California Energy Commission
Clean Transportation Program

FINAL PROJECT REPORT

Monterey Bay Plug-in Electric Vehicle Readiness Plan

Plug-in Electric Vehicle Readiness Plan for Monterey, Santa Cruz and San Benito County

Prepared for: California Energy Commission

Prepared by: Monterey Bay Unified Air Pollution Control District

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As an integral segment of an electric vehicle corridor that will inevitably connect the Los Angeles area with the San Francisco Bay Area, the Monterey Bay Region has seen significant progress in establishing plug-in electric vehicle readiness. The Monterey Bay Unified Air Pollution Control District would like to acknowledge the work and efforts of private and public organizations as well as the individuals that have contributed to the adoption of Electric Vehicles and the growth of Electric Vehicle infrastructure in the Monterey Bay Region. First and foremost, the District would like to acknowledge the Monterey Bay Electric Vehicle Alliance for its continuing effort to promote Electric Vehicle ownership and for hosting outreach and ride and drive activities throughout the Monterey Bay area. Operating for over five years, Monterey Bay Electric Vehicle Alliance as consortium of public, private and commercial representatives has been at the forefront of Electric Vehicle adoption and Electric Vehicle charge station installation in the region. This acknowledgement goes out to all of the Monterey Bay Electric Vehicle Alliance members who contributed their time and inputs to the Monterey Bay Plug-in Electric Vehicle Readiness Plan as well as all the volunteers who offered their time and Electric Vehicles in hosting outreach and ride and drive events.

The District would also like to acknowledge the work of the Monterey Bay Plug-in Electric Vehicle Coordination Council in facilitating and coordinating the activities that were integral to the development and creation of the Plug-in Electric Vehicle Readiness Plan.

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Finally, the District would like to acknowledge the work of Richard Schorske in creating the Plug-in Electric Vehicle Readiness Plan.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation 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 Regional 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 7, 2011 and the agreement was executed as ARV-11-003 on July 27, 2012.

ABSTRACT

Authorized by Assembly Bill 118 and subsequent amendment under Assembly Bill 109, the California Energy Commission manages the Alternative Fuel and Vehicle Technology Program with an annual budget of about $100 million. Under the PON-10-602 solicitation, the California Energy Commission awarded a grant (ARV-11-003) to the Bay Area Air Quality Management District to develop a regional plan to support plug-in electric vehicle readiness. The scope of the readiness plan included the Monterey Bay area. In executing the grant contract with the California Energy Commission, funding was available for the Bay Area Air Quality Management District to execute a contract agreement with the Monterey Bay Unified Air Pollution Control District to develop the Monterey Bay component of the readiness plan. The contract agreement term between Bay Area Air Quality Management District and Monterey Bay Unified Air Pollution Control District was from July 27, 2012, to May 15, 2014.

The project final report discusses the project objectives, specific tasks performed by sub-contractors, conclusions and recommendations on the further development and sustainability of the project.

Keywords: California Energy Commission, Alternative Fuel and Vehicle Technology Program, Bay Area Air Quality Management District, plug-in electric vehicle readiness, Monterey Bay Unified Air Pollution Control District

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EXECUTIVE SUMMARY

The Monterey Bay Plug-in Electric Vehicle Readiness Plan has been developed by the Monterey Bay Plug-in Electric Vehicle Coordinating Council, representing the communities of Monterey, Santa Cruz, and San Benito Counties. The Council's mission is to promote rapid adoption of Plug-in Electric Vehicles in the region, and thereby to advance the environmental and economic well-being of our communities and reduce the harmful impact of global warming. The Council's membership includes senior leaders from counties, cities, public agencies, community organizations, private industry, and utilities. Together with the Monterey Bay Electric Vehicle Alliance, Council partners work collaboratively to develop Plug-in Electric Vehicle charging infrastructure and Plug-in Electric Vehicle-friendly policies throughout the diverse communities of the Monterey Bay. The over-arching goals of the Monterey Bay Plug-in Electric Vehicle Plan are:

- To promote mass adoption of Plug-in Electric Vehicles via individual and fleet deployment, including rental, car share, corporate, and government fleets
- To develop a public charging network enabling all-electric travel throughout the region
- To streamline Electric Vehicle charger installation and promote rapid charge station deployment
- To provide consumer and leadership education and outreach on the benefits of Plug-in Electric Vehicles
- To reduce greenhouse gas emissions and criteria pollutants from light-duty vehicles.

The rate of adoption of Plug-in Electric Vehicles is a function of many factors – including the pricing and performance of vehicles on the market, and government purchase incentives – and these are outside the control of regional stakeholders. However, there are two key factors in helping drive Plug-in Electric Vehicle deployment that can be influenced at the regional level. These include: (1) the development of a robust public charging infrastructure; and (2) public outreach on the benefits of Plug-in Electric Vehicles. Accordingly, much of the Plug-in Electric Vehicle Readiness Plan is devoted to policy guidance and recommendations on accelerating the deployment of Plug-in Electric Vehicle charging stations in residential, commercial, workplace, and destination sites, and creating Plug-in Electric Vehicle-friendly policies.

One of the most important of these recommendations is the development of updated building codes that require "pre-wiring" for Electric Vehicle chargers in new construction. This one policy change alone can save future residential and commercial building owners thousands of dollars in Electric Vehicle charger installation cost saving. In addition, a variety of educational resources are provided to educate the public and fleet managers on the many benefits of shifting to electric drive vehicles. In summary, the Plug-in Electric Vehicle plan includes the following twelve key recommendations to help local governments and other agencies become more Plug-in Electric Vehicle-ready, and to simplify the process of Electric Vehicle charger installation.

R-1. Develop a charger permit form identifying all required elements

R-2. Provide installation process guidance and checklists (templates for both permit forms and installation guidance are provided in the Appendices of the Plug-in Electric Vehicle Readiness Plan)

R-3. Establish reasonable – and flat – charger permit fees

R-4. Establish phone & online permit and inspection appointment systems for new charger installations as feasible

R-5. Participate in training on Electric Vehicle charging technologies and installation

R-6. Provide utility notification of Electric Vehicle charger installations

R-7. Outreach to property managers and Homeowners Associations to offer charging information and solutions related to the challenges of Electric Vehicles in multi-unit developments.

R-8. Adopt building code amendments to mandate pre-wiring for Electric Vehicle Supply Equipment in new and remodeled multi-unit buildings.

R-11. Promote building code amendments that mandate Electric Vehicle-ready parking facilities and public works in new construction or major renovations

R-12. Integrate Plug-in Electric Vehicles into local fleets

In support of local government and industry efforts, the Readiness Plan also recommends that the Monterey Bay Plug-in Electric Vehicle Coordinating Council and its partner organization – the Monterey Bay Electric Vehicle Alliance – work with a broad array of stakeholders to ensure that the expansion of the regional charging network and the development of Plug-in Electric Vehicle-friendly policies remains a high priority for the region. Additional recommendations include:

R-9. Pro-actively meet with charging providers to ensure Monterey Bay charging sites are prioritized

R-10. Engage key stakeholders to provide ongoing oversight of the regional Plug-in Electric Vehicle readiness plan

There are many resources available to the region in support of both public charging infrastructure deployment and public education on Electric Vehicle adoption. The Plug-in Electric Vehicle Coordinating Council and the Monterey Bay Electric Vehicle Alliance have been successful in reaching out to funding agencies, vendors, and local site hosts to encourage development of high-priority charging sites – and they will continue to do so. The Association of Monterey Bay Area Governments has also contributed a crucial companion volume to this Readiness Plan, which provides a high-level suite of maps indicating optimal locations for charging infrastructure throughout the tri-county region – as well as principles for optimized siting of infrastructure within a given facility, campus, or neighborhood. The Association of Monterey Bay Area Governments siting study will be an important resource to inform both public and private site hosts regarding siting needs and opportunities over the next several years and beyond.

Going forward, the Plug-in Electric Vehicle Coordinating Council and the Monterey Bay Electric Vehicle Alliance have also partnered with Ecology Action, the Monterey Bay Unified Air Pollution Control District, and Electric Vehicle Communities Alliance to obtain resources from the California Energy Commission in support of a two-year effort to promote adoption of Plug-in Electric Vehicles and other Alternative Fuel Vehicles throughout the region. This effort will include a series of public "Ride and Drive" events to encourage local residents and fleet managers to test drive the exciting new generation of Plug-in Electric Vehicles in a neutral venue with no sales pressure. With more than twenty Plug-in Electric Vehicles now on the market, and nearly double that number expected by 2017, the Plug-in Electric Vehicle Coordinating Council believes that when consumers experience the performance advantages of electric drive – and understand the remarkable economies of operation -- they will make the choice to go electric.

In summary, the Plug-in Electric Vehicle Readiness Plan – and the ongoing work of the Plug-in Electric Vehicle Council – provides recommendations *and* practical tools to develop the region's Electric Vehicle ecosystem -- and thus help meet the state's goal of reducing greenhouse emissions by 80 percent below 1990 levels. Given that nearly half of the state's emissions come from the transportation sector, Electric Vehicles are a core part of our local and global climate solution. To achieve these critical climate benchmarks, Governor Brown and the state of California have set a goal of getting 1 million Electric Vehicles on the road by 2020, 1.5 million by 2025, and achieving 80 percent electric drive penetration of the vehicle fleet by 2050. By working collaboratively across the public and private sectors, the Monterey Bay region can be a leader in the historic transition from fossil-fueled transportation to clean and renewable electric fueling.

We welcome your participation in this great effort!

CHAPTER 1:
Project Objectives and Methodologies

1.1 Overview of the Monterey Bay Plug-in Electric Vehicle Readiness Planning Process

Roles of the Monterey Bay Electric Vehicle Alliance and Ecology Action: The Monterey Bay Electric Vehicle Alliance (MBEVA) was established in 2009 to promote the rapid adoption of Plug-in Electric Vehicles (PEVs) in the tri-county Monterey Bay Area, including Santa Cruz, Monterey, and San Benito Counties. To advance this mission, MBEVA convened a public-private collaborative network of key leaders and staff from counties, cities, public agencies, community organizations, private industry, universities, and utilities. The Alliance has focused on developing programs and resources to develop PEV-ready infrastructure and to raise public awareness about the benefits of Electric Vehicles. The administrative lead agency for MBEVA is Ecology Action, a 501c3 non-profit organization with a 40-year history of serving the Monterey Bay region with programs in the areas of clean transportation, energy efficiency, climate, pollution prevention, and zero waste.

Representation on the Bay Area EV Strategic Council – via the Monterey Bay Air Pollution Control District: In 2011, the Monterey Bay EV (Electric Vehicle) Alliance joined the Bay Area EV Strategic Council, the formally established Plug-in Electric Vehicle Coordinating Council for the 12 county greater Bay Area. The lead agency representing the Alliance on the Bay Area EV Council is the Monterey Bay Air Pollution Control District. In alignment with its membership in the Council, the tri-county Monterey Bay was included in a regional PEV Readiness Plan funded by the federal Department of Energy (DOE). The DOE plan was completed in 2012 under the joint oversight of the Bay Area Air Quality Management District, the Bay Area EV Strategic Council, and the Association of Bay Area Governments, and with the consulting assistance of ICF International. This Plan is addressed various areas of PEV readiness from a 12-county perspective. However, this high-level regional document was not scoped to include a detailed siting plan for PEV infrastructure in the tri-county region, or locally specific recommendations for PEV readiness. To address these and other local needs, the Bay Area EV Strategic Council, the Bay Area Air Quality Management District, and the California Energy Commission encouraged Monterey Bay stakeholders, led by MBEVA, Ecology Action, and the Monterey Bay Air Pollution Control District, to seek special grant funding from the California Energy Commission.

California Energy Commission Support for Monterey Bay Area PEV Readiness Planning: In 2011, MBEVA and Ecology Action partnered with the Bay Area Air Quality Management District and the Monterey Bay Air Pollution Control District to secure a grant of $200,000 to produce a local PEV Readiness Plan that would include a detailed siting study, locally vetted policy recommendations for EV readiness, a locally defined approach to EV permitting and inspection streamlining, and a more compact reference document on other pertinent PEV readiness issues, including select components of the broader regional plan. EV Communities Alliance, a nonprofit EV policy and planning organization, was selected to provide consulting assistance in the planning process, along with Ecology Action (which is focusing on public outreach and education) and the Association of Monterey Bay Area Governments (AMBAG) – which is responsible for the siting plan. Funds for the planning process originate with the CEC and are administered at the regional level by Bay Area Air Quality Management, and at the local level by the Monterey Bay Air Pollution Control District, which is serving as administrative lead on the planning process.

Creation of the Monterey Bay Plug-in EV Coordinating Council: MBEVA, Ecology Action, and the Monterey Bay Air Pollution Control District determined that a new Council should be created for the specific purpose of overseeing the development and implementation of the Monterey Bay PEV Readiness Plan, in alignment with requirements of the California Energy Commission. Accordingly, the Monterey Bay Plug-in Coordinating Council was created in 2013. The membership and goals of the Council are described below.

1.1.1 The Monterey Bay PEV Coordinating Council

The Monterey Bay Plug-in EV Coordinating Council is the formally established PEV leadership council for Monterey, Santa Cruz, and San Benito Counties. The Council's mission is to develop the *Monterey Bay EV Readiness Plan* to promote rapid adoption of PEVs in the region, and to implement that plan in collaboration with the Monterey Bay EV Alliance and its partner organizations. The Monterey Bay PEV Coordinating Council is a public-private collaborative network of senior leaders from counties, cities, public agencies, community organizations, private industry, and utilities. The Council strategically aligns policies, programs, and resources to develop PEV-ready infrastructure and PEV-friendly policies throughout the diverse communities of the Monterey Bay.

1.1.2 The Monterey Bay PEV Readiness Plan Structure

The Monterey Bay Plan has been developed in close coordination with the Greater Bay Area EV Readiness Plan, which includes a high-level analysis of recommended EV policies relevant to the 12 county Greater Bay Area, including the three Monterey Bay Counties.

1.1.3 Monterey Bay PEV Coordinating Council Activities

The Monterey Bay Plug-in Electric Vehicle Readiness Plan will fulfill these roles as the lead coordinating body for EV ecosystem development in the tri-county region:

- Provide input and guidance for the PEV Readiness Plan – by establishing EV related goals, developing strategies to achieve them, and providing information and recommendations to meet the needs of key stakeholders in the Monterey Bay region.
- Develop resources –by acting as a clearing house for and attractor of major federal, state, regional, and public/private investments and initiatives.
- Coordinate stakeholders – by acting as a neutral space for strategy development and operational coordination among public agencies, industry, utilities, and the community.
- Guide development of a regional EV charging network -- to provide an efficient and user-friendly infrastructure to facilitate all-electric travel within the greater Monterey Bay area.
- Develop EV-friendly policies – to spur development of EV-ready infrastructure, EV-friendly incentives, vehicle-to-grid connections, and EV-related economic and workforce development initiatives.
- Build public and leadership awareness – through the PEV Readiness Plan and related vehicle and infrastructure incentives and programs.

1.1.4 Monterey Bay PEV Readiness Goals and Metrics:

The following metrics in Table 1 below were approved by the Monterey Bay PEV Coordinating Council in July 2013. Refinement of EV sales goals will occur following surveys by Ecology Action that will include review of state EV sales data and surveys of fleet managers in rental, car share, and public fleets.

