA) for the building owner. Some of the solar energy can be allocated to tenants, converting a portion of their energy savings into increased rental income for the owner, which improves the capital valuation of the building. The energy storage system is aggregated with other energy storage assets operated by Powertree to provide ancillary grid series revenue which is also shared with the building owner. EV fueling is provided on a flat rate unlimited charge basis to Powertree subscribers, and building owners are paid for the use of the building or parking lot spaces. The subscription rate for the Powertree service is expected to be competitive with the NRG subscription cost, and Powertree intends to be competitive in the number of chargers available to subscribers. Because the overall package requires no up-front cost for the building owner, and provides revenue in exchange for 24/7 access to the spaces reserved for EV charging, this business model could scale more quickly than that of other network operators that require investments by property owners, or that do not provide as much revenue in compensation for the permanent reservation of parking spaces for EV drivers.

APPENDIX N:
INFORMATION RESOURCES ON EV ISSUES

The resources in this section provide additional information about Electric Vehicles for fleet and consumer use, charging infrastructure, sales trends, and policies.

- **DriveClean:** A guide for zero and near-zero emission vehicles from the California Air Resources Board, available at http://www.driveclean.ca.gov
- **California PEV Collaborative**: Statewide official resource for California PEV readiness, available at http://www.evcollaborative.org/
- **Community Environmental Council**: Provides leadership for greater Santa Barbara and Central Coast EV advocacy, renewable energy, and environmental sustainability, available at http://www.cecsb.org/index.php
- **Clean Cities Coalition of the Central Coast**: Provides leadership for electric and alternative fuel vehicles for fleet managers and other stakeholders throughout the Central Coast. http://www.c-5.org/
- **San Luis Obispo County Air Pollution Control District**: Clean air issues for San Luis Obispo County and on the PCC Steering Committee, available at http://www.slocleanair.org/index
- **Santa Barbara County Air Pollution Control District:** Clean air issues for Santa Barbara County and on the PCC Steering Committee, available at http://www.sbcapcd.org/
- **Ventura County Air Pollution Control District:** Clean air issues for Ventura County and on the PCC Steering Committee, available at http://www.vcapcd.org/
- **Santa Barbara EV Association:** The regional chapter of the Electric Auto Association (EAA) provides advocacy and information on EV issues, available at http://sbeva.org/ls/
- **Recargo**: Provides charging station maps, links to points of interest near charging stations, and EV community communication and social media tools, available at http://www.recargo.com/
- **Plug-Share**: Provides charging station maps, and access to residential EV charging stations on a peer-to-peer basis, along with smartphone apps for EV charging, trip planning, and energy management, available at http://www.plugshare.com/
- **Best Practices in regional and state EV programs:** The Hawaii EV program website offers reports and case studies on Hawaii's aggressive EV transition programs, available at http://energy.hawaii.gov/programs/transportation-on-the-move/ev-ready-program
- **Department of Energy (DOE): Alternative Fuels & Advanced Vehicle Data Center**: Provides information on EV and alternative fuel vehicles and petroleum reduction strategies, available at http://www.afdc.energy.gov/fuels/
- **Department of Energy resources**: The Department of Energy provides the following resources, available at http://www.afdc.energy.gov/fuels/electricity.html

- Hybrid and Plug-In Electric Vehicles fact sheet, available at http://www.afdc.energy.gov/afdc/pdfs/52723.pdf
- Plug-In Electric Vehicle Handbook for Consumers, available at http://www.afdc.energy.gov/afdc/pdfs/51226.pdf
- Plug-In Electric Vehicle Handbook for Electrical Contractors, available at http://www.afdc.energy.gov/afdc/pdfs/51228.pdf
- Plug-In Electric Vehicle Handbook for Fleet Managers,available at http://www.afdc.energy.gov/afdc/pdfs/pev_handbook.pdf
- Plug-In Electric Vehicle Handbook for Public Charging Station Hosts, available at http://www.afdc.energy.gov/afdc/pdfs/51227.pdf

- **Plugging In – A Consumer's Guide to the Electric Vehicle** - EPRI, available at http://www.epri.com/search/Pages/results.aspx?k=Plugging%20In:%20A%20Consumer's%20Guide%20to%20the%20Electric%20Vehicle
- **Plug-in America** - A non-profit coalition of electric car owners and advocates. This site includes compendiums of information on current electric car models and charging equipment, available at http://www.pluginamerica.org
- **Ready, Set, Charge California! - A Guide to EV Ready Communities** – provides detailed information on community EV readiness, available at http://www.baclimate.org/impact/evguidelines.html
- **U.S. DOE Clean Cities EV fleet handbook,** available at http://www.afdc.energy.gov/pdfs/pev_handbook.pdf
- **U.S. DOE Clean Cities EV and Alternative Fuel Vehicle (AFV) fleet case studies,** available at http://www.afdc.energy.gov/case/
- **American Public Works Association (APWA) fleet resources,** available at http://classic.apwa.net/ResourceCenter/index.asp?Section=equipment&SectionName=Equipment+%26+Fleet+Management
- **California Energy Commission (CEC) links to funding for EVs and EV infrastructure**, available at http://www.energy.ca.gov/drive/projects/electric.html
- **Methods for Estimating EV Deployment in the Region: Online Tool Tracks Electric Vehicle Purchases,** available at http://www.energycenter.org/projectstatistics. The California Center for Sustainable Energy (CCSE) released an online tool that shows details of **EV purchasing trends** based on rebates awarded by the statewide Clean Vehicle Rebate Project (CVRP). This is currently the most comprehensive single tool for estimating PEV deployment in the region, as it includes zip code level tracking. However, the tool does not take into account legacy EVs from the 1990's (such as the original Toyota RAV.) It also does not take into account the initial portion of 2012 model year Chevrolet Volts, which were not eligible for the state clean vehicle sticker. Subsequent Volts are included. It should be noted that as many as 25 percent of EV drivers may not take the state rebate. Therefore, CVRP data may undercount actual EV deployment.

APPENDIX O:
SAMPLE BROCHURE ON EV READINESS FOR DISTRIBUTION BY LOCAL GOVERNMENT GUIDE TO ELECTRIC VEHICLES AND CHARGING IN VENTURA COUNTY

Welcome to the EV Era!

The County of Ventura welcomes your interest in Electric Vehicles (EVs)! EVs are now available in a rapidly increasing variety of models – with a total cost of ownership that can be significantly lower than conventional cars.[23] The use of EVs in the Central Coast and beyond will:

- Reduce the amount of gas we burn
- Improve our air quality and public health
- Cut the emissions causing global warming
- Boost our local economy (by utilizing increasingly renewable local power to "fuel" our cars)

Reduce our overall transportation expenses. To further encourage the shift to EVs, charging stations are being installed at convenient locations throughout Ventura County. In addition, residents and businesses are encouraged to install their own EV chargers for both private and public use (see information on available rebates in the Resources section of this brochure). To help clarify the charger installation process, this Guide describes permitting requirements and installation options, and the help available from the County and our many local "EV ecosystem" partners.