Table 1: Goals and Metrics for the Regional PEV Planning Process

Goal	Quantitative Measure	Target
1. Promote mass adoption of PEVs	1.A. # of PEV's sold or leased (2015 – 2025)	Pro-rata allocation of statewide goal of 1.5M PEVs by 2025
	1B. # of PEVs in rental and car share fleets 1C. # of PEVs in city and county fleets (21 municipalities, 3 counties)	2015 – 2020 goals to be determined following 2014 alternative fuel vehicle survey by Ecology Action
2. Develop a public charge network enabling all-electric travel throughout the region	2A. # of Level 1 charge points	2015: 200
	2B. # of Level 2 charge points	2015: 200
	2C. # of Fast Charge points	2015: 10
3. Streamline EVSE installation to promote rapid EVSE deployment	3A. # of counties and cities adopting enhanced EV readiness policies and practices that include (at a minimum) mandated EV stub-outs and EV parking set-asides in new construction	2014: 5 2015: 10 2020: 24
4. Provide consumer and leadership education and outreach on the benefits of PEVs	4A. # of people attending "green vehicle" showcases and other EV-related public events, such as ride-and-drive opportunities	Annual Goal: At least 2 Green Vehicle events per year reaching at least 3,000 people/year
	4B. # of meetings for local leaders briefed on PEVs in the Monterey Bay	Annual Goal: 3 workshops/yr.
	4C. # of ride and drive events per year	Annual Goal: 8 ride & drive events
5. Reduce greenhouse gas (GHG) emissions and criteria pollutants from light-duty vehicle	5A. Total emissions (including GHG and criteria pollutants) from the LDV fleet	Emissions goals are established in the Clean Air Plan of the Monterey Bay Air Pollution Control District

Source: Monterey Bay PEV Coordinating Council

1.2 Comprehensive Charging Network Development

1.2.1 Role of the Siting Study by AMBAG in the Context of Ongoing Charger Deployments

The Counties of Monterey, Santa Cruz, and San Benito have begun to install a significant number of PEV chargers, which are identified in the charger siting study developed by AMBAG. However, these allocations are only starting to meet the needs of the region's PEV drivers. To help guide and catalyze the growth of a more robust charging network in the region, the AMBAG infrastructure plan identifies an optimum grid of chargers across the region, which will provide both public and private site owners and EVSE vendors with prioritized recommendations for charger deployment based on expected intensity of use, as well as the long-term need to address ubiquity of charge across the region's large land area.

NRG Settlement Impact: The announcement of the $100 million dollar NRG settlement of the Dynegy lawsuit with the California Public Utilities Commission has created an urgency to pro-actively identify prospective EVSE sites that could be funded in part through the planned NRG build-out of "make-ready" level 2 sites (which will include pre-wiring but not the EV charger as such). As noted above, the NRG "eVgo" program design will include development of a regionally focused charger network in the greater Bay Area. However, the extent of deployment in the Monterey Bay area is not yet determined. The NRG deployment design includes eVgo plazas consisting of both a Fast Charger and level 2 chargers, with expansion capability. Because NRG plans for the region are not yet fully defined, pro-active outreach will be important to communicate the case for the region – focusing on the expected density of EVs in the area, and the region's role as a bridge in the state's north-south coastal travel corridor. Under the proposed settlement, Fast Chargers will be available to members of the public, whereas the 10,000 make-ready Level 2 sites will be linked to the NRG subscriber-only program.

Other Local, State and Federal-Funded Industry Charger Deployment Projects: After completion of the AMBAG infrastructure planning process, the Monterey Bay PEV Coordinating Council will expand 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 will be available from the Monterey Bay Unified Air Pollution Control District.

Encouragement of Local Charger Investment: In addition to leveraging publicly funded infrastructure deployed through larger EV charger companies, individual site owners in the region will be encouraged to invest their own resources in publicly accessible charging, through ongoing outreach activities, including three annual workshops in each of the three Monterey Bay counties, and a minimum of two additional green vehicle events reaching at least 3,000 people per year. These events will be supported through the collaborative efforts of the PEV Council, MBEVA, Ecology Action, and the Monterey Bay Air District.

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 Powertree) or charge network operator (such as EcoTality) that may be willing to subsidize the installation and operation of the charging equipment partly or fully at no cost to the owner. The vendors may collect monthly subscription plan fees or per charge fees from EV drivers to support the up-front cost of the installations.

1.2.2 Promotion of EV-ready Buildings and Parking Lots

The highly variable cost of installing Level 2 EV infrastructure (ranging as widely as $1,000 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 – do not consistently have the requisite conduit and panel capacity to support a 240 volt outlet or outlets in a convenient location. By requiring new conduit and stub-outs 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 chargers (and, in some cases, solar PV) pre-wiring in new or substantially remodeled commercial and residential structures.

Effective in July 2012, Title 24 of the California state building code, known as the CalGreen standards, defined a voluntary standard for PEV readiness (Part 11 of Title 24) that local governments may adopt. This standard 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 two units), CalGreen will require 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).

Going beyond the CalGreen standards, local agencies may wish to add additional requirements for pre-wiring (in addition to the raceway and conduit), as well as electrical switchgear (panels) of the appropriate capacity to support PEV infrastructure. 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 following ordinance language developed by the city of Mountlake Terrace in Washington in Table 2 below.

Table 2: EV Installation Requirements from Montlake Terrace, Washington

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: City of Montlake Terrance

EVs and Photovoltaic Connections: EVs and distributed photovoltaic charging are highly complementary technologies, particularly with the addition of fixed battery storage that can enable stored solar power to supplant a more expensive, higher-carbon power from the grid. Therefore, Monterey Bay communities may wish to consider adoption of a solar PV ordinance similar to that of Chula Vista, linked to EV-readiness ordinances. Given the environmental and economic synergy between EVs and renewable electricity, communities, non-governmental organizations, and industry partners may also wish to build on existing public education strategies that link outreach and awareness efforts on EVs and solar PV where feasible and appropriate. This approach could be reinforced 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.

1.2.3 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. The Monterey Bay PEV Coordinating Council has 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 – and the number of "electric miles" they travel -- grows as more publicly accessible charging becomes available. 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. The Electric Power Research Institute 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 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.

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, Fast Charging).
4. **Decide who will own the EV charging equipment**. It could be the company, the building/parking lot owner, or a 3rd party EV service provider.
5. **Identify incentives and 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!

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, Leadership in Energy and Environmental Design 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.

- **Triple Bottom Line Financial Reporting** – Triple bottom line 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 Triple bottom line standard accounting practices in 2007, and ongoing deployment of carbon accounting measures in California and nationwide, many organizations with a corporate social responsibility initiative or specific obligations under Assembly Bill 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.

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. Environmental Protection Agency'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, Environmental Protection Agency employees now have access to a pair of Level 2 charging stations by ChargePoint and Eaton.

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 2-5 miles per hour of EV range -- can be an excellent workplace charging solution. Implementing Level 1 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 is typically 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.

Level 1 charging equipment solutions range in cost from the cost of an extension cord to $1,000+ 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 $800, 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.

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, Internal Revenue Service 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.

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.

As of early 2013, the Congress voted to extend the Investment Tax Credit on a retroactive basis for EV charging equipment purchased in 2012 or 2013, 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.

1.2.4 Case Study: Workplace EV Charging Deployment at Palo Alto Research Center

The Palo Alto Research Center is a research and development organization made famous when Steve Jobs commercialized their pioneering designs for the computer mouse and graphic user interface. The Research Center 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, the research center 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, the Palo Alto Research Center 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 research center 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, the Palo Alto Research Center 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, the Palo Alto Research Center 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 is available via Plug-In America. Another strong listing is at Plug-In Recharge.

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 –to be introduced by 2014.) 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. Issues that should be considered include the following:

- **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.
- **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. 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 and the California Air Resources Board 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 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.

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 Americans with Disabilities Act (ADA) requirements is important at this point, especially since ADA compliance requirements are subject to local interpretation. 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*.

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 National Electric Code 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 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 and the International Brotherhood of Electrical Workers.

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.

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.

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 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. As an example, a solar installation may generate approximately 70,000 kWh/year. This is enough electricity for 250,000 miles of electricity-fueled driving. The cost of the system was approximately $950,000. A solar project sized for fueling just a single EV would generate enough electricity in a year to drive about 10,000 miles. The cost of such an installation at the time of this writing is approximately $20,000. Through a Power Purchase Agreement, businesses have the opportunity to own the asset by investing their own capital, or to enter into a power 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.

1.2.5 Summary Checklist of EV-Friendly Policies and Practices for Monterey Jurisdictions

The following checklist, shown in Table 3, summarizes recommendations of the Monterey Bay PEV Coordinating Council defined in Section 2C above and may be utilized as the basis for periodic assessments of local EV readiness. A baseline assessment of these key dimensions of readiness was completed by ICF International and included in the "Background and Analysis" volume of the *Bay Area and Monterey Bay Area Plug-in Electric Vehicle Readiness Plan,* published in December 2012. As part of the public comment period for the Draft Readiness Plan, the checklist below will be reviewed with local government leaders. In its final form, it will be utilized as benchmarking tool for the Coordinating Council and local governments to assess the current status of their EV ecosystem activities, and to determine the resources and time required to advance key goals for EV readiness.

Table 3: Checklist of EV-Friendly Policies and Practices for Monterey Jurisdictions

Recommended Practice	Current Status	Next Steps (with 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. Establish reasonable – and flat – charger permit fees		
R-4. Establish phone & online permit and inspection appointment systems		
R-5. Participate in training on EVSE technologies and installation		
R-6. Provide utility notification of EVSE installations		
R-7. Outreach to HOAs and property managers to offer multi-unit development solutions		
R-8. Adopt building code amendments to mandate pre-wiring for EVSE in new and remodeled multi-unit buildings		
R-9. Pro-actively meet with charging providers to ensure Monterey Bay sites are prioritized		
R-10. Engage key stakeholders to provide oversight of EV infrastructure and EV-friendly policy plans		
R-11. Promote building code amendments that mandate EV and solar-ready buildings, parking, and public works for new construction or major renovations.		

Source: Monterey Bay PEV Coordinating Council

1.3 PEV Marketing and Outreach

1.3.1 Aggregate Purchase Initiatives to Lower EV Initial Cost:

Consumer surveys indicate that a principal barrier to PEV deployment is price of PEVs relative to equivalent internal combustion engine (ICE) vehicles. To address this issue, aggregate EV purchase programs have been developed by the Bay Area EV Strategic Council (which includes formal Monterey Bay representation via the Monterey Bay Unified Air Pollution Control District.) An initial aggregate purchase pilot program was developed for greater Bay Area stakeholders by the joint efforts of the Bay Area Climate Collaborative, EV Communities Alliance, and the Bay Area EV Strategic Council. This program provided 50 Mitsubishi i-MiEVs to local Bay Area cities at extremely low lease rates, including a one year no-down, no-payment option, with an option to return the car after a year's use at no charge (if driven less than 5,000 miles.) For a three-year lease, rates were provided of less than $120/month, with no down payment (with a 5,000-mile annual cap before per mile charges are accrued). Many jurisdictions determined that they could more than cover the cost of the vehicle from gas savings alone. Additional manufacturers are currently engaged in negotiations to expand this program offering to the greater Bay Area, including Monterey. The Monterey PEV Coordinating Council, MBEVA, and Ecology Action will be engaged in future outreach and marketing to provide deals of this quality to local fleet managers in cooperation with the Bay Area EV Strategic Council and other stakeholders.

1.3.2 Encouraging Adoption of PEVs via "EV 101" Activities and other Educational Programs:

The Monterey Bay PEV Council, MBEVA, and Ecology Action will pro-actively outreach to affinity groups, major employers, and fleet operators -- in partnership with the Monterey Bay Unified Air Pollution Control District – to ensure a robust program of ongoing EV awareness and educational activities. MBEVA stakeholders will work together to support five EV ride and drive events each year, as well as EV showcases with a minimum of 3,000 attendees. EV ride and drive events with test vehicles will include very large-scale Earth Day events and Plug-in Week activities in Santa Cruz and other communities. EV 101 presentations will 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 and EVSE vendors and resources. The EV Council and MBEVA are committed to providing a minimum of three EV-related workshops per year (one per County) with the first workshops dedicated to presenting the PEV Readiness Plan in concert with information on emerging EV products and infrastructure.

1.3.3 Outreach to inform and Encourage Workplace Charging:

The EV workshops described above will include significant outreach to employers that are most likely to respond to the EV value proposition and the imperative to provide robust EV charging throughout the region. These include larger employers, property managers, retail establishments, businesses concerned with their sustainability profile and green image, colleges, universities, medical centers, transit agencies, and community-based organizations. Workplace charging and fleet resources, such as the U.S. Department of Energy (DOE) Clean Cities guide to EV fleets and the companion guide to workplace charging will be made available, along with complementary local information on the activities of MBEVA, Ecology Action, and the Monterey Bay Air District. In addition, workplace charging will be addressed during EV outreach workshops scheduled to begin in Q3 of 2013, which will take place in each of the three Monterey Bay counties.

1.3.4 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 will be communicated at the three 2013 EV outreach workshops, and at the five annual ride and drive events and green car showcases. Additionally, information resources will be hosted on the MBEVA, Ecology Action and Air District websites, with links to additional resources, including PG&E, EV automakers, Plug-in America, and GoElectricDrive, among many others.

CHAPTER 2: Activities and Data Collection

2.1 Plans for Streamlining EVSE Permitting, Installation and Inspection

2.1.1 Outreach and Education for Building Inspectors, Installers and Local Government Staff:

The Monterey Bay PEV Coordinating Council has hosted *EV readiness workshops* (one in each Monterey Bay area county) as part of the EV Readiness Plan development process. These workshops brought 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 the following issues in the context of the overall Monterey Bay PEV Readiness Plan:

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

Ecology Action and EV Communities Alliance will work with the PEV Council, MBEVA, and the Monterey Bay Air Pollution Control District to support this outreach and education on a periodic basis in coming years. The Monterey Bay PEV Coordinating Council 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. To this end, Monterey Bay PEV Coordinating Council team members are participating actively in the regular calls hosted by the PEV Collaborative to align regional workplans and participating in relevant PEV conferences.

In addition to the broader EV workshops for local governments provided by the PEV Council, the International Brotherhood of Electrical Workers of the Monterey region has created a special certification program for EV charging station installations, including a 24-hour training class.

2.1.2 EV Charger Permitting and Inspection Guide

Current Permitting Costs and Processes in Monterey Bay Area Jurisdictions: As part of the 12 county Greater Bay Area PEV Readiness Plan development process, a survey was conducted in the summer of 2013 of Monterey Bay and other regional jurisdictions regarding permitting costs and procedures. The results of this survey for Monterey Bay are presented below. The data show that permit costs are generally low but vary by jurisdiction. In addition, the wait time and complexity of permitting processes vary. Moreover, inspection procedures also vary from jurisdiction to jurisdiction. In order to promote a more customer-friendly and uniform experience in the Monterey Bay region and the greater Bay Area, the Monterey Bay PEV Council is providing model jurisdiction permit checklists and processes. These will be vetted with local government leaders in the draft Readiness Plan public input process, and specific process improvements will be considered for inclusion in the Final Plan to be published in Fall, 2013. Table 4 below is excerpted from data developed by ICF International for the 12 County Regional PEV Readiness Plan.

Table 4: EVSE Permit Costs

City / County	Permitting				Zoning & Parking Ordinances
	Permit fee (single family)	Timeframe	Application	Permitting process	
SAN BENITO COUNTY					
City of Hollister	-	Same day	Over the counter	Pre and post inspection	Only started
City of San Juan Bautista	less than $100	2-5 days	Over the counter	Plan check only	-
San Benito County	less than $100	Same day	Over the counter	Post-inspection	-
SANTA CRUZ COUNTY					
City of Capitola	$101-$250	2-5 days	Over the counter	Pre and post inspection	Looking at agencies
City of Scotts Valley	-	6-10 days	Over the counter	More than one pre- inspection	Looking at agencies
City of Watsonville	$101-$250	Same day	Over the counter	Post-inspection	More info
Santa Cruz County	$251-$500	Same day	Over the counter	Intermediate and post- inspection	
MONTEREY COUNTY					
City of Carmel By the Sea	$101-$250	6-10 days	Over the counter	Post-inspection	looking at agencies
City of Gonzales	less than $100	2-5 days	Over the counter	Pre and post inspection	-
City of King City	$101-$250	2-5 days	Over the counter	Intermediate and post- inspection	-
City of Monterey	$101-$250	2-5 days	Over the counter	Post-inspection	-
City of Salinas	$251-$500	2-5 days	Over the counter	Post-inspection	more info
City of Sand City	less than $100	2-5 days	Over the counter	Post-inspection	just started
City of Seaside	less than $100	6-10 days	Over the counter	Pre and post inspection	just started
City of Soledad	$101-$250	3-5 weeks	Over the counter	Intermediate and post- inspection	more info
Monterey County	$101-$250	Same day	Over the counter	Post-inspection	looking at agencies

Source: ICF International

Permitting Checklist: Electrical contractors and consumers have expressed concern about uneven processes for EV charger installations. To address this challenge on a greater Bay Area regionwide basis, the Bay Area Air Quality Management District, in collaboration with the Bay Area EV Strategic Council, the Association of Bay Area Governments, and ICF International, developed a common EVSE Permitting and Installation Checklist for the greater Bay Area PEV Readiness Plan. This checklist, shown in Table 5 below, is also recommended for consideration and adoption by Monterey Bay Area jurisdiction

Table 5: EV Charging Permitting Checklist for Greater Bay Area Local Government

<table>
<tr><th></th><th>Residential</th><th>Non-Residential</th></tr>
<tr><td rowspan="2">Phase 1: Pre-Work Contractor</td><td>Understand intended use of the EVSE (i.e. personal)</td><td>Obtain an address for the location
Determine ownership of the site and/or authorization to install equipment at site
Understand intended use of the EVSE (i.e. fleet, employee, customer, visitor, etc.)
Determine number of vehicles charging and connectors per charging station
Determine source of power and authorization to use source</td></tr>
<tr><td colspan="2">Determine type of vehicle(s) to be charged at EVSE
Evaluate mounting type options (i.e. bollard, pole-mount, wall-mount, ceiling-mount)
Clarify communication requirements (i.e. ethernet, cellular, wi-fi, none, or other)
Determine the National Electrical Manufacturers’ Association Enclosure type
Determine the physical dimensions of the space(s)
Inspect the type of circuit breaker panel board intended for the installation</td></tr>
<tr><td>Phase 2: Pre-Work Customer</td><td colspan="2">Identify incentives or rate structures through the utility
Determine size of electrical service at the site
Identify and contact applicable local permit office(s) to identify specific requirements, including local fire, environmental, construction, building, concealment and engineering requirements
Identify incentives available through local, state, or federal programs
Contact insurance company to acquire additional insurance or separate coverage as needed
Hire the contractor and verify credentials with all subcontractors. Ensure electrical contractor’s license for electrical work is current</td></tr>
<tr><td>Phase 3: On-Site Evaluation</td><td colspan="2">Verify EVSE meets UL requirements and is listed by UL or another nationally recognized testing laboratory
Verify EVSE has an appropriate National Electrical Manufacturers’ Association rated enclosure (National Electric Code 110.28) based on environment and customer needs, such as weatherization or greater levels of resistance to water and corrosive agents
Determine the level of charger meets customer’s PEV requirements (most vehicles require the maximum of a 240V / 32A circuit (40A breaker)
Based on proposed EVSE location, determine if cord length will reach a vehicle's charging inlet without excessive slack and does not need to be more than 25’ in length (National Electric Code 625.17)</td></tr>
</table>

	Residential	Non-Residential
	Cord management methodologies have been considered to reduce the risk of tripping hazards and accidental damage to the connector Mounting type selection based on requirements to meet site guidelines Determine whether EVSE communication options are beneficial to customer and/or local utility	
Phase 4: On-Site Survey	Ensure overhead doors and vehicle parking spot do not conflict with EVSE location Place EVSE in a location convenient to charging port on vehicle and typical orientation of the vehicle when in garage (i.e. backed in or head-first) Ensure functionality of lighting in the garage to meet National Electric Code code 210.70.	Space(s) should be visible to drivers and pedestrians Determine proximity to building entrance (could be considered an incentive for PEV use) Select spaces proximate to existing transformer or panel with sufficient electrical capacity EVSE installation should maintain a minimum parking space length to comply with local zoning requirements If available, use wider parking spaces to reduce the risk of cord set damage and minimize the intersection of cords with walking paths Ensure sufficient lighting at proposed space(s) to reduce risk of tripping and damage to charging station from vehicle impact or vandalism. Light levels above two-foot candles are recommended For lots with accessible parking, the first charging station should be prioritized for an ADA accessible parking space and for every 25th additional station another accessible space is installed Determine availability of space for informative signage EVSE with multiple cords should be placed to avoid crossing other parking spaces All available charging station mounting options should be considered and optimized for the space Determine if hazardous materials were located at the site

<table>
<tr><th></th><th>Residential</th><th>Non-Residential</th></tr>
<tr><td></td><td></td><td>PARKING DECKS
Place EVSE towards the interior of a parking deck to avoid weather-related impacts on equipment
PARKING LOTS
Avoid existing infrastructure and landscaping to mitigate costs, potential hazards and other negative impacts
ON-STREET
Install on streets with high foot and vehicle traffic to mitigate vandalism
Avoid existing infrastructure and landscaping to mitigate costs, potential hazards and other negative impacts
Installations at ADA accessible spaces should be considered in public streets were
accessible parking exists
For pull-in spaces, EVSE should be placed in front of the spaced and either centered on the space or placed between two spaces (if two connectors are available). EVSE with more than two connectors should not be used in on-street applications
For parallel parking locations, the charging station should be installed at the front third of the parked vehicle and based on the direction of traffic flow. EVSE with a single connector is recommended to reduce potential trip hazards</td></tr>
<tr><td></td><td colspan="2">Mount the connector at a height between 36” and 48” from the ground (National Electric Code 625.29) unless otherwise indicated by the manufacturer
Install wall or pole-mount stations and enclosures at a height between 36” and 48”
Ensure sufficient space exists around electrical equipment for safe operation and maintenance (National Electric Code 110.26). Recommended space is 30” wide, 3’ deep, and 6’6” high
Minimize tripping hazards and utilize cord management technologies when possible
Equipment operating above 50 volts must be protected against physical damage (National Electric Code 110.27). Ensure the vehicle is out of the line of vehicle travel and use wheel stops or other protective measures
EVSE must be located such that ADA routes maintain a pathway of 36” at all times</td></tr>
</table>

<table>
<tr><th></th><th>Residential</th><th>Non-Residential</th></tr>
<tr><td>Phase 5: Contractor Installation Preparation</td><td colspan="2">Price quote submitted to customer and approved including utility upgrades
Order equipment
Provide stamped engineering calculations as needed
Provide site plan modification with diagrams as necessary
Complete all necessary service upgrades and/or new service assessments
Complete permit applications as required by local permitting department
Ensure permit is approved and collected
Schedule all necessary contract work (i.e. boring, concrete, and/or paving restoration) and utility work (i.e. utility marking, service upgrade, new service and/or meter pull)
Ensure utility marking of existing power lines, gas lines or other infrastructure is completed and utilize “Call Before You Dig” services</td></tr>
<tr><td rowspan="2">Phase 6: Installation</td><td>Residential garages may permit the use of nonmetallic-sheathed cable in lieu of conduit</td><td>Run conduit from power source to station location
For EVSE great than 60 amperes, a separate disconnect is required (National Electric Code 625.23) and should be installed concurrently with conduit and visible from the EVSE</td></tr>
<tr><td colspan="2">Post permit at site in visible location
Remove material to run conduit and/or wiring (i.e. drywall, insulation, pavers, concrete, pavement, earth, etc.)
Contractors are encouraged to examine requirement for installation sites and types of wiring in Chapter 3 of the NEC
Pull wiring. Charging stations require a neutral line and a ground line and equipment is considered to be a continuous load
Conductors should be sized to support 125 percent of the rated equipment load (National Electric Code 625.21)
Prepare mounting surface and install per equipment manufacturer instructions
Floor-mount typically requires a concrete foundation with J-bolts on station base plate with space to allow conductors to enter through the base</td></tr>
</table>

	Residential	Non-Residential
	Wall/Pole/Ceiling-mount: install brackets for mounting of the equipment Install bollard(s) and/or wheel stop(s) as needed Install informative signage to identify the EVSE and potential trip hazards Install additional electrical panels or sub-panels as needed Install service upgrades, new service and/or new meter as needed. Utility may also pull a meter to allow for charging station wires to be connected to a panel Make electrical connection Perform finish work to repair existing infrastructure, surfaces, and landscaping	
Phase 7: Inspection	An initial electrical inspection by applicable building, fire, environmental and electrical authorities should occur after conduit has been run and prior to connecting equipment and running wires. If necessary, contractor should correct any issues and schedule a second rough inspection If required, the inspector will perform a final inspection to ensure compliance with National Electric Code and other codes adopted within the jurisdiction by inspecting wiring, connections, mounting and finish work Contractor should verify EVSE functionality	
Additional Resources	National Codes and Standards American National Standards Institute National Fire Protection Association Underwriters Laboratories, Inc. International Association of Electrical Inspectors International Code Council National Electrical Contractors Association -NEIS Standards National Electrical Contractors Association and National Fire Protection Association Webinars Electric Vehicle Infrastructure Training Program Installer Training Course/Certification	

Source: Bay Area Air Quality Management District

Sample EV Charging Permit: The following sample permit for Charging Equipment Installation can serve as a model for jurisdictions that do not yet have an EVSE-specific permit form. This format was recommended in the *Ready, Set, Charge California! EV Readiness Guide.*

Permit for Charging Equipment Installation
Electric Vehicle Supply Equipment (EVSE)
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® National Fire Protection Association 70, Article 625 Electric Vehicle Charging System

This permit contains a general reference to the National Electric Code or electrical code used in the jurisdiction. All work and installed equipment will comply with the requirements of the National Electric Code, 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 plug-in hybrid electric vehicle (PHEV) 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.

Section 1 of the permit application (Figure 1) requires basic identifying information be submitted. 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.

Section 2 of the permit application 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

Section 3 consists of standard certification statement 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.

Section 4 of the document 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 NEC® 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.

Application for Electric Vehicle Charging Installation

Figure 1: Section 1: Permit Applicant Information

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: *Ready, Set, Charge California*

Table 6: Section 2: Permit Code Information

NECO Chapter or Article	CODE DESCRIPTION
Chapter2 and 3	**BRANCH CIRCUIT** A new electrical box added on a branch circuit shall comply with National Fire Protection Association 70 National Electrical Code® Chapter 2 Wiring and Protection and Chapter 3 Wiring Methods and Materials and all administrative requirements of the National Electric Code or the electrical code in effect in the jurisdiction

NECO Chapter or Article	CODE DESCRIPTION
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.
625.14	**RATING**

NECO Chapter or Article	CODE DESCRIPTION
	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

NECO Chapter or Article	CODE DESCRIPTION
	equipment intended for connection to receptacle outlets rated at 125 volts, single phase, 15 and 20 amperes.
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**

NECO Chapter or Article	CODE DESCRIPTION
	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.
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

NECO Chapter or Article	CODE DESCRIPTION
	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.

Source: Ready, Set, Charge California

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, National Fire Protection Association 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 National Fire Protection Association 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_______________________

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

Simplified Checklist for Building Inspectors for Residential EVSE Installation

The following checklist (Figure 2) may be used as a simplified model for Building Inspectors to adapt for local use.

Figure 2: Building Inspectors Checklist

1INFORMATION	PLAN CHECK NO.:	EXPIRATION DATE:	STATUS:
	PROJECT ADDRESS:		
	WORK DESCRIPTION:		
	APPLICANT'S NAME:	TEL. NO.:	
	ADDRESS:	EMAIL:	

Source: Ready, Set, Charge California

A. General PERMITTING Requirements

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

B. ELECTRICAL INSTALLATION REQUIREMENTS

Electric Vehicles – an automotive type of 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.

EV Charger Installation Guidance for Single Family Residences by the Tri-County Uniform Code Committee
(from the Tri-Chapter Uniform Code Committee of the International Code Council, cited in Ready, Set, Charge California)

INTERNATIONAL CODE COUNCIL TRI-CHAPTER
UNIFORM CODE COMMITTEE
Charger Installation Guidance

POLICY NUMBER: **17**

APPROVAL DATE: **August 12, 2010**

REVISION DATE: **APRIL 14, 2011**

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

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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

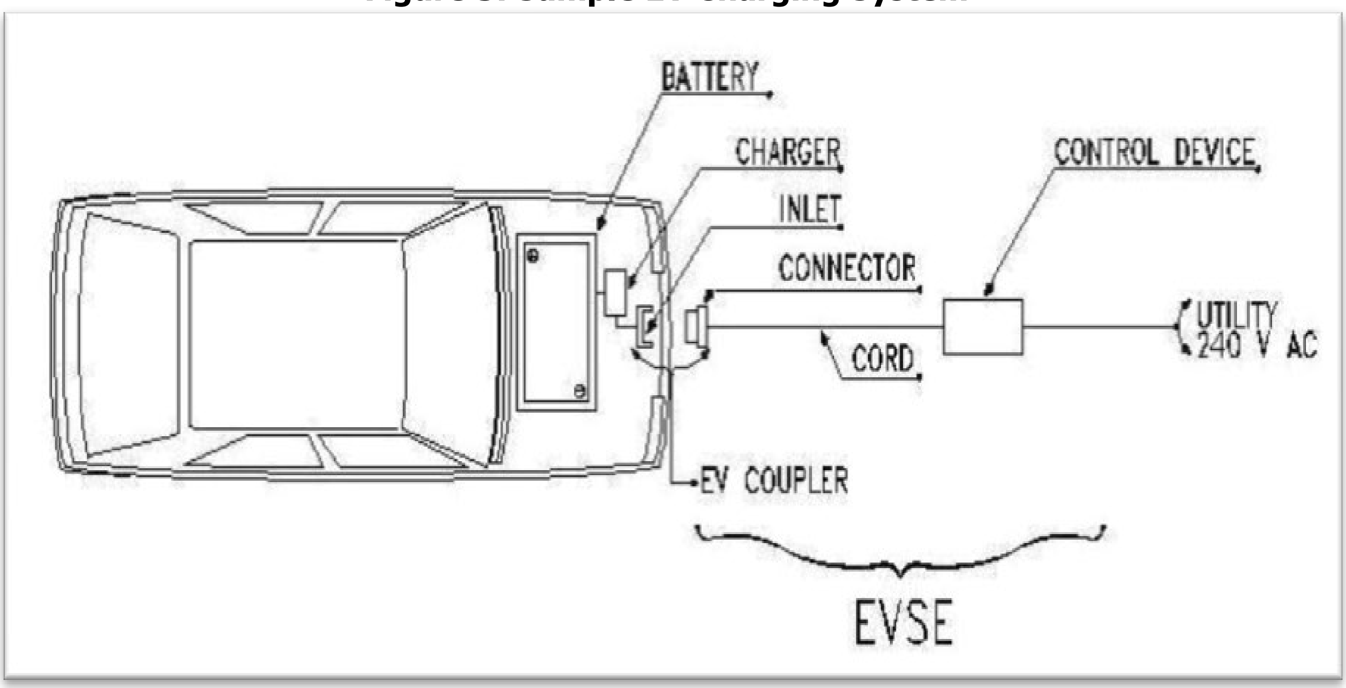
ISSUE (S):

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 Tri-chapter Uniform Code Committee EV sub-committee was formed in June 2010 to research and understand the technical requirement for EV and develop a guideline to expedite the permit and inspection process.