EV Benefits

Increasing numbers of drivers are choosing EVs because they are fun to drive with plentiful torque, much quieter than gas-powered vehicles, emit at least 75 percent fewer greenhouse gases (even after taking into account electricity use), and are almost three times more energy efficient. The estimated cost of electricity needed to power an EV is equivalent to less than one dollar per gallon of gasoline! Depending on the type of vehicle you now drive and the type of EV you buy, you can expect fueling costs to decline from a current level of 8-20 cents per mile to 2-4 cents per mile for an EV in its all-electric operating mode. Also, "100 percent electric" Battery EVs (known as BEVs) have fewer moving parts than regular cars, and therefore reduced maintenance cost is expected.

EV Options – Battery Electric vs. Plug-in Hybrid

There are two basic EV options: **BEVs** – such as the Nissan Leaf - - operate entirely off of battery power and have zero tailpipe emissions. **Plug-in Hybrid Electric Vehicles** (PHEVs) –

23 See the resources at the end of this brochure for more information.

such as the Chevy Volt -- have both a shorter-range battery and an internal combustion engine that kicks in when the battery energy is low. BEVs are typically less costly than PHEVs. BEV driving ranges vary widely – for example, a Nissan Leaf is rated at approximately 75 miles, while the Tesla Model S has battery options ranging from 208 miles to 265 miles. PHEV "all-electric" driving ranges vary from approximately 12 miles (the Plug-in Prius) to approximately 38 miles (the Chevy Volt.) Once battery power is depleted, the PHEV gas engine takes over seamlessly, and allows unlimited driving with great hybrid gas mileage and normal refueling with the gas engine. According to GM, current Volt PHEV owners are operating about 70 percent+ of their total miles in all-electric mode. The increasing network of public charging stations allow PHEV drivers to drive in electric mode more often and allow BEV drivers to travel further each day.

EV Charging Technology

Approximately 90 percent of charging takes place at home, and there are three levels of EV charging:

Level 1: Level 1 chargers utilize 110 volts AC (15 amps) – and require ~ 10-20 hours to fully charge a BEV, depending on battery size. Most EV drivers utilize this slow trickle charging overnight. In fact, many EV drivers who travel less than 50 miles per day use this type of inexpensive charging exclusively at their homes, waking up every morning with a fully charged battery. All EVs come standard with a portable 110 volt charging device that can plug directly into a typical 110-volt receptacle, and this is the least expensive type of charging to provide.

Level 2: Level 2 chargers utilize 220/240 volts AC (30– 80 amps) – and require ~ 3-7 hours to fully recharge a BEV. Approximately 10-20 miles of additional driving range is provided per hour of charging. Residential Level 2 chargers are available for approximately $500 - $1200, with installation costs of $300 - $500 or more depending on distance to the electrical panel, conduit needs, and panel upgrades. Level 2 home chargers generally require "hard wiring" into a dedicated 240-volt circuit (check with your charger manufacturer, installer, and building inspector for specific information). Commercial Level 2 chargers cost between ~$2,000 to $4,000+ each depending on hardware design, vandal resistance, communications features, and available multi-port options for accommodating two or more vehicles.

DC Fast Charging: DC Fast Chargers enable rapid charging of an EV (from a nearly-empty battery) in 20 – 30 minutes. Fast Chargers require a charging connecter based on the "Chademo" or "Combo" standard. These are currently available on the Nissan Leaf, the Mitsubishi i-MiEV, Chevy Spark EV, BMW i3 and some forthcoming EVs. With Fast Chargers, vehicles can gain approximately 60 – 80 miles of additional driving range in just 20-30 minutes of charging. However, Fast Chargers are costly to buy and install (in the range of ~$35,000 – $60,000) and typically require significant electrical panel and service upgrades. Due to their cost and electrical requirements, Fast Chargers are typically deployed only for commercial locations or EV fleets.

Approximately 200+ Fast Chargers will likely be installed in the state by the end of 2014. As of late 2013, Ventura County has Fast Chargers in Thousand Oaks and Camarillo, with more planned. In the next several years a network should be available on the 101 corridor between San Francisco and Los Angeles. These will likely be more costly to use on a per-charge basis than Level 2 devices and will typically be used for "range extension" on longer trips, rather than for regular daily charging (which is done mainly overnight at home).

Tesla Motors also has an even faster charging network called "Superchargers" that enable up to 200 miles of range in half an hour. They only work with Tesla vehicles, are free to use, and sufficient Superchargers already exist to drive the West Coast from Mexico to Canada and should be available for cross country trips by the end of 2014. Tesla plans to quickly blanket the country by 2015, enabling a Tesla car to travel virtually anywhere due to their large (200-265 mile) range and strategically placed Superchargers.

All EVs are equipped with a standard connector – known as the J1772 connector -- that can work at either Level 1 (110 volts) or Level 2 charging rates. J1772 connectors (illustrated on left) have extensive safety features, including automatic power shut-off if the connector is unplugged.

Home Charger Installations

Most PHEV owners and many BEV drivers who travel less than 50 miles per day use inexpensive 110-volt charging. If you have a dedicated outlet available in a garage or driveway, you can plug in the charging device that comes with the car and be ready to charge (having an electrician verify the outlet is in good shape, or install a new one, is recommended). For those needing faster 240-volt charging, the residential home installation process typically starts at the EV dealership. Many auto companies and dealers offer "turn-key" installation services with a specified charging manufacturer and installer. For customers choosing the "turn-key" option, the installer will come to the home to assess charger location and utility service options, obtain necessary permits, oversee inspections, and notify utilities regarding possible service upgrades. For customers that want to choose a different charger than their dealership supports, or who wish to utilize their own installer, the following checklist may be helpful.

Customer contacts charger manufacturer or store to identify preferred equipment (see Resource list below). Charger companies may recommend specific installers.

1. **Electrician visits site** and determines if customer has adequate electrical capacity for new EV circuit and evaluates meter options and costs.
2. **Utility planner visits site (if needed)** to evaluate meter location.
3. **Customer approves estimate**, and signs contract.
4. **Customer or electrician orders charger** and any related electrical supplies.
5. **Electrician obtains permit** at the local authority having jurisdiction (usually your local city).
6. **Electrician performs work**, including meter install if needed, and contact s City for inspection.
7. **City inspects and approves installation** – or issues notice of correction. Electrician trains customer on use, and job is complete.
8. **City sends notice of final inspection** to utility.

Multi-Unit Dwelling Charger Installations (steps below also may apply to commercial building tenants)

For residents of apartments or condos, or for commercial office tenants, the process of EV charger installation will likely be handled by a property manager or owner and could also

involve a tenants' association (or HOA) approval process. Installation processes typically involve these steps:

1. **Tenant receives EV charger specification** from dealer and contacts building management.
2. **Building rep works with EV owner to determine siting**, use, and cost allocation for both charger installation and electricity.
3. **Tenant or homeowners' associations are** contacted where applicable.
4. **Building rep approves charger** installation.
5. **Building rep consults with charger manufacturer** to identified qualified installer.
6. **Contractor prepares estimate** and layout and contacts utility planner (usually needed).
7. **Utility planner reviews plan** and issues service recommendations if needed.
8. **Contractor updates plan** as necessary and obtains permit.
9. **Contractor orders charger and related equipment.**
10. **Utility provides new service** if needed.
11. **Contractor installs charger** and contacts City for inspection.
12. **Contractor or building rep contacts utility** to initiate service.

EV Charger Siting, Vehicle Rebates, & Electric Utility Resources

For tenants and owners of retail and office space, the installation of EV chargers in on-site lots or garages can provide benefits to employees, customers, and the general public. EV chargers attract customers and clients with EVs -- and they signal a strong company commitment to the environment. For homeowners or renters, EV charging overnight is the best option for convenience and cost. The following resources can be helpful in learning more about charger issues.

EV Charger Resources: Publicly accessible charger siting can be complex. Businesses and local government are encouraged to consult two important guides to EV charger siting in California:

- *Ready, Set, Charge California! Guide to EV Ready Communities*: A comprehensive guide to local EV preparedness and charging installations for home and workplaces, available at www.ReadySetCharge.org
- **California Plug-in Vehicle Resource Center,** available at http://www.driveclean.ca.gov/pev/Charging/Public_and_Workplace_Charging.php

Utility Resources: Both SCE and PG&E have robust information resources on all aspects of EV Charging.

- PG&E, available at www.pge.com/mybusiness/environment/pge/electricvehicles/index.shtml
- Southern California Edison, available at http://www.sce.com/residential/rates/electric-vehicles.htm
- Vehicle and Charger Rebates: EV charger and vehicle rebates may be available but are subject to constant change. Rebate information is available at

http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project/additional-incentives. A brief summary of siting and installation considerations is provided below as an introductory overview to the issue.

Commercial Charger Installation Checklist

1. Location: Select highest-utilization, highest-visibility locations 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. Consider providing safe and secure 110-volt outlets (especially for all-day parking) where Level 2 equipment is not practical.
3. Access: Consider and comply with ADA guidelines for disabled access and take precautions to ensure that charger cord management is optimized to reduce risk of accident or injury.
4. Security: Select secure locations with adequate lighting.
5. Signage: Provide enforcement and other signs that comply with the MUTCD and California Vehicle Codes.
6. Equipment Protection: Safeguard EV charging equipment via use of curbs, wheel stops, setbacks, bumper guards, and bollards, as appropriate, while accommodating ADA access and foot traffic.
7. Fleet Use: If your business is operating EVs, consider dual purpose charging sites that could also accommodate the general public, where feasible and appropriate.
8. Payment: Publicly accessible EV chargers can be ordered with credit card readers and other payment mechanisms (which typically require an annual charger licensing fee.) EV site owners can determine how much a charge session costs, and how to bill for parking in addition to charging. (Note that many EV chargers can bill separately for parking and charging.) Please note that current state law (AB 475) requires that cars occupying designated EV spaces be plugged in to the charger.

EV Information Resources

- Charger Permits through Ventura Building and Safety Division can be found at http://www.ventura.org/rma/build_safe/one_stop/index.html
- Vehicle Rebate information can be found on the California Center for Sustainable Energy website at www.energycenter.org.
- EV rates, service, and information can be found on the PG&E website at www.pge.com/mybusiness/environment/pge/electricvehicles/index.shtml
- EV Charger Installation Information can be found on the Ready, Set, Charge! website at www.readysetcharge.org.
- EV Business Guide information can be found on the Business Climate Coalition website at www.bc3sfbay.org/ev-guide-for-businesses.html
- EV Product Information can be found on the Plug-in American website at www.pluginamerica.org/vehicles

EV Charger Manufacturers

- AeroVironment is available at www.avinc.com

- ChargePoint is available at www.chargepoint.com
- Clipper Creek is available at www.clippercreek.com
- Schneider Electric is available at http://www.schneider-electric.com/products/us/en/50600-electric-vehicle-charging-stations/
- General Electric is available at www.geindustrial.com
- Leviton is available at http://www.leviton.com/OA_HTML/SectionDisplay.jsp?section=37818&minisite=10251

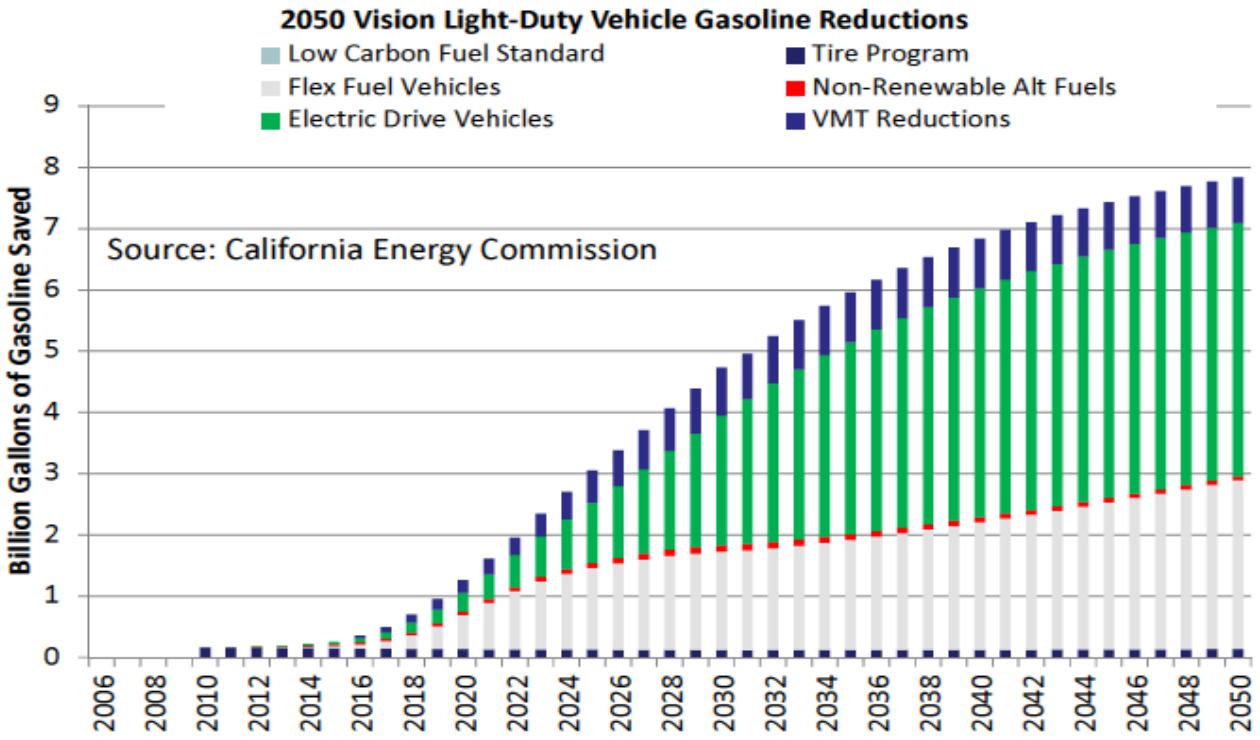
APPENDIX P:
GHG ANALYSIS OF POTENTIAL EV DEPLOYMENTS IN THE CENTRAL COAST

The assessment of likely GHG impacts of EV deployment in the coming years is a complex issue that will be influenced by several factors that are difficult to predict far in advance, including: 1) The price of EVs and batteries, and the attractiveness of forthcoming EV models; 2) the price of gasoline vs. electricity; 3) progress in reducing the GHG intensity of electricity on the California grid; 4) Future regulatory developments related to the ZEV mandate and the low-carbon fuel standard; 5) the state of the overall economy (which determines how much money consumers have to invest in new cars) and 6) population growth in the state and region. The following discussion addresses many of these factors, and the very wide range of estimates for California EV sales that have been developed by industry analysts and government agencies.