Sample EV Charging System

Electric Vehicle Supply Equipment (EVSE) consists of the connector, cord, and interface to utility power. Currently the interface between the EVSE and utility power will be directly hard-wired to the control device, and each automaker has its own EVSE design. A single design called the J1772 Standard EV coupler will be available soon that will be applicable for all electric vehicles. The design is shown in Figure 3.

Figure 3: Sample EV Charging System



Source: International Council Code

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

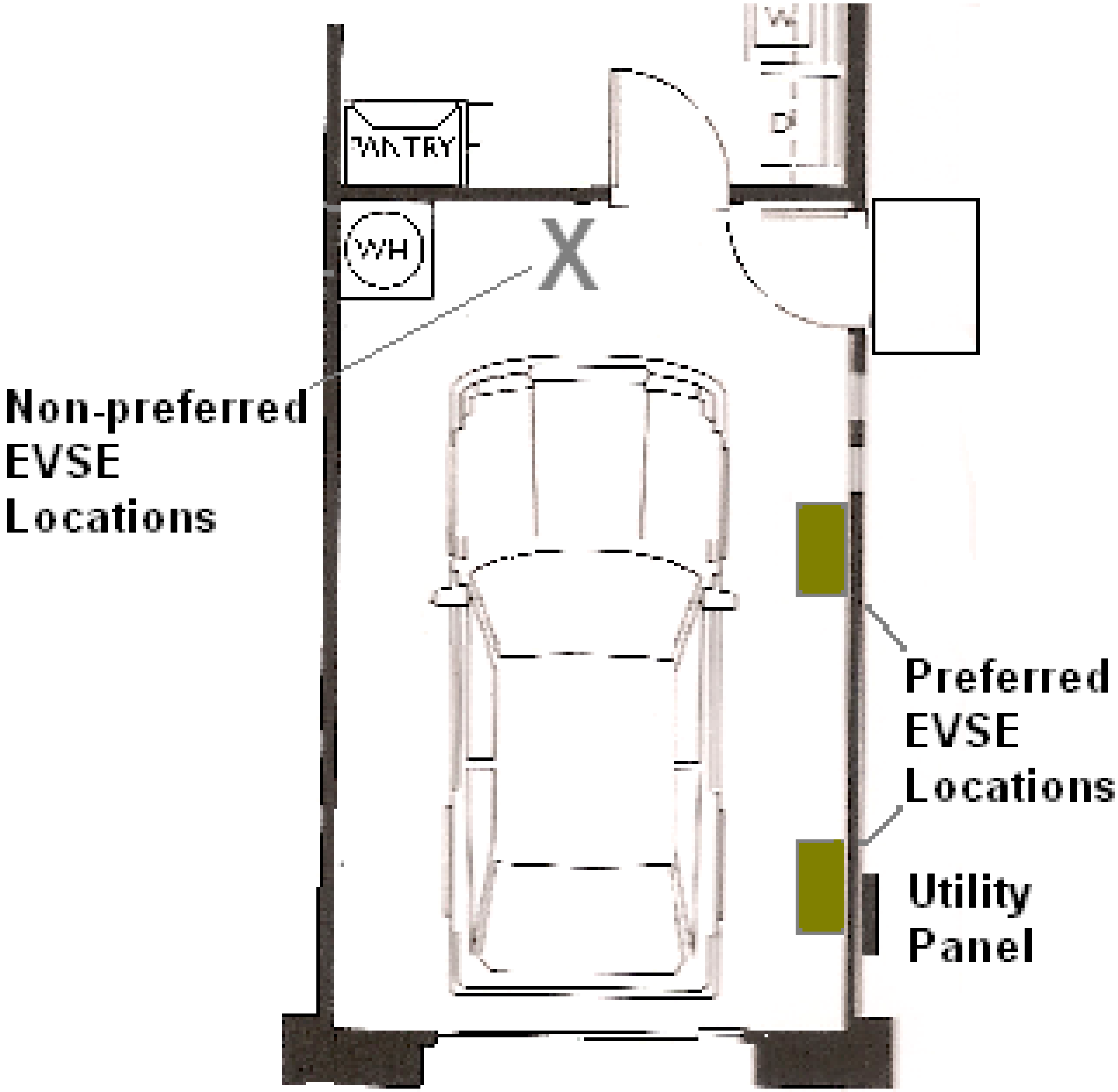
Proposed Guidelines

An electrical permit is required for an EV charging system to be installed in the garage or carport of a Single Family Residence. 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 must be available for the inspector at the site.

A diagram of preffered EVSE locations are shown in Figure 4.

Figure 4: Diagram of Preferred EVSE Locations



Soure: International Council Code

Charger Installation Guidance for Commercial EV Charger Installations by the Tri-County Uniform Code Committee

(from the Tri-Chapter Uniform Code Committee of the International Code Council, cited in Ready, Set, Charge California)

INTERNATIONAL CODE COUNCIL
TRI-CHAPTER
UNIFORM CODE COMMITTEE

POLICY NUMBER: **18**

APPROVAL DATE: **April 14, 2011**

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

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

CODE REFERENCE(S):

2010 California Electrical Code (CEC)

2010 California Building Code

2010 California Green Building Standards Code

Underwriters Laboratory listed charging system

ISSUE(S):

The Tri-Chapter Uniform Code Committee 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.

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 California Building Codes, 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 California Building Codes, 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 California Building Codes accessibility requirement.

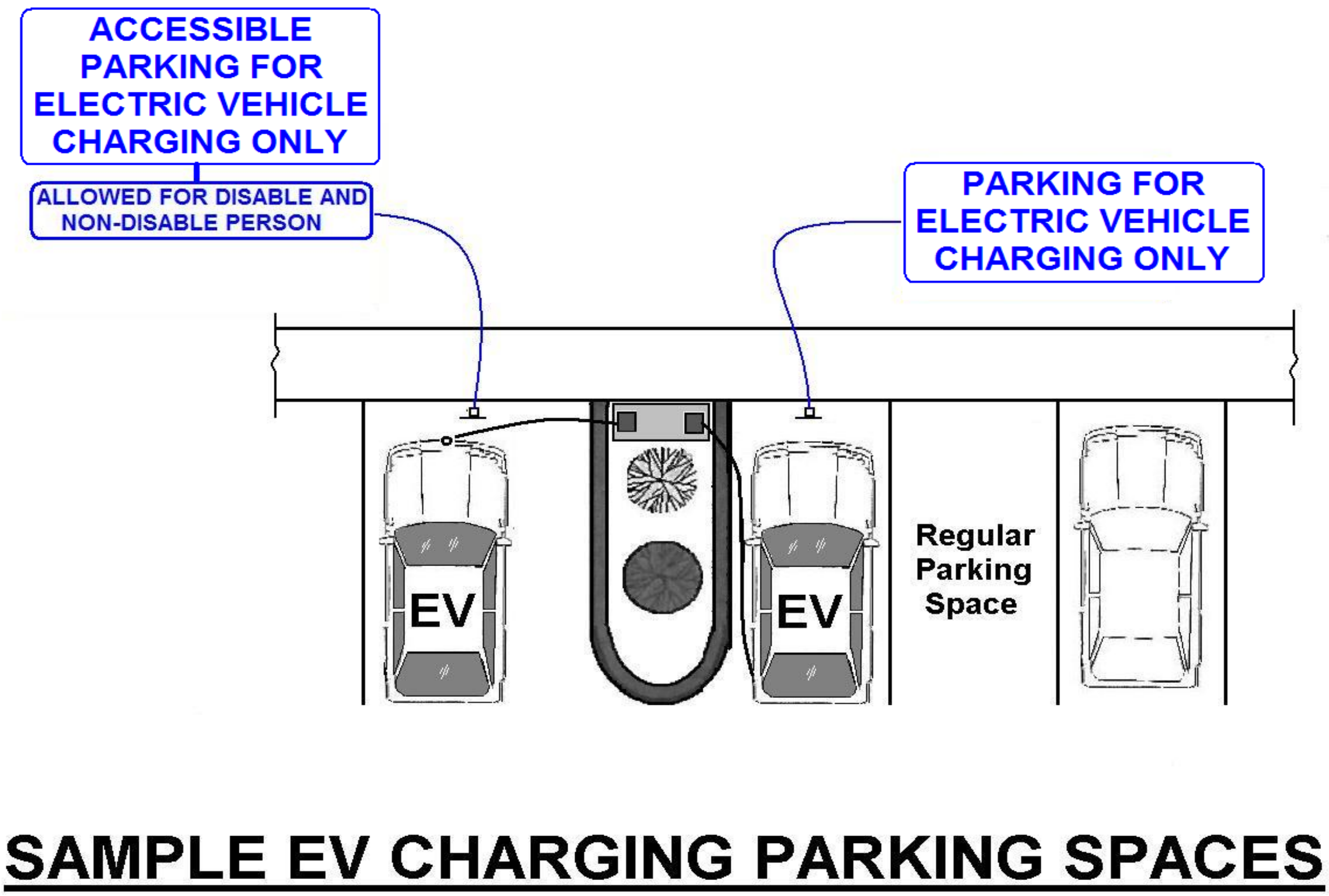
The EV charging parking space(s) may be counted towards the number of required low-emitting/fuel-efficient parking in the California Green Building Standards Code.

Other requirements:

- Charging system equipment, EVSE installed inside individual garage of multi-family dwellings shall follow Tri-chapter Uniform Code Committee 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.

A sample of EV Charging spaces are shown in Figure 5.

Figure 5: Sample EV Charging Parking Spaces



Source: International Council Code

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

On-Street Electric Vehicle Charging Stations

Purpose

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

Definitions: (See Section 3.1 for applicable definitions)

Permitted Locations

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

A. **Size:** An Electric Vehicle charging station may be the same size as a standard parking space.

B. **Signage:**

   a. Each electric vehicle charging station 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. (See Section 3.6 on Signage).

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

C. **Location:**

   a. When installing only one EVCS, utilizing the last space on a block face in the direction of travel reduces 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.

D. **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.

E. **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.

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

G. **Controls and Equipment:**

   1. Charging station card-readers, controls and connector devices should be no lower than 36-inches or higher than 48-inches from the pedestrian surface.

   2. 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.

H. **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.

I. **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.

J. **Notification:** Information on any fees or terms of use should be clearly visible in day or nighttime conditions.

K. **Communications:** Charging station equipment should be equipped with cellular phone service, wired or wireless communications.

L. **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

A. **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.

B. **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)

C. **Location.**

a. An EVCS with a single connector is generally recommended for parallel parking configurations and should be installed near the front of the electric vehicle charging station based upon the direction of travel.

b. Charging stations serving perpendicular or angle parking configurations should be centered, or to the left in front of the electric vehicle charging station for single connectors (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.

D. **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)

E. **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.

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

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

H. **Communications.** Charging station equipment should be equipped with cellular phone service, wired or wireless communications.

2.1.3 Model Ordinances to Promote 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

EV Infrastructure -- in the form of charging stations of various electrical levels -- are permitted in zoning districts as identified in Table 7 below. The first column designates the zone, the second, third and fourth columns indicate the type of EV Infrastructure. For each zoning district, the table identifies the type of infrastructure permitted and the process by which it is permitted. A "P" represents that the EV Infrastructure is a permitted use in the corresponding zone. A column left blank indicates that type of EV Infrastructure is not permitted in that district.

Table 7: Zoning Districts and Allowed Electric Vehicle Infrastructure

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

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

Design and Installation Criteria

A. **Size.** Electric vehicle charging stations may be the same size as standard parking spaces 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.

B. **Signage**.

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

C. **Accessibility**. Where charging station equipment is provided within an adjacent pedestrian circulation area, such as a sidewalk or accessible "path of travel" to the building entrance, the charging station 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. (See Section 3.5.2.1 Accessible Electric Vehicle Charging Stations)

D. **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)
E. **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.
F. **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. For a complete list of these ordinance amendments, please refer to Appendix 8.3. 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[1].

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.

EVSC 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):

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1 SeaTac Municipal Code. 14 December 2010. September 2011 is available at http://www.codepublishing.com/WA/Seatac/html/Seatac15/seatac1540.html#15.40

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 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)[2].

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]:[3]

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

B. The first column in Table 8 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.

Table 8: Required number of electric vehicle charging stations (sample)

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)

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

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

Recreational/Entertainment/Cultural	1%

Source: CalGreen

C. **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 section shall be designed to allow for double the amount of electric vehicle parking shown in Table 8.

   1. 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 Lots: 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[4].

2.1.4 Code Amendments for 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

4 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.

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.

Definitions: (See Section 3.1 for applicable definitions)

Electric Vehicle Charging Stations reserved – no reference needed. What typically exists

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

A. **Director**. The "Director" means the head of the local jurisdiction department responsible for administering the off-street and on-street parking programs.
B. **Charging**. For the purposes of this Chapter, "charging" means any parked PEV connected to the charging station. (See Section 2.1 for definition of "charging")

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

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

2.1.5 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[5].

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: 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[6].

Adopted Code Language: CalGreen (effective July 2012)

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

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

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: 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.

2.1.6 Guidelines for Accessibility and ADA Compliance

EV Charging Stations must comply with provisions of the Americans with Disabilities Act (ADA). In 2013, the Governor's Office of Planning and Research, in cooperation with the Division of the State Architect, issued draft guidelines entitled, *Plug-in Electric Vehicles: Universal Charging Access Guidelines and Best Practices.* These draft guidelines do not have the force of law, but they are the most current statement of state policy and intention, and as such are an important resource for local permitting authorities. According to OPR, these guidelines may in the future be integrated into the California Building Code's *Chapter 11B Division 2: Scoping Requirements,* however, they are not yet part of the Building Code. The Guidelines begin with a clear advisory regarding the positive mandate to provide ADA accessibility.

Advisory: EVG-250 Electric Vehicle Charging Stations. A reasonable portion of Electric Vehicle Charging Stations are required to be accessible. If provided by a state or local government on public property or on-street within the public right of way, vehicle charging is considered a program or service that must be accessible to and useable by individuals with disabilities. Accessibility covers not just the physical dimensions of the charging station, and operable parts of the device, but also the functionality of the 'self-contained, closed product' charging system. If provided at privately owned or operated public accommodations, they must also be accessible as a service provided to the general public.

Monterey Bay PEV contractors and permitting authorities are strongly urged to consult this reference source for further guidance on ADA issues. To provide a general overview of ADA issues and illustration of approaches to commonly encountered challenges, a summary of current best practice is provided as an initial orientation to the issues.

Introduction to the ADA: The Americans with Disabilities Act (ADA) became federal law in 1990 with the intent to prohibit discrimination of individuals on the basis of disabilities. Title I of the ADA prohibits private employers, state and local governments, employment agencies and labor unions from discriminating against qualified individuals with disabilities in job application procedures, hiring, firing, advancement, compensation, job training, and other terms, conditions, and privileges of employment. The ADA covers employers with 15 or more employees, including state and local governments.

An employer is required to make a reasonable accommodation to the known disability of a qualified applicant or employee if it would not impose an "undue hardship" on the operation of the employer's business. Reasonable accommodations are adjustments or modifications provided by an employer to enable people with disabilities to enjoy equal employment opportunities. The Equal Employment Opportunity Commission 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*[7]. 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[8] that was developed in 1997 (last revised 2-10-2005) by the State Department of General Services. The Policy was developed to provide 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.

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

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

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 finalized and formally adopted by the State, two courses of action may be considered by local agencies; one for new construction and one for existing parking facilities (see Table 9 below). 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.

Table 9: Installation Options for Accessible EV Charging Stations (EVCS)

	New Construction[1]	**Existing Parking Facility**
1st EVCS	The first EVCS should be accessible and be installed in an existing van-accessible parking space or in a new 17-foot wide EVCS meeting all requirements of a van-accessible parking space. If in a new space it does not have to be designated with a D9-6/R7-8b (disabled parking symbol/VAN-accessible) or contain a striped access aisle.	The first EVCS should be accessible, and may be installed in the existing van-accessible space, in an existing accessible parking space, in a standard parking space (9-feet wide minimum) adjacent to an “access aisle”, or in a standard parking space with a 3-foot wide (minimum) unstriped path of travel between the battery charging station and the vehicle inlet.