The Policy Context

California has developed very robust goals for GHG reduction under AB 32 and related laws, which require an 80 percent reduction in carbon below 1990 levels by 2050. This also requires an equivalent reduction in emissions from motor vehicles, which is nearly 50 percent of the total CO2 emissions in California's metro areas, including the Central Coast. The California Air Resources Board has a multi-dimensional strategy for achieving these goals, including mandated emissions reductions for internal combustion engine (ICE) vehicles, and – most importantly – a massive shift to electric drive vehicles, which is projected to result in 80 percent of vehicles sold being classified as electric drive (either electric or hydrogen fuel cell) by 2050. In their *2050 Alternative Fuels Vision,* CARB and the California Energy Commission developed the following strategic pathway to the requisite reductions – illustrating in Figure 20 that the preponderance of savings are projected to come from electric drive vehicles.

Figure 20: Light-Duty Vehicle Gasoline Saving Programs



Source: California Energy Commission, *2050 Alternative Fuels Vision*

It is noteworthy that reduction in vehicle miles travelled (VMT), while a desirable policy goal, is not anticipated to save much gasoline even after the full implementation of SB 375 "smart growth" and transportation demand management reforms. Further, while many fuel sources can deliver some GHG reduction over conventional gasoline, electricity has the unique virtue of drawing from multiple potential fuel sources, including renewable low-carbon hydro, geothermal, solar, and wind; as well as natural gas and nuclear (though the "lower-carbon" status of both natural gas and nuclear is the subject of ongoing debate.) Most importantly, as California's grid becomes greener through the implementation of the Renewable Portfolio Standard, which calls for a 33 percent renewable source of electricity by 2020, the GHG intensity of each kilowatt hour (kWh) of electricity will decline. Thus, EV's will become "greener" as California's grid grows greener. Further, Governor Brown's initiative to deploy 12,000 new megawatts of distributed smaller-scale solar energy by 2020 will be an ideal match for much of California's EV infrastructure, accelerating the transition to nearly carbon-free driving. Table 26, which was published by the CEC, indicates the environmental advantage of electric fueling.

Table 26: Full Fuel Cycle Comparison of Alternative Fuels to Standard Gasoline

Alternative Fuel	Full Fuel Cycle Analysis		
	GHG Reduction	Petroleum Reduction	Fossil Fuel Reduction
Biodiesel (B20)	**10-13%**	**15-17%**	**n/a**
Renewable Diesel (RD30)	**20%**	**29%**	**n/a**
Electricity			
Hybrid Electric	**25%**	**25%**	**25%**
Plug-in Hybrid	**48%**	**60%**	**46%**
Battery Electric	**72%**	**99.8%**	**65%**
Ethanol (E85)			
Midwest Corn	**15-28%**	**70-73%**	**27-45%**
California Corn	**36%**	**70-73%**	**27-45%**
Cellulose	**60-72%**	**73-75%**	**72-80%**
Hydrogen			
Electrolysis	**26%**	**99.7%**	**13%**
Natural Gas	**54%**	**99.7%**	**41%**
Natural Gas			
CNG – light-duty vehicle	**20-30%**	**>99%**	**4-13%**
CNG – heavy-duty	**11-23%**	**>99%**	**2-8%**

Source: Full Fuel Cycle Assessment: *Well-to-Wheels Energy Inputs, Emissions, and Water Impacts,* TIAX LLC. Prepared for the California Energy Commission, June 2007 Energy Commission-600-2007-004-F

As summarized above, BEV emissions are estimated by CARB to be nearly 75 percent lower than the average conventional gasoline-powered vehicle, and 55 percent lower than the average conventional hybrid vehicle. Plug-in Hybrid Electric Vehicle (PHEV) emissions (in the case of PHEVs with a 20 mile all-electric range) reduce GHGs by 60 percent compared to a conventional vehicle, and 30 percent compared to a standard hybrid.[24] (Typically, a longer all-electric driving range—such as the 40 mile all-electric range of the Chevy Volt -- is associated with greater GHG reductions – with Chevy Volt customers reporting that 70 percent of their miles are "all electric.") It is especially noteworthy that the EV emissions advantage will increase over time. By 2020, California's grid is expected to have 40 percent lower emissions than the grid in 2008, due in large part to an increase in near-zero carbon renewable

24 Taking Charge: Establishing California Leadership in the Plug-in Electric Vehicle Marketplace; The California Plug-in Electric Vehicle Collaborative, December 2010, p. 17.

generation from 11 percent to 31 percent. This will reduce grid carbon emissions from 447 grams/CO2 per kWh to 261 grams/C02 per kWh by 2020.[25]

Discussion of Assumptions for GHG Reduction Analysis

To compute the GHG savings of new Electric Vehicle deployments, for the BEV class of vehicles, it is assumed that vehicles are driven at a monthly rate of 1,000 miles. For comparative purposes, it is assumed that the average consumption of gasoline powered vehicles is 27.5 MPG and that the CO2 emissions from one gallon of gasoline is 19.4 lbs. (In fact, actual mileage for California drivers will vary based on economic factors and the overall aging of the fleet over the coming years. The 27.5 MPG number is significantly above current fleet fuel economy standards and reflects the enhanced mileage expected by 2020. Therefore, this average number is very conservative relative to the comparative advantage of PEVs.) For PHEV, we assume an average of 80 MPG equivalent based on 70 percent all-electric miles. This number is also difficult to predict going forward, because manufacturer battery sizes on PHEVs will likely fluctuate based on future battery pricing and the availability of public charging. However, it is notable that both BMW and Mitsubishi PHEVs are planned to provide nearly 40 miles of battery range, similar to the Chevy Volt, vs. the much smaller range of the recently introduced Prius Plug-in (which has only 12 miles of all-electric range.)

The breakout of PHEV and BEV sales is also difficult to predict going forward. As of late 2013, recent California Vehicle Rebate Program data showed Southern California PEV sales trending somewhat toward PHEV dominance, while Bay Area PEV sales showed continuing strength in the BEV category, reflecting shorter driving distances for some residents. According to data cited by the California PEV Collaborative, there is projected to be a balance of 2-1 in favor of PHEVs over BEVs by 2020. According to data from the California Vehicle Rebate Program, as of 2013, BEVs are somewhat more numerous in denser urban areas, while PHEVs are more numerous where commute distances are longer. It is anticipated that 70 percent of PHEV miles will be all-electric miles, assuming that improved charging infrastructure will counterbalance the smaller capacity PHEV batteries.

To summarize the comparative advantage of BEV vs. PHEV, here are the calculated savings of GHG per vehicle per month are:

BEV GHG & Fuel Savings = 1000 miles per month / 27.5 MPG = 36.36 gallons saved x 19.4 lbs. CO2 per gallon = 705.45 lbs. of CO2 per month per vehicle.

PHEV GHG & Fuel Savings = (1000 miles / 27.5 MPG) – (1,000 miles / 80 MPG) = 23.9 gallon saved per month x 19.4 pounds of CO2 = 463.66 lbs. of CO2 per month per vehicle.

Additional assumptions pertaining to VMT trends and aggregate GHG impacts of PEVs vs. improved ICE emissions trends are explained further below.

California PEV Sales Projections

Projecting adoption rates between now and 2020 is an inexact science at best, as illustrated in the ICF Consulting and California PEV Collaborative charts below that demonstrate the range of expert views, and the potential elasticity of demand under different economic and policy

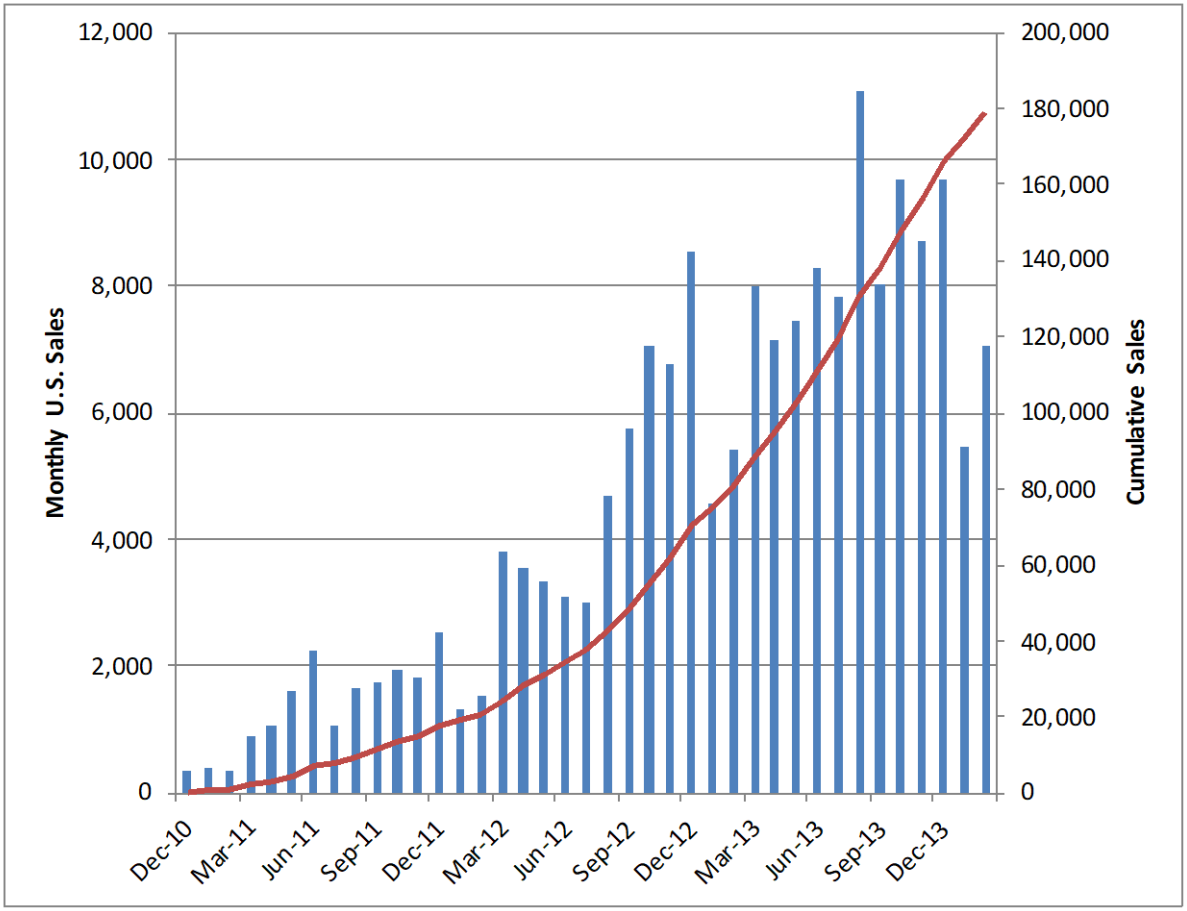
25 Ibid, p. 17.

scenarios analyzed by EPRI, the CEC, the Electrification Coalition, and ICF itself. Taking into account the full range of forecasts identified above, ICF judged the "high-side" forecast for California to be 500,000/year by 2020, or 38.5 percent of new car sales, with the "low-side" being just a fifth of that total, at 8.8 percent. On the high side, the *cumulative* electric vehicle population would reach 10.2 percent by 2020. For purposes of comparison, total California sales in the pre-recession peak years of 2007-08 were in the range of 1.6 million units, while 2009-10 sales were in the range of 1.1M to 1.3M units. Thus, even new car sales units as a whole can vary as much as 40 percent year over year. Further, there is an ongoing trend toward consumers keeping cars longer, reflecting better build quality. Thus, an ongoing economic downturn could permanently shift the replacement rate and promote greater retention of dirtier vehicles.

As ICF explains in its study, the low forecast assumes that EVs will continue to command a significant initial price premium, and that governments will limit subsidies. The mid-level scenario assumes ongoing higher incentives on vehicles and charging. The high penetration scenario assumes significant consumer interest, rapid cost reductions, significant government subsidies continuing to 2020 and beyond, and a major increase in gasoline prices, and/or new regulatory requirements.

Given these variables, rather than picking a single estimate for future EV penetration, California's *PEV Collaborative* – the most important network of public and private sector EV stakeholders in the state – has simply publicized the broad range of scenarios that have been issued by different research organization, leaving it to stakeholders to make estimates for their own purposes. These estimates range from the most pessimistic forecast of 2 percent of total vehicle sales in 2020 (Goldman Sachs) to the most optimistic forecast of 14 percent of total sales (International Energy Agency). For reference, it took conventional hybrid vehicles almost 10 years to reach 5 percent sales penetration. A conservative assumption is that PEV sales will at least follow the trend established by conventional hybrid vehicles. The first three years of PEV national sales are graphed in Figure 21, and cumulative sales are approximately 180,000 PEVs. California PEVs sales are about one-third the national total, or a cumulative 60,000 vehicles.