	New Construction[1]	Existing Parking Facility
2nd EVCS	The second EVCS should be accessible and be installed in an existing accessible parking space or in a new 14-foot wide EVCS meeting all requirements of an accessible parking space. If in a new space it does not have to be designated with a D9-6 (disabled parking sign) or contain a striped access aisle.	The second EVCS should be accessible and may be installed in a standard parking space (9-feet wide minimum) with a 3-foot wide (minimum) un-striped path of travel[2].
3rd EVCS	The third EVCS and beyond may be installed in a standard parking space no less than 9-feet wide.	The third EVCS and beyond may be installed in a standard parking space no less than 9-feet wide.

Note: 1 includes existing facilities increased in size by 50 percent or greater or by 30 parking spaces or greater (percent or number to be determined by local agency) 2 If the first battery charging station can simultaneously charge two PEVs, the card-reading device would qualify as accessible for each vehicle
Source: CalGreen

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. An example of an accessible fuel station is shown in Figure 6. 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).

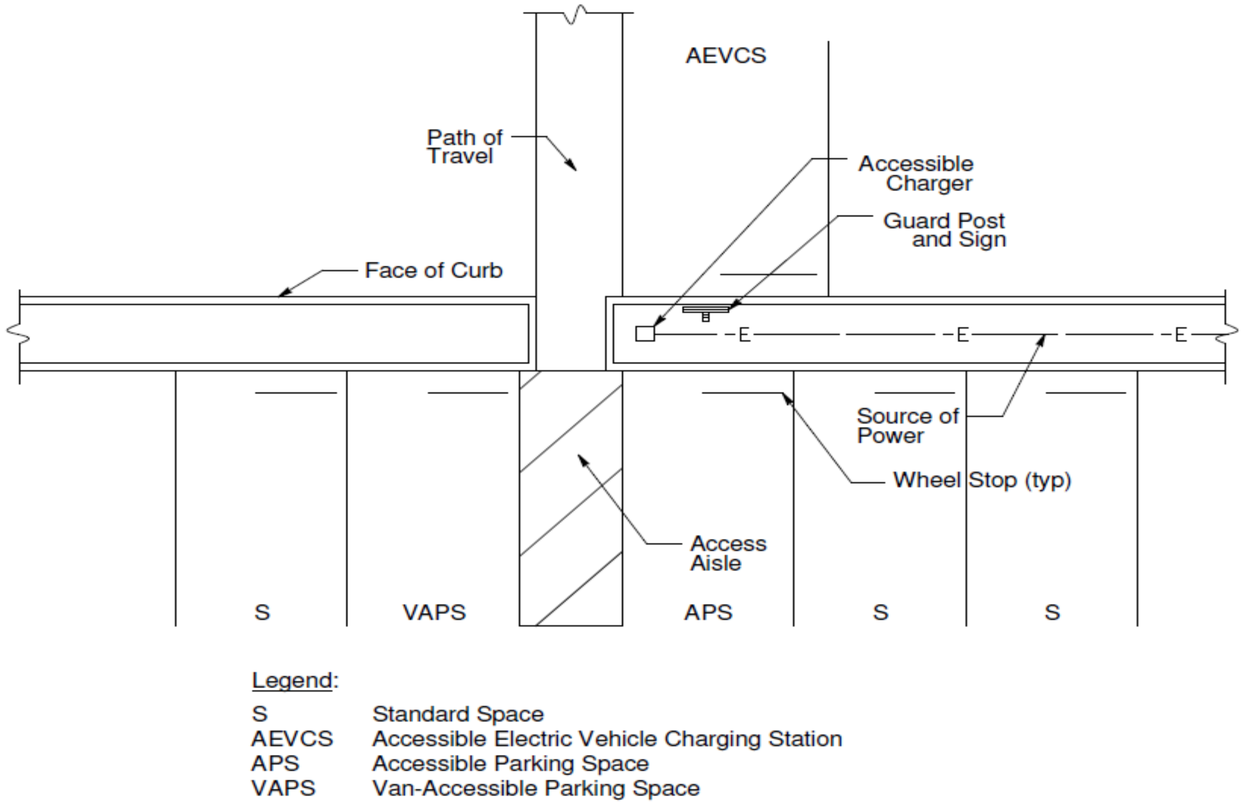
- In new construction a path of travel (see definitions) no less than 3-feet in width must exist between the level accessible area in front of the charging station and an exterior accessible route of travel to the main building entrance
- The electric cable and connector may cross over the level accessible area when inserted in the vehicle charging inlet.

Figure 6: Example of an Accessible Liquid Fuel Dispenser

Source: Shell

Figures 7, 8 and 9 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.

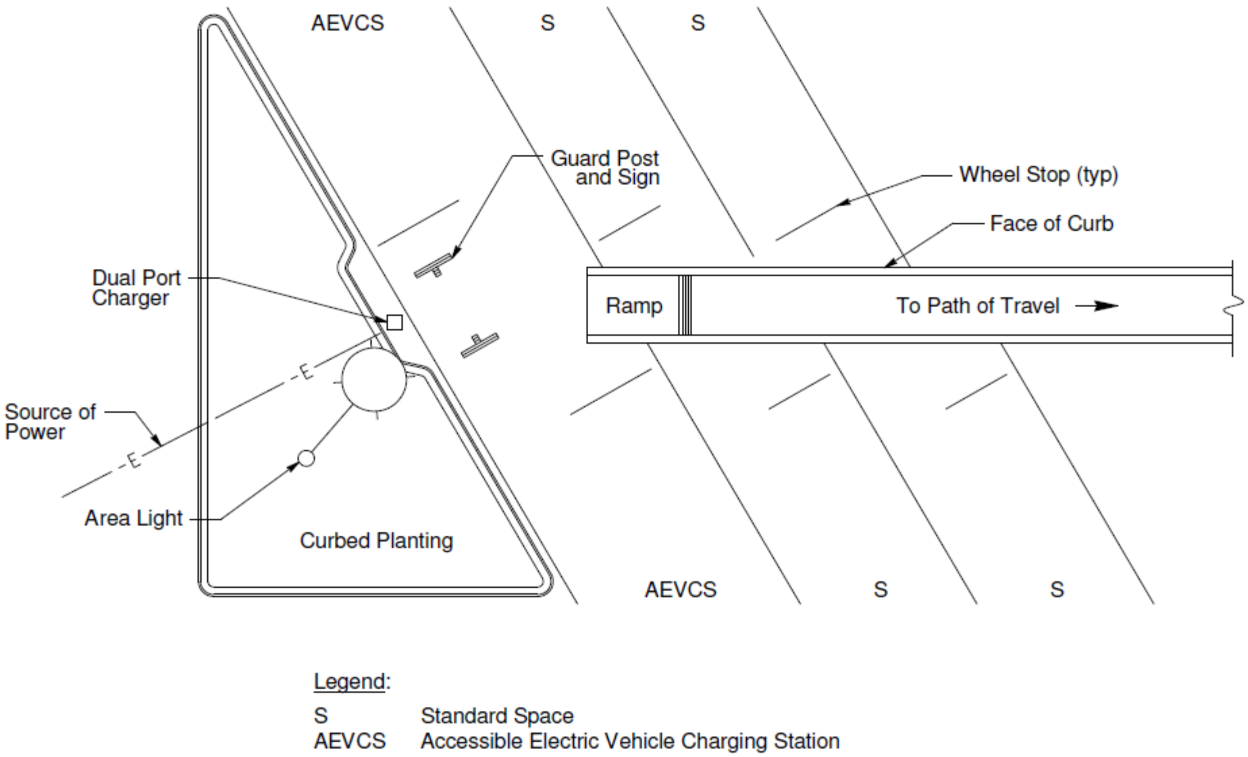
Figure 7: Example of First EVCS in Existing Parking Facility



Source: California State Building Code

Comment: This example 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.

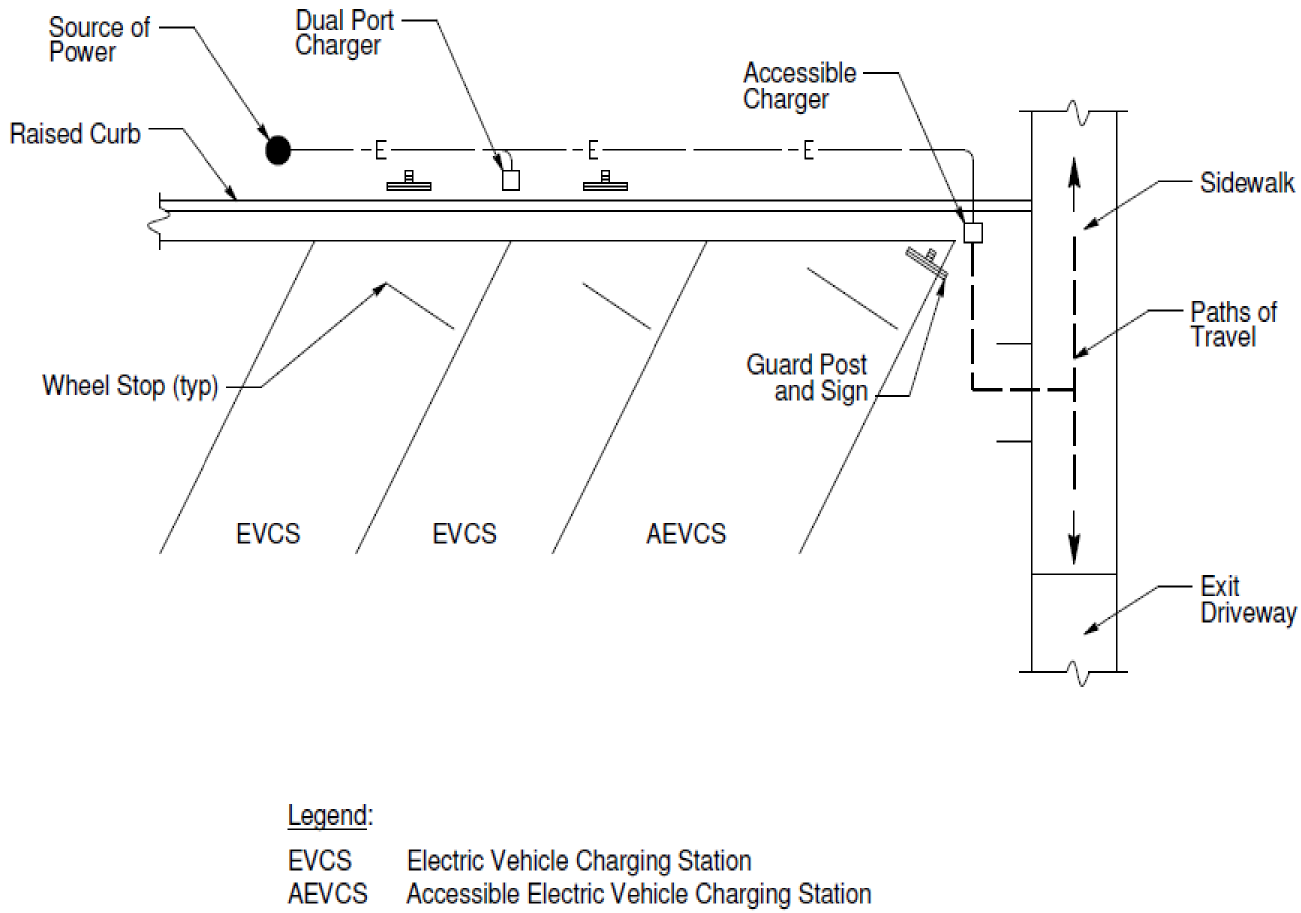
Figure 8: Example of First Two EVCS in Existing Parking Facility



Source: California State Building Code

Comment: This example in 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 9: Example of First Two EVCS in Existing Parking Facility



Source: California State Building Code

Comment: The figure above 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.

2.1.7 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 Manual on Uniform Traffic Control Devices (CA MUTCD). Sign sizes, shapes and colors vary based upon the type of message, whether an international symbol exists, and the type of roadway where the sign is to be used. Local authorities may use additional or alternative signs, not approved in the CA-MUTCD in public parking facilities.

General Service Signs

General service signs that are currently contained in the MUTCD and CA-MUTCD are intended to provide general guidance to the charging station and should be installed at a suitable distance in advance of the turn-off or intersecting roadway, or at the charging station and should be considered for use when meeting the qualifying criteria in chapter 2F of the CA MUTCD. The color format for general service signs is shown in Table 10 below:

Table 10: Color format for general service signs

Letters	Symbols	Arrows	Borders	Background
White	White	White	White	Blue

Source: MUTCD

Below in Figure 10 are the General Service Signs with recommended sizes currently approved in the CA MUTCD. The G66-21 (CA) sign was added to the CA MUTCD to be used on conventional roads. It should also be used in public parking facilities at all decision points and at the electric vehicle charging station. The D9-11b sign can be combined with either the G66-21 (CA) or the D9-11bP.

Figure 10: General Service Signs

G66-21 (CA)	D9-11bP	D9-11b
Parking Facility 12" x 12"	Freeway 30" x 24"	Freeway 30" x 30"
Parking Facility 18" x 18"	Expressway 30" x 24"	Expressway 30" x 30"
Conventional Road 24" x 24"	Conventional Road 24" x 18"	Conventional Road 24" x 24"

Source: MUTCD

General Service Signs approved in the California MUTCD

Below in Figure 11 are the typical types of advance turn and directional arrows used with the electric vehicle charging signs:

Figure 11: Advance turn and directional arrows used with PEV vehicle charging signs

Advance Turn and Directional Arrow Auxiliary Signs for use with General Service Signs

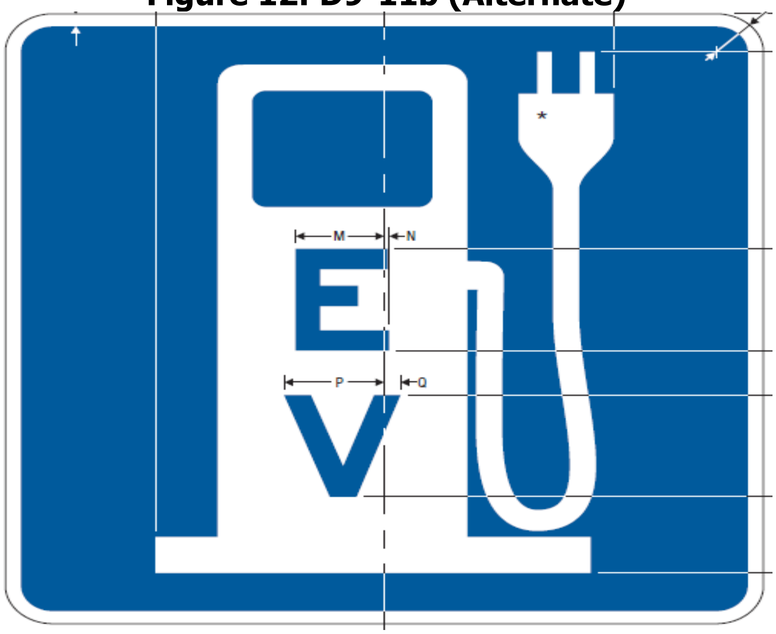
M5-1 M5-2 M6-1 M6-2 M6-3

Source: MUTCD

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

Guidance: On April 1, 2011, the Federal Highway Administration issued an Interim Approval for use of an alternate D9-11b sign to the States of Oregon and Washington (see Figure 12 below). The Highway Administration 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 Highway Administration. 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 12: D9-11b (Alternate)



Source: MUTCD

Regulatory Signs

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

Regulatory signs shown below in Figure 13 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 13: Examples of Regulatory Signs Being Tested in Oregon and Washington

Source: MUTCD

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 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.

2.2 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, and the California Public Utilities Commission.

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.

2.2.1 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, often large coal or nuclear plants are designed to operate continuously and at low cost. Peaking power plants, which are operated only a handful of hours per year when demand is highest, are often fired with natural gas, and are often more costly to operate. Many other types of plants, such as hydro and solar, operate in between. 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.[9]

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.

2.2.2 Plans to Minimize Effects of Charging on Peak Loads

Research conducted by the Electric Power Research Institute 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

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

allowing for more efficient operation and gaining a new market for off-peak power that now sits idle.[10] The additional 1.8 million PEVs by the year 2020 are expected to increase California's electric system load demand by 4.6 terawatt hours (TW-hrs.) by 2020. 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, California Public Utilities Commission, May 2009.

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 as indicated in Table 11 below. 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.

Table 11: 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%	474	0.64%

Source: Electric Power Research Institute

In the 2013-2020 planning horizon, utility analysis indicates that potential for negative grid impacts is minimal and are limited primarily to the possibility of clustering of PEVs in neighborhoods with limited power infrastructure. For instance, a California Public Utilities Commission report cited a Southern California Edison (SCE) analysis that shows that additional peak demand (around 7pm) could be substantial if a large number of PEV customers plug in and charge immediately upon returning home from work. The California Public Utilities Commission 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.

2.2.3 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

10 Driving the Solution: The Plug-In Hybrid Vehicle, Lucy Sanna Electric Power Research Institute Journal, 2005.

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 Monterey Bay PEV Coordinating Council in early 2013 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 Pollution Control District Counties in March of 2013 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, a peak load of about 500 W per vehicle typically might occur at around 5:00-7:00 p.m. If all the vehicles were BEVs, then the peak load would be about 700 W per vehicle on average. 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.

Despite these preparations, utilities will still need to upgrade transformers in some areas. It will be important for stakeholders to work together to ensure accurate and prompt utility notification of new PEV load. 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.

Time of Use Tariffs

Time of use 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 the following categories:

Whole-house Time of Use with a single rate – this time of use 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.

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 time of use 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 12 below describes the current SCE program of EVSE incentives and special PEV rates.

Table 12: SCE EVSE incentives and PEV rates

Pilot Program	Incentive Type	PEV Rate
EV Discount Rate	Two time of use 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.

2.2.4 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.[11]

- **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, original equipment manufacturers 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. As of the end of 2012, the reporting period from original equipment manufacturers and other third parties have not been standardized, but both PG&E and SCE continue to work the issue.
- **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 original equipment manufacturers is 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 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, Senate Bill 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, Monterey Bay PEV Coordinating Council is actively outreaching to local government to increase awareness and participation in notification protocols based on permitting activity for EV chargers.

2.2.5 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 original equipment manufacturers and other energy system intermediaries such as energy storage and demand response aggregators and EVSE network operators to further develop protocols for "load

11 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.

shedding" of PEV charging as these loads grow over the coming years. To begin this process, the California ISO in collaboration with the California Public Utilities Commission 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. Monterey Bay PEV Coordinating Council has been represented in this process through its partnership with EV 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, Monterey Bay PEV Coordinating Council 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, Monterey Bay PEV Coordinating Council 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 original equipment manufacturers and commercial V2G ecosystems begin to emerge.

2.2.6 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 total 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. The actual bill is presented in Figure 14 below, while a simplified presentation of the rate structure is shown in Figure 15.

Figure 14: PG&E A-10 Rate

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 15: DCFC Calculations

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

19kWh EV battery

Does not include taxes.

Source : PG&E Tariffs are available at
http://www.pge.com/tariffs/ERS.SHTML#ERS

Given 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). Using the same assumption of four charges per day in the summer, below in Table 13 is an illustration of the monthly DCFC energy cost with the two major California utilities in the Central Coast.

Table 13: DCFC Energy Cost

Utility	Tariff	kW charge	Monthly Cost
PG&E	A-1[12]	None	$487
SCE	Time of Use EV-4[13]	$12.18	$1,131[14]

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) time of use 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 time of use 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, see an example in Figure 16 below. 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 electrical components. Those with battery back-up are far more expensive but have additional revenue scenarios (discussed further in Section 3 of this Guide.)

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

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

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

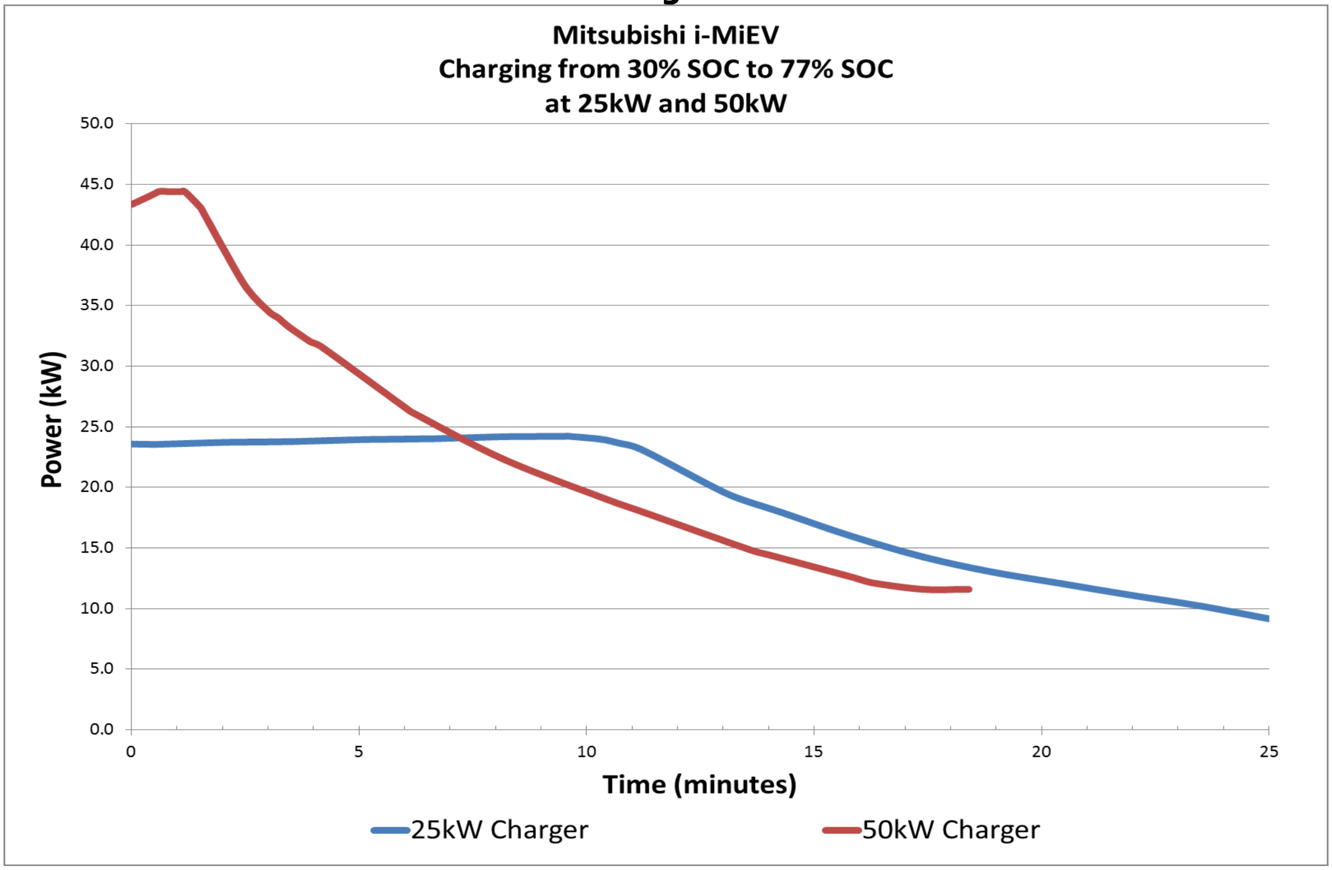
Figure 16: RAPIDAS / Kanematsu 208-volt Battery Backed Fast Charger on Portland's "Electric Avenue

Source: Kanematsu

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 the diagram 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 to 80 percent state-of-charge charging scenario.

In the illustrative case shown in Figure 17 below, a Mitsubishi "i" at a 30 percent state-of-charge can be recharged to 77 percent state-of-charge 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.

Figure 17: Mitsubishi i-MiEV Charging from 30 Percent state-of-charge to 77 Percent state-of-charge at 25kW and 50kW



Source: Study Conducted by Larry Butkovich, General Manager 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.

2.2.7 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 most 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 using PG&E’s tariff, shown in Table 14, demonstrates the impact of operating a Fast Charger with and without battery back-up.

Table 14: Assessing the Cost of Fast Charging With or Without Battery Storage

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 always drawing less than 20 kW from the grid. 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 $1,000 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, 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 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 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.

CHAPTER 3:
Observations and Further Recommendations

3.1 Overview of Barriers and Solutions to Deployment of PEVs

3.1.1 Summary of Vehicle Cost and Charging Infrastructure Issues

The Monterey Bay PEV Coordinating Council has designated the Association of Monterey Bay Governments (AMBAG) to develop a comprehensive regional PEV infrastructure plan, which will include guidelines for siting and developing a robust EV infrastructure. In addition to appropriate siting and support for charging infrastructure, key challenges that must be met to spur mass adoption of PEVs include issues of vehicle cost, ease of installation of residential and commercial charging, and ease of use of charging infrastructure, as summarized below.

Vehicle Cost Issues: PEVs are now in the early stage of technology and market development, and face a barrier of high initial up-front cost, with manufacturer's suggested retail prices for available entry-level PEVs ranging from the mid $20,000 range to the low $40,000 range, prior to rebates. Federal and State incentives can reduce this cost by approximately $9000 - $10,000, which is well within the range of the average new vehicle, at $28,000 in 2011. Further, EVs can be powered for a fraction of the price of gasoline, as much as 80 percent less depending on electricity rate plans and driving habits, and whether the PEV makes use of a range extender gasoline engine (as in the Plug-in Hybrid Electric Vehicle or PHEV configuration.)

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. Other emerging approaches, now pioneering in Europe and Asia with Nissan and Renault, include the potential for separate financing of the battery, which can be structured with the electricity payment as a "bundled solution" that is still less than the price of gasoline. This could lower the initial purchase price of the car.

Over the next several years, battery prices are also expected to decline, with the federal Department of Energy (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. Regionally actionable strategies for addressing the current pricing challenges include group purchases and lease deals for fleet PEVs. An initial set of public fleet deployments through the Bay Area Climate Collaborative and EV Communities Alliance has demonstrated that highly favorable lease terms (in the $125/month range) with no money down and a relatively low annual mileage cap (adequate for most public fleet use cases) has spurred sales with many Bay Area municipalities. These favorable terms will be made available to Monterey Bay fleet managers as well, in both the private and public sector.

Public Charging Infrastructure: The availability of public charging infrastructure is a leading sign to the public of PEV readiness for mainstream adoption and ease of use. More intensive outreach and education of local government and business leaders will likely lead to the installation of greater numbers of PEV Chargers in new construction and retrofits at key locations. Varying charging levels are available for PEVs – including 110 volt Level 1 chargers (which typically require eight hours or more for a full charge); or 240 volt Level 2 chargers (which can require 3-6 hours for a full charge); or 480 volt three-phase DC Fast Charging, which requires approximately 20 to 30 minutes for an 80 percent charge. Cost factors and other issues pertaining to PEV charging rates are discussed in greater detail in the AMBAG Regional Siting Plan, and in Section 3 of this document.

Unlike any other vehicle purchases, would-be Battery-Electric Vehicle (BEV) consumers are not merely buying a car, they are "buying into" a completely new fueling ecosystem that functions differently from the familiar and ubiquitous gasoline station. According to a 2011 survey by Deloitte and Touché, for more than 80 percent of respondents, convenience of charging, 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, Monterey Bay PEV Coordinating Council 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

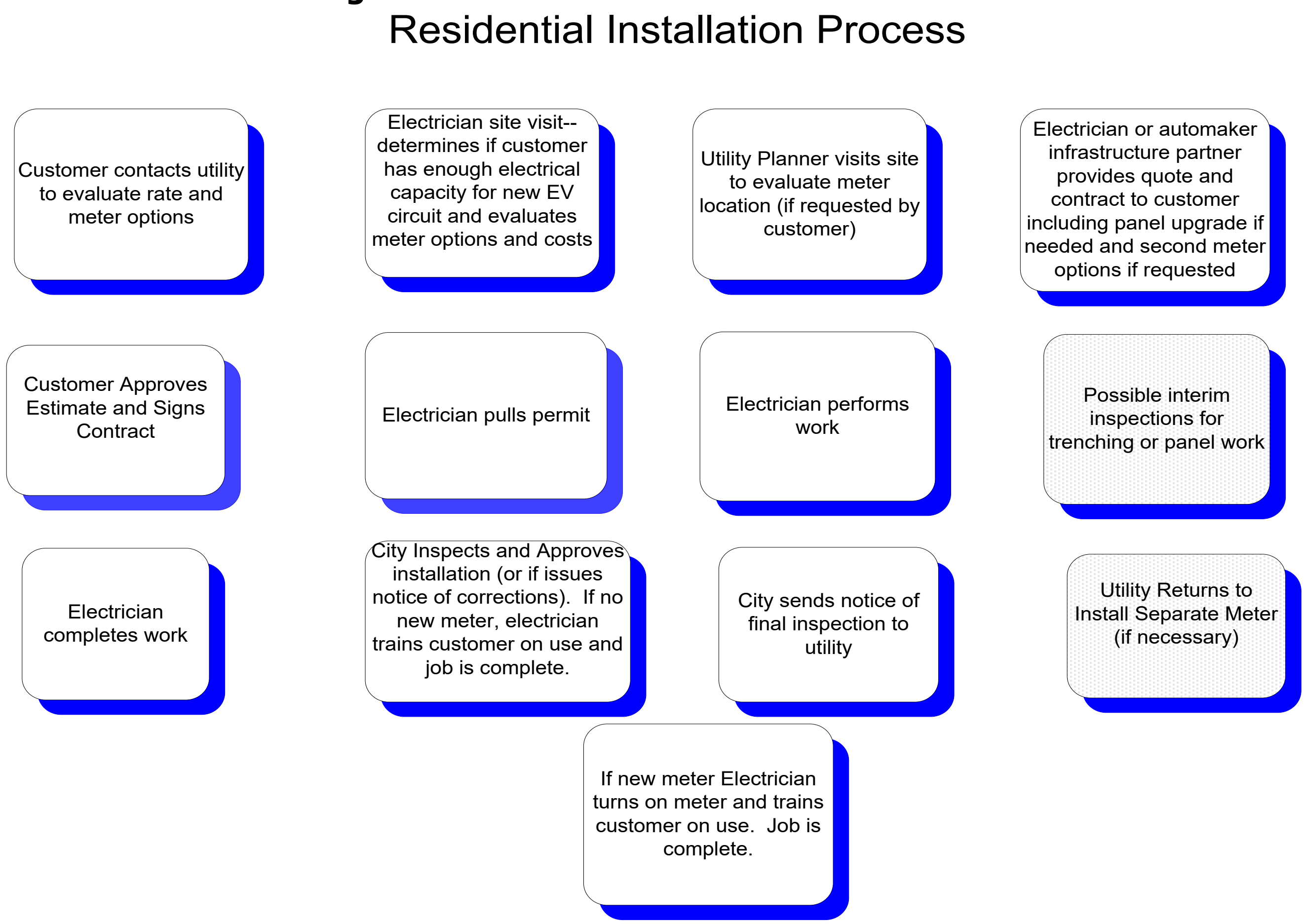
Each of these challenges is discussed briefly below, along with policy recommendations for consideration by the local government leaders.