Figure 21: Plug-in Electric Vehicle Sales



Source: Plug-in Electric Vehicle Collaborative Presentation, March 2014

Regional EV projections should also take into account the potential influence of Senate Bill 375, which requires California's metro areas to develop integrated regional transportation plans (RTPs), in combination with regional land use plans that will set and achieve regional GHG targets. Some regions, such as the San Francisco Bay Area, have determined that per capita GHG reduction targets can only be met by combining GHG reduction measures – such as improved transit and reduced VMT from land use changes – with accelerated development of the PEV ecosystem. Accordingly, additional resources for Electric Vehicle incentives and charging infrastructure are being programmed into long-range transportation plans. SB 375 requires the California Air Resources Board (CARB) to approve the targets set by each region, and these regional targets are shown in Table 27. SB 375 also requires that California's 18 Metropolitan Planning Organizations (MPOs) create "Sustainable Community Strategies" (SCS) that integrate land use and transportation planning -- and demonstrate an ability to actually achieve proposed reduction targets for the years 2020 and 2035. In February 2011, CARB certified the *per capita* GHG reduction targets indicated for each region.

Table 27: Regional Greenhouse Gas Emission Reduction Targets

SB 375 Regional GHG Reduction Targets (approved by CARB, February 2011)		
Regional Planning Areas for Sustainable Communities Strategies	**2020 Target***	**2030 Target***
South Coast (SACOG)	-8	-13
Bay Area (MTC)	-7	-13
San Diego Region (SANDAG)	-7	-13
Sacramento Area (SACOG)	-7	-16
San Joaquin Valley (six MPOs)	-5	-10
Tahoe	-7	-5
Shasta	0	0
Butte	+1	+1
San Luis Obispo	-8	-8
Santa Barbara	0	0
Monterey Bay	0	-5

Source: CARB - *Targets are expressed as percent change in *per capita* greenhouse emissions relative to 2005.

Determining the potential EV contribution to these targets in California is really an exercise in goal setting rather than historical trendline analysis, since there is no meaningful history of large numbers of EVs being available to California drivers over a long period of time, and the myriad of macro-economic factors (especially gas prices and personal income, unemployment, and interest rates) are extremely difficult to predict in advance. Therefore, PCC has set an aspirational goal that 5-10 percent of vehicles sold in 2020 would be PEVs, and to reduce the region's GHGs by accelerating the shift to PEVs.

Accordingly, for the purposes of the initial planning phase of the PCC PEV readiness project, planners utilized a "high case" PEV penetration estimate (drawn from the PEV Collaborative Strategic Plan referenced above) to illustrate potential impact of PEV deployment in the region over the 2012 - 2020 period. In the chart below, Greenhouse gas emissions (GHG) are calculated in grams of carbon dioxide equivalent (gCO_2E) per vehicle mile traveled (VMT). This is accomplished by factoring in expected decreases in regular vehicle (ICE) emissions intensity per projected impact of California's Low Carbon Fuel Standards, Pavely 1 regulations, and EPA standards. The calculation is performed as follows: (Basic Emissions per Mile) - (projected emissions reductions) = **Vehicle Emissions per Mile.** Total Emissions per Mile are calculated for three vehicle types:

- A standard light duty passenger vehicle with and internal combustion engine (ICE)
- A plug-in hybrid electric (PHEV) based on the 2011 Chevy Volt
- A battery-electric vehicle (BEV) based on the 2011 Nissan LEAF.

Total vehicle miles traveled (VMT) for the three-county region were calculated by taking the average, annual, VMT for the country from 1999 to 2009: (Total VMT for years between 1999 and 2009) / 10 = **Average Annual VMT for Region**. Regional Emissions are calculated by

taking the Vehicle Emissions per mile for each of the three vehicle types and multiplying it by the percentage of the total VMT by that vehicle type in the region. For example:

(Vehicle Emissions per Mile for ICE) x (% total VMT by ICE) = **Regional Emissions from ICE**

(Vehicle Emissions per Mile for PHEV) x (% total VMT by PHEV) = **Regional Emissions from PHEV** (Vehicle Emissions per Mile for BEV) x (% total VMT by BEV) = **Regional Emissions from BEV.** Total regional emissions are calculated by adding up the Regional Emissions for each vehicle type: (Regional Emissions for ICE) + (Regional Emissions for PHEV) + (Regional Emissions for BEV) = **Total Regional Emissions.** For reference purposes "LOW" EV adoption scenario for the year 2020, 96 percent of the total VMT would still be traveled by ICE vehicles while 2 percent are traveled by PHEVs and 2 percent are traveled by BEVs. In a "High" EV adoption scenario for the year 2020, 86 percent of the total VMT would still be traveled by ICE vehicles while 10 percent are traveled by PHEVs and 4 percent are traveled by BEVs. The results of this analysis are summarized in Table 28.

Table 28: Analysis of GHG Reductions from PEV Integration

Yr.	Projected Total VMT for Region (kg/CO2)	ICE Only		"High" EV integration (kilograms/CO2)				
		Kilograms per VMT	Total GHG Emissions "ICE only Scenario"	Total ICE	Total PHEV (Volt)	Total BEV (LEAF)	Total GHG Emissions	GHG Decrease from "ICE only Scenario"
2011	7,271,538,123	0.3	2,181,461,437	2,181,461,437	0	0	2,181,461,437	0
2012	7,351,525,043	0.293	2,152,434,638	2,123,140,003	4,160,562	4,737,701	2,132,038,266	20,396,373
2013	7,432,391,818	0.282	2,093,779,099	2,036,786,432	8,327,679	9,482,867	2,054,596,979	39,182,121
2014	7,514,148,128	0.270	2,027,242,024	1,944,469,732	12,500,059	14,234,026	1,971,203,816	56,038,207
2015	7,596,803,758	0.254	1,928,030,810	1,823,068,812	16,589,511	18,989,658	1,858,647,981	69,382,828
2016	7,680,368,599	0.238	1,828,887,773	1,704,431,960	20,635,702	23,748,199	1,748,815,860	80,071,912
2017	7,764,852,654	0.234	1,815,034,308	1,666,818,606	24,502,569	28,508,038	1,719,829,213	95,205,095
2018	7,850,266,033	0.229	1,800,654,771	1,629,106,391	28,272,502	33,267,515	1,690,646,409	110,008,362
2019	7,936,618,959	0.225	1,785,739,266	1,591,307,975	31,940,927	38,024,923	1,661,273,825	124,465,441
2020	8,023,921,768	0.219	1,760,247,838	1,544,635,080	35,296,743	42,778,504	1,622,710,327	137,537,511
2021	8,112,184,907	0.219	1,774,540,448	1,533,025,493	39,418,137	47,526,447	1,619,970,078	154,570,371
2022	8,201,418,941	0.218	1,788,934,507	1,521,113,122	43,579,046	52,266,894	1,616,959,061	171,975,446
2023	8,291,634,549	0.218	1,803,430,515	1,508,894,243	47,779,325	56,997,929	1,613,671,496	189,759,018
2024	8,382,842,529	0.217	1,818,028,974	1,496,365,107	52,018,816	61,717,584	1,610,101,507	207,927,467
2025	8,475,053,797	0.216	1,832,730,384	1,483,521,936	56,297,345	66,423,836	1,606,243,118	226,487,266
2026	8,568,279,389	0.216	1,847,535,243	1,470,360,923	60,614,727	71,114,606	1,602,090,256	245,444,988
2027	8,662,530,462	0.215	1,862,444,049	1,456,878,233	64,970,758	75,787,755	1,597,636,747	264,807,303
2028	8,757,818,297	0.214	1,877,457,298	1,443,070,003	69,365,223	80,441,090	1,592,876,315	284,580,982
2029	8,854,154,299	0.214	1,892,575,481	1,428,932,340	73,797,888	85,072,353	1,587,802,581	304,772,900
2030	8,951,549,996	0.213	1,907,799,093	1,414,461,325	78,268,507	89,679,228	1,582,409,060	325,390,032