3.1.2 Single-Family Residential Charger Installation Streamlining Overview

Residential charging is the backbone of the EV charging infrastructure. It is the most convenient option for most drivers, and the least costly based on availability of special EV or "time-of-use" utility rates available from PG&E. Overnight charging also reduces the burden on the utility grid, including its generation and distribution systems. Currently, installation costs for charging at home can be variable, and generally these costs are born fully by the EV driver. Depending on the age and condition of electrical infrastructure in a particular residence, 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 substantial additional costs. Because of this expense, many PHEV drivers and BEV drivers that travel less than 40 miles per day are opting for Level 1 charging at home, at least initially.

To access a less expensive EV-specific electricity rate, PG&E customers can specify a "time-of-use" or time of use 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. Figure 18 on the next page (reading left to right) indicates the complex set of "handoffs" required in many charging station installation scenarios.

Figure 18: Residential Installation Process



Source: Association of Monterey Bay Governments

3.1.3 Recommendations for Streamlining and Accelerating PEV and Charging System Deployment

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 charger infrastructure streamlining recommendations identified below, with explanatory discussion following Table 15 below.

Table 15: PEV Readiness Policy Recommendations

Streamlining 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.
R-2. Provide installation process guidance and checklists	**2A.** City/County leads to modify and adopt.
R-3. Establish reasonable – and flat – charger permit fees.	**3A.** Present information on existing fee structures and recommendation for standardization where feasible and appropriate. **3B.** Report on any fee adjustments by localities.
R-4. Establish phone & online permit and inspection appointment systems for new charger installations as feasible	**4A.** Present examples of online and phone permit and inspection request systems in California. **4B.** Report on online and phone access initiatives by localities.
R-5. Participate in training on EVSE technologies and installation	**5A.** Host EVSE product information and installation workshops for prospective site hosts and contractors.
R-6. Provide utility notification of EVSE installations	**6A.** Host meetings to develop utility notification protocols as needed with local jurisdiction staff and PG&E.
R-7. Outreach to property managers and HOAs to offer multi-unit development info and solutions	**7.A.** Develop multi-family development solutions workshop with utilities, industry experts, and installation contractors
Accelerating PEV Readiness and PEV Deployment	
R-8. Adopt building code amendments to mandate pre-wiring for EVSE in new and remodeled multi-unit buildings.	**8A.** Present model EV-friendly building code amendments to city staff **8B.** Report on results of outreach and engagement process

Streamlining EV Charger Installations	
R-9. Pro-actively meet with charging providers to ensure local sites are prioritized	**9A.** Coordinate plans for charger network deployment with key vendors and EV Service Providers, e.g., NRG, Chargepoint, AeroVironment, Car Charging Group. Powertree, Green Charge Networks, et. Al.
R-10. Engage key stakeholders to provide ongoing oversight of the regional PEV readiness plan	**10A.** Engage staff from local jurisdictions and key agencies for ongoing refinement and monitoring/implementation of the EVSE siting and readiness plan, to include (at a minimum) a representative from the Air Pollution Control District, transportation agencies, counties, and major cities of the region
R-11. Promote building code amendments that mandate EV-ready parking facilities and public works in new construction or major renovations	**11A.** Promote model ordinances and guidelines specifying: -- **minimum levels of pre-wiring** (going beyond the raceway and conduit mandated by 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 MontereyBay Plug-in Electric Vehicle Readiness Plan.
R-12. Integrate PEVs into local public and private fleets	**12A.** Provide guidance to fleet managers on PEV fleet options **12B.** Encourage public agencies to adopt formal goals for PEV fleet acquisitions (e.g., 50% of fleet vehicles will be PEVs by 2025) **12C.** Promote aggregate PEV purchases with attractive financing in cooperation with other local jurisdictions in the region

Source: Association of Monterey Bay Governments

Discussion of Recommendations

R-1. Develop a charger permit form identifying all required elements: Given the relative novelty of EV charging equipment, it can be helpful to both consumers and permitting authorities to provide a simple EV charger permit form and accompanying guidelines for EV chargers. 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 Section 5 of this document. This generic permit form highlights relevant sections of the National Electrical Code and has been co-developed with the National Electrical Manufacturers' Association**.**

R-2. Provide installation process guidance and checklists: 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 Section 5 for residential, commercial, and multifamily installations.

R-3. Establish reasonable – and flat – charger permit fees. Currently, permitting fees for Monterey Bay 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.

R-4. Establish phone and online permit and inspection appointment systems for new EV Charger installations where feasible: 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.) 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. An interim step between online systems is automated phone appointment-setting for inspections. This can reduce transaction time and costs for contractors, residents, and local government staff.

R5. Provide training on EVSE technologies and installation: EV chargers and technologies are unfamiliar to many electrical contractors and building officials. To address this information gap, Monterey Bay PEV Coordinating Council proposes to host a workshop that includes contractors and permitting officials in each County.

R6. Provide utility notification of EVSE installations: EV chargers rated at Level 2 (240 volts) may impose significant impacts on grid infrastructure, especially local transformers, if and when 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 some cases cause a localized outage. To mitigate these impacts, 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.)

R7. Outreach to property managers and HOAs to offer Multi-Unit Development information and solutions: 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, the Monterey Bay PEV Coordinating Council will work with Ecology Action, MBEVA, utilities, and apartment management associations and HOAs to present workshops on solutions for multi-unit developments. Solutions for multi-unit developments are inherently complex, insofar as Multi-Unit Development (MUD) installations must typically conform to the associations or development's facility needs and existing parking layout; economically access adequate power; potentially re-assign parking to permit cost-effective siting of charging stations; and develop protocols for cost-sharing of both capital and operating costs for the charger, including energy and other maintenance and operational expenses.

R8. Adopt building code amendments to mandate pre-wiring for EVSE in new and remodeled multi-unit buildings. A strong policy approach to advancing deployment of chargers in multi-unit development is mandated pre-wiring for EV chargers. The threshold for mandated pre-wiring can be set at new construction or at the time of a major re-model. This is emerging as a recommendation in multiple regions in California. For example, the EV plan recommendations developed for the Southern California Association of Governments (SCAG) by the Luskin Center for Innovation at University of California Los Angeles has recommended that that EV charging stations – not merely pre-wiring – be required of all multi-unit developments at the time of an ownership change. This may be politically challenging for some jurisdictions. However, pre-wiring as such will be a cost-saver for building owners and can be positioned as a "middle-ground" recommendation for jurisdictions not ready to mandate EV charging stations themselves.

R9. Pro-actively meet with EV charging providers to ensure Monterey Bay sites are prioritized: The California Energy Commission's AB 118 Investment Plan for promoting Alternative Fuel Vehicles and related infrastructure provides opportunities for EV charging companies and public agencies to collaboratively develop proposals for EV charger deployment. To ensure that Monterey Bay sites have the best opportunity to be funded in the statewide competition for funds, it is recommended that the Monterey Bay PEV Coordinating Council pro-actively reach out to EV Service Providers, such as Chargepoint, AeroVironment, ECOtality, Powertree, Green Charge Networks, and others as appropriate. In addition, the Plug-in Electric Vehicle Readiness Plan would benefit from close coordination with NRG on its Freedom station deployment (of Fast Chargers and Level Two chargers) and the "make ready" program which will be serving 10,000 sites over the coming years.

R10. Engage key stakeholders to provide ongoing oversight of the PEV readiness plan: The Monterey Bay Plug-in Electric Vehicle Readiness Plan has already engaged many local stakeholders to advise on the development of the region's PEV Readiness Plan. As the Plan transitions from development to implementation phases, the PEV Coordinating Council, Ecology Action, and MBEVA will work together to engage representatives from all municipalities in the region to ensure the maximum deployment of recommended EV readiness policies and programs.

R11. Promote building code amendments that promote EV-ready parking facilities and public works in new construction and major renovations. In addition to regulations pertaining to EV ready buildings, it is recommended that local cities and counties consider adoption of building code amendments that will address EV readiness in parking facilities and public works. There are multiple levels of EV readiness that can be defined in code. The least expensive option at the time of construction of new parking and public works is mandated raceway and conduit for future EV charging stations. This is consistent with existing 2012 CalGreen state building code voluntary standards. A more robust policy option is to mandate the inclusion of actual wiring within the raceway and the electrical switchgear needed to handle the EV charger. Including these components in the ordinance will save more money over time as installation costs are significantly reduced when all the relevant work is performed at the time of facility construction. Recommended minimum set-asides for PEV-ready parking can span a large range. For Monterey Bay communities, a recommended set-aside is in the mid-range of policy options –a 3 percent minimum set aside for office, lodging, medical, and governmental buildings; a 1 percent minimum for retail, recreational, and cultural facilities; and a 10 percent minimum for multiple-dwelling units.

R12. Integrate PEVs into local public and private fleets: PEV fleet adoption can be accelerated through focused programs of outreach and education to fleet managers and organizational leaders. Evaluating the PEV total cost of ownership requires careful assessment of projected fueling expenses based in part on time of use of charging, cost of charging infrastructure, potentially reduced maintenance expenses, battery life, and resale valuations. The Monterey PEV Coordinating Council will provide guidance to fleet managers through the regional PEV Plan and related outreach activities, and through a series of three workshops targeting local jurisdictions in Santa Cruz, Monterey, and San Benito Counties. In addition, the Monterey Bay PEV Council will encourage public agencies to adopt formal goals for PEV fleet acquisitions (e.g., 50 percent of fleet vehicles will be PEVs by 2025). Finally, the Council will work with Ecology Action, the Monterey Bay Unified Pollution Control District, and other stakeholders to promote aggregate PEV purchases with attractive financing in cooperation with the Bay Area EV Strategic Council, the Bay Area Climate Collaborative, and other agencies as appropriate.

3.1.4 Multi-Unit Residential Charger Installation Challenges and Solutions

PEV stakeholders may face a complex set of challenges in facilitating charger installations in multi-dwelling units – including condominiums, apartments, and townhomes. Challenges unique to multi-unit developments include space constraints, the cost of apportioning the costs of the initial installation, tracking usage across multiple users, providing adequate power at reasonable cost to multiple chargers, and addressing the myriad concerns of Homeowners' Associations regarding functionality, aesthetics, cost, liability, ongoing management, and more. For each problem, however, there is a mitigation, if not a perfect solution. A useful overview of challenges and solutions has been provided by San Diego Gas and Electric on their website.

A summary of key issues is included below.

- **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 now available from NRG, a nationwide energy services company. The make-ready program will bring power and a charger stub-out to the designated "make-ready" sites in a

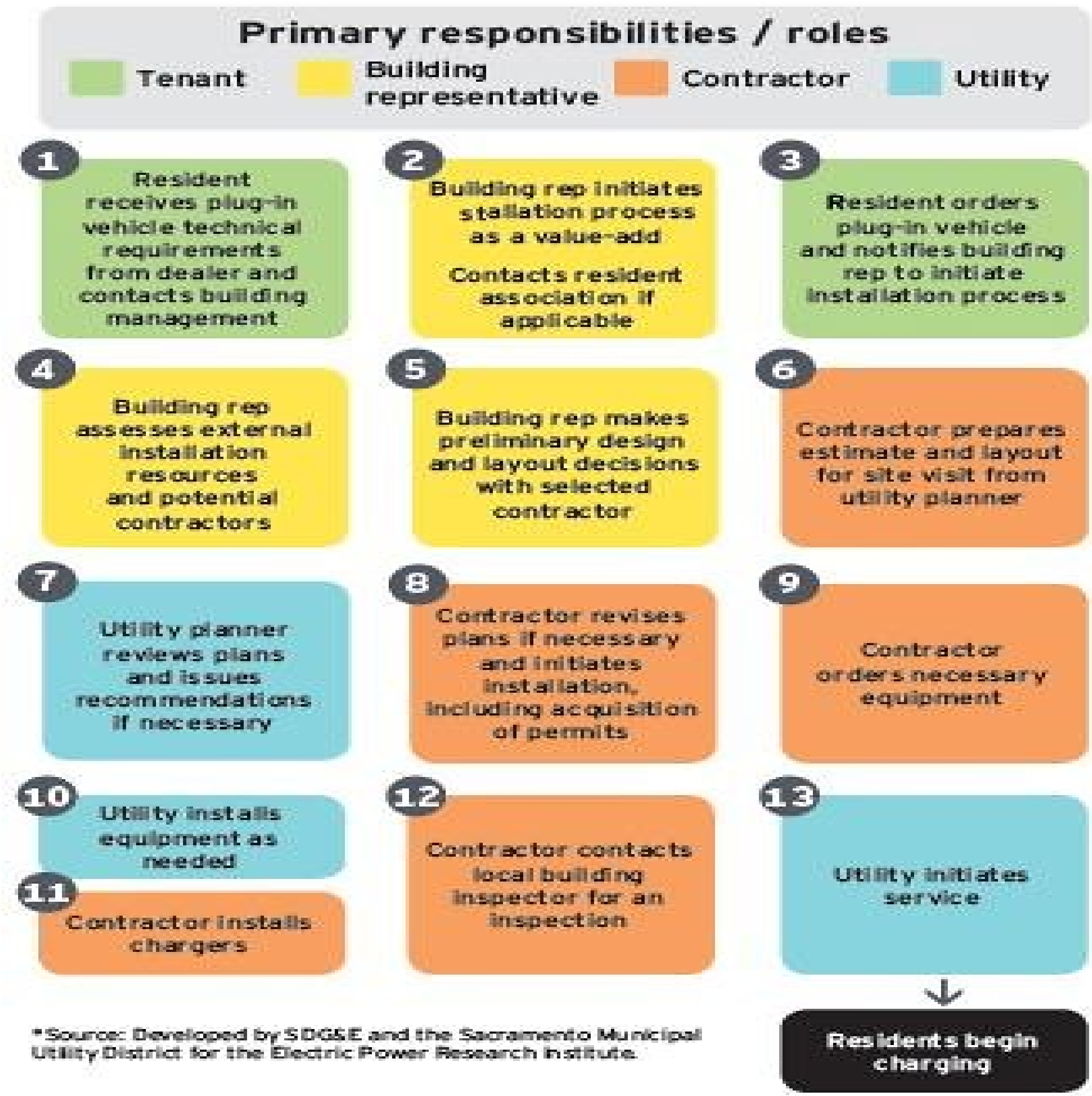
qualified multi-unit building. Under the terms of this program approved by the California Public Utilities Commission, in the first 18 months following the completion of the make-ready site, the site host is obligated to contract exclusively with NRG to install a Level 2 charger if they wish to move forward with an actual installation. (They may also choose not to install a charger.)

- NRG may also initiate installation of the charger on their own, but they will do so only if 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.
- **Challenges to accessing off-peak charging rates:** Off-peak EV charging rates may require a new meter and utility service. Most multi-dwelling units 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 companies such as EverCharge, which 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. Other charger companies, including ChargePoint, have billing solutions that work on multiple charger platforms to apportion energy costs to EVSEs among different multi-unit tenants and management.
- **Limited electrical capacity:** Level 2 chargers typically require a minimum 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 smaller-capacity batteries, as commonly utilized on Plug-in Hybrid EVs (PHEVs). Level 1 charging can be provided by a simple grounded (GFCI) 15-amp circuit, combined with the portable charging device that all PEVs have as standard equipment. Alternatively, a commercial-level Level 1 charger may be procured with a built-in standard EV charge connector (known as the SAE J1772 connector.) A commercial Level 1 charger is approximately the same cost to purchase as the lowest-cost Level 2 commercial chargers (around $1000), but the power requirements and associated electrical system upgrades can be significant cost-saving factors.