Source: CARB

SB 375 Integration with Sustainable Communities Strategies

The Sustainable Communities and Climate Protection Act of 2008 requires regional planning agencies and local governments to develop strategies to reduce GHG emissions from passenger vehicles – primarily by reducing per capita vehicle miles travelled (VMT). SB 375 policies are driven by the 18 designated Metropolitan Planning Organizations in the state. In the Central Coast, each of the three PCC Counties participates in a different MPO and Council of Governments context. The County of San Luis Obispo and affiliated municipalities and public agencies are working through the San Luis Obispo Council of Governments (SLOCOG). In Santa Barbara, the County and other stakeholders are working through the Santa Barbara County Association of Governments (SBCAG), with the Community Environmental Council (a

PCC Steering Committee member) as a liaison from the broader sustainable transportation community. Ventura County is participating in the large-scale Southern California Association of Governments (SCAG) SB 375 effort, which includes six counties representing 18 million residents. In all three counties, local stakeholders have been working since 2011 to integrate the existing Regional Transportation Plan (RTP) process with the Regional Housing Needs Allocation (RHNA) process into a new Sustainable Communities Strategy, which is the core strategy embedded in SB 375. Each of the regional plans are focused on land use and transportation planning measures as key enablers of VMT reduction. However, each of the Air Pollution Control Districts participating in PCC have committed to pro-actively bring the policy recommendations in the Central Coast PEV Readiness Plan to the attention of other partners in the Sustainable Communities Strategy development process upon completion of the final plan. By these means, PCC leaders will help educator the other stakeholders in the SB 375 process in the importance of incorporating PEV-friendly policies and strategies where feasible and appropriate into regional and sub-regional transportation plans to accelerate achievement of targeted GHG reductions.

APPENDIX Q:
ATTRACTION OF PEV MANUFACTURING, INFRASTRUCTURE, AND SERVICES TO THE REGION

The Central Coast lies in a strategic location in California for EV infrastructure deployment, though its manufacturing base is relatively limited compared to the Los Angeles and San Francisco Bay Areas. The strengths of the region include its geographic proximity to greater Los Angeles (on the south end of the region) and its status as a key transportation bridge between north and south. Ventura County has immediate access to the LA/South Coast metroplex, and a strong base of high-tech employment. An additional strength lies in the workforce and high-tech arena, with Santa Barbara and San Luis Obispo Counties both hosting flagship public universities (UC Santa Barbara and Cal Poly.) These universities have strong research and industry engagement across many clean energy and clean tech domains, although they lack EV specific programs.

AeroVironment, one of the largest EV charging station manufacturers has an office in Simi Valley, and Liberty Plug-ins, which makes access control systems for EV charging is located in Santa Barbara. Given the likely growth in demand for PEVs in the area – as well as economic, institutional, and workforce strengths of the region -- there is an opportunity to attract steadily increasing EV related infrastructure to the region, particularly if local institutions can collaborate to win important grants that could boost regional momentum now building for the EV transition. To this end, the PCC Steering Committee is closely tracking funding opportunities from state and federal sources, and will encourage regional agencies, municipalities, and business stakeholder to cooperate on crafting competitive proposals to gain funding for the charging infrastructure envisioned in this Plan.

In addition, the PCC Steering Committee is helping introduce EV solutions directly to local businesses with a potential interest in EV charging with vendors that can assist them. Specifically, the PCC is promoting "site walks" at some of the largest businesses in the region to ensure that these companies are introduced to charging infrastructure development options, including emerging "no money down" options that incorporate innovative financing models. For example, the PCC has arranged for local employers to meet with Powertree Systems, a provider of charging networks that include integrated solar PV and battery energy storage, provided under a PPA-type arrangement that pays employers for use of the parking spaces and provides a revenue share for the EV, solar, and battery storage revenue streams. Unlike many other business models, the host site does not have to invest any capital to gain the benefit of onsite EV charging and renewable energy. This model could enable much larger infrastructure deployment in the Central Coast than others that require significant up-front investment. Likewise, PCC is coordinating closely with NRG on the stub-out program as well as the DC Fast Charge deployment (qualified for Ventura County only).

By pro-actively partnering with reputable vendors and entrepreneurs with innovative business models, PCC hopes to build on the momentum of our early EV adopters and develop a reputation as one of the "go-to regions" in the state for deployment of state-of-the-art EV

charging and related EV infrastructure.

APPENDIX R:
INTRODUCTION TO THE CHARGING SITE MAPS

Strategic Approach to the Plug-in Central Coast EVSE Siting Plan

Charging infrastructure siting is essential to successful PEV deployment. To address siting requirements, the Ventura County Air Pollution Control District – a founding member of the PCC Steering Committee – has developed a siting plan for the region. The siting plan is built on the understanding that the preponderance of PEV charging occurs at home. However, public charging is an essential adjunct to residential charging as a spur to PEV adoption. Therefore, the PCC siting plan has developed a response to these key questions:

- Location: What are optimal locations for public EVSE in the region? Options include workplaces, multi-unit residential developments, and recreational and commercial destinations, and key travel corridors, on either public or private property.
- Quantity: How many EVSE are needed to support PEV drivers?
- Level of charging: What charging rates area appropriate for various kinds of charging sites: Level 1, Level 2, or DC fast charging?

There is no single right answer to these questions, as the requirements for EVSE infrastructure will shift over time in response to changes in battery range and cost, charging technology, and PEV and EVSE deployment trends. Therefore, the siting plan provides an overview of the different PEV market segments and recommends criteria and locations for consideration by public agencies and private entities when siting future PEV charging infrastructure in the Central Coast.

The goal of this siting plan is to help guide and coordinate future PEV charging infrastructure-siting efforts based on projected demand. To that end, this siting analysis combines various parameters such as PEV usage, EVSE usage, land use, and regional travel patterns to identify the most appropriate areas to:

- Extend the range of PEVs for intra- and inter-regional travel along various corridors;
- Maximize all-electric miles by providing ample opportunities for charging while minimizing the risk of stranded PEVs; and
- Provide charging opportunities for PEV owners who lack access to home charging.

Siting Criteria

The PCC siting plan is designed to identify optimal places to deploy EVSE for the consideration of various stakeholders. This exercise is not intended to mandate specific locations for deployment, which is outside the authority of PCC -- but rather to guide infrastructure siting more broadly at the sub-regional level. As noted above, the siting plan focuses on workplace charging and publicly accessible charging (also referred to as opportunity charging) and includes locations proximate MDUs. The number of EVSE needed to support PEV deployment will change based on parameters such as the PHEV/BEV balance, all-electric range, and charging cost factors. EV Service Providers (EVSPs) are still developing their business models, and the price that consumers are willing to pay for vehicle charging is not yet fully determined.

These factors will also be important in determining how rapidly EVSE are deployed in the region.

Workplace charging deployment is especially important as a means to increase electric miles driven for PHEVs and to extend the commute range and usability of BEVs. Opportunity charging is distinguished from residential and workplace charging and covers a wide range of situations where a PEV driver may need to charge when away from home and work. Within this category are retail parking lots, on-street parking, transit center parking, cultural and recreational centers, etc.

This Plan provides some general guidance with respect to whether chargers should be Level 1, Level 2, or a mix of these – for anyone who is considering installing EVSE. Table 29 below (developed by ICF International) shows that the preference for one type of charging over another will be mainly biased by the duration of time that the PEV driver may be parked at that specific location:

Table 29: Preferred Charging Methods at Various Locations

Category	Typical Venues	Available Charging	Charging Method (Primary/Secondary
Opportunity and Destination	Shopping Centers	0.5 – 2 hours	Level 2/DC Fast Level 2/DC Fast Level 2/DC
	Airport (short term parking)	< 1 hour	
	Street/Meters	1– 2 hours	Fast Level 1/Level 2
	Cultural and Sports Centers	1– 5 hours	Level 2/Level 1
	Parking Garages	2 – 10 hours	Level 2/Level 1
	Hotels/Recreation Sites	8 – 72 hours	Level 2/Level 1
Corridor/ Pathway	Interstate Highways	< 0.5 hours	DC Fast/Level 2
	Commuting/Recreation Roads	< 0.5 hours	DC Fast/Level 2
Emergency	Fixed Mobile	< 0.1 hours	DC Fast
		< 1 hour	Level 2/DC Fast

Source: Plug-in Central Coast

DC Fast Charging

Fast charging is particularly well-suited to serve inter- and intra-regional travel corridors, as an alternative for PEV owners who do not have access to charging at home, and for emergency charging situations. In the short term, Fast Charging is not yet standard on all PEVs, and is an extra cost option on many models. DC fast charging – via the established Japanese Chademo standard or the emerging SAE Combo standard -- is the most readily available technology at this time. The California Energy Commission is requiring that many new state funded DC Fast Chargers have dual compatibility to serve both SAE Combo and Chademo vehicles, which should reduce chances for obsolete or under-utilized hardware. However, AC fast charging (up to 22 KWh charge rates – which is approximate half the speed of current Fast Chargers) and even battery switch (newly proposed by Tesla) may also emerge as significant technologies in

the future. Finally, it is important to note that as Fast Charging is deployed more densely in the region, and more PEV models are equipped for Fast Charging, there may be a reduced demand on the Level 1 and Level 2 opportunity- charging network.

Existing and Proposed Charging Infrastructure on the Central Coast

The principal goal of the PCC PEV Readiness Plan is to encourage and facilitate mass adoption of PEVs in the tri-county Central Coast region. The installation of PEV charging infrastructure near major highways in the tri-counties is a critical factor to support this goal. The development of this plan has coincided with the construction of almost 200 Level 2 charging stations and several DC Fast Charge stations along the Central Coast. This initial infrastructure has not only provided range-extending electrical miles for PEVs, but it also serves to showcase the technology and raise public awareness. Maps of existing PEV charging sites provide the baseline case. The process of installing these stations has also provided crucial information on the steps needed for the future construction of new charging locations. This appendix contains four sets of maps of the tri-county region including:

1. Existing or Near Complete PEV Charging Sites
2. Potential Workplace Charging Sites
3. Potential Charging Sites at Park N Ride Lots
4. Potential and Existing Commercial Center Locations

Theory of Constraints Applied to Future PEV Charging Installation Planning

One of the principal lessons learned from the initial build-out of PEV charging stations in the Central Coast and other areas across the country is the existence of several constraints that limit the construction of new PEV charging stations. Motivated site hosts were crucial to the development of existing installations. However, many other desirable sites were canvassed in the process of placing these first 200 stations, and most of the sites that did not move forward were due to site owner reluctance – due to the lack of necessary resources, lack of available staff to work on the project, or absence of demand from customers or stakeholders to push forward and assume the responsibility for constructing (and in most cases) operating and maintaining an EV charging station.

The theory of constraints according to E.M. Goldratt states, "The throughput of any system is determined by one constraint (bottleneck)."[26] This mapping portion of the PEV Readiness Plan was created with this theory in mind. Rather than deplete limited grant resources on computer modeling, the mapping work below integrates local knowledge of population centers, major traffic arteries, and large employers that has been gained in more than two years of intensive siting efforts by PCC and its member agencies. This has enabled PCC to focus planning resources on identification and outreach to those locations that are most likely to: a) serve the maximum number of PEV drivers; and, b) be most welcome by prospective site hosts, taking into account local knowledge of previous siting efforts.

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26 Eliyahu Goldratt and Jeff Cox. The Goal: A Process of Ongoing Improvement, (Great Barrington, MA, North River Press, 1984).

PEV Charging Installation Mapping Priorities for the Central Coast

The first set of maps on existing installations provides a snapshot of current infrastructure and illustrates where future infrastructure bottlenecks may occur. Many existing sites were developed under the California Energy Commission's *Reconnect California* grant program, which upgraded legacy PEV charging stations constructed over a decade ago, at very little cost to the site owner.

The second set of maps focuses on potential workplace PEV charging stations, where employers may install PEV charging stations for employees and authorized visitors to use. These EVSE sites may provide the largest impact on PEV adoption and the most significant increase in electric miles travelled (EMT), both for battery EVs and plug-in hybrids. This set of workplace charging maps identifies the largest employers on the Central Coast, which typically have the greatest resources for potential infrastructure investment, and the largest number of current and prospective PEV drivers. Initial surveys indicate that technology companies with more white-collar employees are more likely to install workplace charging.

The third set of maps identifies Park and Ride lots that may be potential sites for EV charging stations adjacent to major highway corridors. Some of these may be ideal locations for DC Fast Charge stations, particularly in cases where they are proximate to amenities such as coffee shops. As many of these sites are government owned and maintained, they are appropriate candidates for public investment, and the process of obtaining approvals can be simpler. Many previous efforts at Fast Charge development at commercial centers have been stymied by site owner reluctance to surrender parking spaces in long-duration agreements, in return for either no revenue or very limited revenue sharing.

Large retail shopping centers on the Central Coast are plotted in the fourth set of maps to highlight opportunities for additional Level 2 or (potentially) Fast Charge locations. Many of the region's retail shopping centers want to attract EV drivers as customers and present a "green" image. While larger shopping centers are shown in the maps, some neighborhood retail centers may also be ideal candidates for infrastructure placement as the most desirable locations are built out.