Additional cost mitigation strategies can include placement of charging equipment in guest parking or other common areas, rather than in individual stalls. This may require residents to move their vehicle when not charging. In some cases, property management organizations or Homeowners' Associations (HOAs) may 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 charger maintenance and replacement costs.

Multi-family installations sometimes require engineered drawings that include (1) a site plan; (2) a layout showing the electrical work needed and; (3) 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*. The flow chart following shown in Figure 19 indicates the complexity of the multi-dwelling unit installation process, and the inflection points where local jurisdictions, utility staff, contractors, multi-dwelling unit owners, and EV owners must interact for a successful installation.

Figure 19: Multi-Dwelling Unit Installation Flowchart



Source: Developed by SDG&E and the Sacramento Municipal Utility District for the Electric Power Research Institute

To prepare for the installation of EV charging equipment, stakeholders in a multi-unit complex may find it helpful to engage the following activities in this logical sequence. (These guidelines are adapted from processes refined 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.
2. **Engage local EV resources to identify charger options:** Ecology Action, MBEVA, and the Monterey Bay Unified Air Pollution Control District are committed to offering periodic workshops to help consumers learn about EV charging options, costs, and business models. PEV Charging suppliers can also provide information on specific features. Charging technologies for multi-unit use range from simple standalone units that are open to all users without electricity usage tracking, 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 evaluate the wide array of EVSE options available for residential and commercial charging, visit Plug In America, Advanced Energy or GoElectricDrive.
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 multi-dwelling unit team identify the issues to be addressed:
   - How 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?
4. 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.
5. **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 multi-dwelling unit 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).

6. **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.
7. **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.
8. **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.)
9. **Inform residents:** Current and future residents should receive information on where, when, and how to use the new charging stations.

In most cases, there are a large number of steps involved in the installation of charging in a multi-unit development. To move through the process, charging station vendors and utility staff with hands-on experience can help solve 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.

3.1.5 Recommendations for Multi-Unit Residential Charger Deployment

Overview: As noted above, the challenge of installing PEV charging in multifamily residences – including apartments and condominiums – is a key obstacle to full market penetration of EVs. Since much of the Monterey Bay 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, multi-dwelling unit challenges from building owner and resident perspectives, and policy approaches adopted in Los Angeles, which can be considered by Monterey Bay stakeholders.

The City of Los Angeles was among the first municipality in California to begin tackling the multi-development unit 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 in the Monterey Bay region, 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 Multi-Dwelling Units 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 can be significantly less than Level 2, if electrical panel upgrades can be minimized or eliminated by the use of the lower-power charger. Also, simple grounded outlets, if they can be tied to resident meters, can bypass the need for Level 2 J1772 devices. However, if a J1772 device is desired for safety or convenience reasons, a Level 1 J1772 EVSE is approximately the same cost as an equivalent Level 2 charger. There is currently no Level 1 device on the market with sophisticated payment or billing management services, and it is likely that such devices, when they are introduced, will be priced equivalently to a similarly equipped Level 2 device.

Choosing Charging Levels in Multi-Dwelling Units Contexts: EV charging requirements are influenced by the type of PEV (BEV vs. PHEV), battery capacity, daily distance driven and use pattern, and electricity prices, among other factors. Battery charging times for the Nissan Leaf and Chevrolet Volt are indicated below in Table 16 for illustrative purposes.

Table 16: Battery Charging Times

Vehicle Model	Battery Capacity	Hours	
		Level 1 (110/120V)	Level 2 (220/240V)
Nissan Leaf (1)	24 kWh	20	7
Chevrolet Volt (2)	16 kWh	10	4

Source: Nissan Leaf Information is available at http://www.nissanusa.com/leaf-electric-car/faq/view/97#/leaf-electric-car/faq/view/97. Chevrolet Bolt Information is available http://www.chevrolet.com/volt/#technology

Drivers who are depleting the battery on a daily basis need to charge nightly. But if drivers deplete one third 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 and appropriateness of installing a Level 1 vs. a 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 and other BEVs. Level 1 charging may not require any new installation costs, as drivers may use the Level 1 portable charging device that comes with the vehicle, and a 110 outlet is often available in an existing lot or garage.

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 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 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 (if needed for future expansion of Level 2 capacity to multiple stations) will typically trigger a plan review, meaning the applicant will typically 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 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 the price of a 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 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, since these can both enhance resident convenience and enhance the long-term value of the building. The agreement required to install charging could be between individuals, or between the HOA and individuals. For example, EV owners desiring a specific parking space might be willing to pay extra for the space, or swap spaces with the owner of the desired space, if necessary, to lower 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 on an hourly or per charge basis. Opportunities to shift space assignments as needed should be explored 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 rates, average monthly electricity costs are roughly $30 for seven-hour charging every other night, 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, depending on space rental costs. In some higher density downtown areas, space rental fees can be substantial. Apartment owners and managers can pass on amortized capital and installation for chargers to users, but because of the transient nature of renters, and the small number of EV owners currently in apartments, cost recovery within the tenancy of a particular apartment dweller will be challenging in many cases.

Requiring EVSE Installations Upon Sale of a Building: Given the cost factors typically involved in a Level 2 installation scenario, the Luskin Center and other EV readiness advocates have 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.

Mandated EV Charging Code Options: As noted above, 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. 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. The actual text of the ordinance is included in Section 5C of this Plan, "Model Ordinances to Promote Charging in New Construction or Major Remodel."

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, are possible solutions. 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 help pay for the EVSC over time.

3.2 Guidelines for EV Fleets

Context: Monterey Bay 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, the final recommendation of the Monterey PEV Coordinating Council for consideration by local government stakeholders is to *Integrate PEVs into Local Fleets.*

3.2.1 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. 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. 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 natural gas vehicles. 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 Assembly Bill 32 goals, Senate Bill 375 Sustainable Communities Strategies, and municipal and county-level Climate Action Plans

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 Environmental Protection Agency. Additional information on GHG impacts resulting from PEV deployment in the Monterey Bay area is available in the 12 County Bay Area PEV Readiness Plan, available from the website of the Bay Area Air Quality Management District.

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 below 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 costs for ICE v BEV

Operating Cost Comparison ICE vs. BEV	**Internal Combustion (ICE)** TYPE: 5 passenger RANGE: 400 mi. with 16 Gallon tank GASOLINE: $3.50 Gallon FUEL COST/TANK: $56.00/ 400 m	**Battery Electric Vehicle (BEV)** TYPE: Nissan LEAF ~ 1kWh = 4 mi. driving distance RANGE: 96 mi. w/ 24kWh battery ELECTRICITY: $0.056 / kWh (off-peak PG&E summer rate with "E9B" Plan) eFUEL COST: $5.60 / 400 mi.	**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.: $56/400 miles = 14 cents/mile	**$0.014** Electricity cost of 5.6 cents per kWh. 1kWh = 4 Mi. of driving distance = 1.4 cents per mile	**10x less**
Lifetime Costs (6 yrs./108k mi.)	$15,120	$1,512	**$13,608 savings in 6 Yrs.**
Maintenance	**Gasoline (ICE)**	**Electric (BEV)**	**Maintenance**
Est. routine service and engine wear Lifetime Costs (6 Yrs./ 108K mi)	~$6,000	~$2,000	**$4,000 savings in 6 Yrs.**
Ownership	**Gasoline (ICE)**	**Electric (BEV)**	**Ownership Savings**
Est. Insurance (6 Yrs./108K mi.)	~$6,000	~$5,000	**$1,000 savings in 6 Yrs.**
Est. DMV Smog (6 Yrs./108K mi.)	~$400	~$0	**$400 savings in 6 Yrs.**
TOTALS	~$27,520	~$8,512	**~$19,008/6 Yrs.**

Source: PG&E, Nissan

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. By late 2012, PEV models will include examples from every class of vehicle – from high-performance motorcycles (Vectrix, Zero, et. Al.) to medium-duty cargo vans (Smith Electric) to heavy duty Class 8 (Navistar), to SUVs, crossovers, pickups, mini-vans, vans, compacts, sports cars, and luxury cars. Given the rapidly evolving alternative fuel vehicle fleet market, fleet operators are advised to obtain the latest information from organizations such as Plug-in America[15], which tracks all classes of PEVs, and CalStart[16], which focuses on medium and heavy-duty options.

3.2.2 Operating costs for ICE v BEV

A very promising approach to PEV awareness building involves the integration of PEVs into rental and car share fleets. By providing consumers with opportunities to try out PEVs in longer-term use, consumers have a better opportunity to understand PEV performance characteristics, and to experience a variety of models in real-world contexts. Further, car sharing also has the potential to reduce congestion and parking, as car sharing has been shown to reduce rates of car ownership and to boost utilization of other modes of travel, including biking and walking, as well as public transit. For this reason, many regional transportation agencies, local governments, and non-governmental organizations are partnering with car share organizations to pilot test and scale up deployment of EVs in car share applications. In the Monterey Bay regional context, Ecology Action is partnering with a traditional rental company, Hertz, to test PEVs in a car sharing configuration. The program is planned for launch in early 2014, with free sign-up and an estimated $10/hour use fee. The initial car share location will be at the Ecology Action in downtown Santa Cruz. If the program

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15 Plug-in America is available at http://www.pluginamerica.org/

16 CalStart is available at http://www.calstart.org

is successful, it could be expanded to other locations in the area. This program will be widely watched as a test of the feasibility of introducing PEV car share in smaller urban settings.

3.2.3 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.

3.2.4 Publicly Accessible Charger Cost Factors

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

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

Charger Type	Charge	Time to Charge Vehicles at Various States of Charge			Charger Hardware Costs[17]	Installation Costs[18]	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*[19]	$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: PGE

Fleet Charging and Management: Several manufacturers, including Aerovironment, ECOtality, Coulomb, 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

17 Hardware costs are trending downward quickly

18 For hard-to serve installations, costs can vary upwards

19 Higher-cost units have multi-car charging capability

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 Fleet Purchasing: Surveys of major fleets in the tri-county area are ongoing in the summer of 2013 by Ecology Action and will be completed in conjunction with release of the Final PEV Readiness Plan. To advance PEV plans, Monterey Bay fleet operators may wish to consult these key resources:

- U.S. DOE Clean Cities EV fleet handbook
- U.S. DOE Clean Cities EV and Alternative Fuel Vehicle case studies
- American Public Works Association fleet resources
- California Energy Commission links to funded fleet initiatives and infrastructure initiatives

GLOSSARY

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.

ASSOCIATION OF MONTEREY BAY AREA GOVERNMENTS (AMBAG)–A Joint Powers Authority (JPA) governed by a twenty-four-member Board of Directors comprised of elected officials from each City and County within the region. AMBAG performs metropolitan level transportation planning on behalf of the region. Among its many duties, AMBAG manages the region's transportation demand model and prepares regional housing, population and employment forecast that are utilized in a variety of regional plans.[20]

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 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.

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).

[20] AMBAG is available at https://ambag.org/about-us

KILOWATT-HOUR (kWh)—The most commonly used unit of measure telling the amount of electricity consumed over time, means one kilowatt of electricity supplied for one hour. In 1989, a typical California household consumed 534 kWh in an average month.

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.

MONTEREY BAY ELECTRIC VEHICLE ALLIANCE (MBEVA)– Founded in 2009, MBEVA is a California grassroots public-private partnership comprised of diverse stakeholders in the tri-county region of Monterey, San Benito, and Santa Cruz Counties whose overall mission is to promote rapid adoption of plug-in electric vehicles.[21]

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)—A global association of more than 128,000 engineers and related technical experts in the aerospace, automotive, and commercial-vehicle industries. The leader in connecting and educating mobility professionals to enable safe, clean, and accessible mobility solutions.[22]

SOCIETY OF AUTOMOTIVE ENGINEERS J1772 RECOMMENDED PRACTICE FOR ELECTRIC VEHICLE AND PLUG-IN HYBRID ELECTRIC VEHICLE CONDUCTIVE CHARGE COUPLER (SAE J1772)—Covers the general physical, electrical, functional, and performance requirements to facilitate conductive charging of EV/PHEV vehicles in North America. Defines a common EV/PHEV and supply equipment vehicle conductive charging method including operation requirements and the functional and dimensional requirements for the vehicle inlet and mating connector.[23]

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.

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[21] MBEVA is available at https://mbeva.org/about/

[22] Society of Automotive Engineers (https://www.sae.org/about/)

[23] Society of Automotive Engineers (https://www.sae.org/standards/content/j1772_201001/)

APPENDIX A: 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 of Santa Barbara**: 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, available at http://www.c-5.org/.
- **San Luis Obispo County Air Pollution Control District**: Provides leadership on clean air issues for San Luis Obispo County and on the Monterey Bay PEV Coordinating Council Steering Committee, available at http://www.slocleanair.org/index.
- **Santa Barbara County Air Pollution Control District:** Provides leadership on clean air issues for Santa Barbara County and on the Monterey Bay PEV Coordinating Council Steering Committee, available at http://www.sbcapcd.org/.
- **Ventura County Air Pollution Control District:** Provides leadership on clean air issues for Ventura County and on the Monterey Bay PEV Coordinating Council 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/.
- **Re-Cargo**: 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/afdc/vehicles/index.html.
- **Department of Energy resources**:
    - Hybrid and Plug-In Electric Vehicles fact sheet is available at http://www.afdc.energy.gov/afdc/pdfs/52723.pdf.
    - Plug-In Electric Vehicle Handbook for Consumers is available at http://www.afdc.energy.gov/afdc/pdfs/51226.pdf.

  - Plug-In Electric Vehicle Handbook for Electrical Contractors is available at http://www.afdc.energy.gov/afdc/pdfs/51228.pdf.
  - Plug-In Electric Vehicle Handbook for Fleet Managers is available at http://www.afdc.energy.gov/afdc/pdfs/pev_handbook.pdf.
  - Plug-In Electric Vehicle Handbook for Public Charging Station Hosts is available at http://www.afdc.energy.gov/afdc/pdfs/51227.pdf.
- **Plugging In – A Consumer's Guide to the Electric Vehicle**: From the Electric Power Research Institute, available at http://www.baaqmd.gov/~/media/Files/Strategic Incentives/EV Ready/EPRIPlugging InA Consumers Guide to the Electric Vehicle.ashx.
- **Electric Auto Association** (EAA): A not-for-profit educational, support, and advocacy group that promotes electric vehicles, available at http://www.electricauto.org/.
- **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 is available at http://www.afdc.energy.gov/pdfs/pev_handbook.pdf.

U.S. DOE Clean Cities EV and Alternative Fuel Vehicle fleet case studies are available at http://www.afdc.energy.gov/case/.

American Public Works Association 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 funding for Evs and EV infrastructure are 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 released an online tool that shows details of EV purchasing trends based on rebates awarded by the statewide Clean Vehicle Rebate Project. 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 is estimated that no more than a few dozen Volts sold in the Central Coast are in the original group that was not included in the Clean Vehicle Rebate Project database.

APPENDIX B:
Sample Brochure on EV Readiness for Distribution by Local Government

Guide to Electric Vehicle Charging in the Monterey Bay Area

Welcome to the EV Era!

The local governments of the Monterey Bay Area welcome 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. The use of EVs in the Monterey Bay Area 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 the Monterey Bay Area. A convenient map of charging stations is available at www.recargo.com/search. 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 issues and installation options, and the help available from our many local "EV ecosystem" partners.

EV Benefits

EVs are a great match for Monterey Bay are lifestyles because they are 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. PHEVs – 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 100 miles, while the forthcoming Tesla Model S has battery options ranging from 160 miles to 320 miles. PHEV "all-electric" driving ranges vary from approximately 12 miles (the 2012 Plug-in Prius) to approximately 40 miles (the

Chevy Volt.) Once battery power is depleted, the PHEV gas engine takes over seamlessly, and allows unlimited driving 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.

EV Charging Technology

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. All EVs are equipped with a portable 110 volt charging device that can plug directly into a typical 110-volt receptacle, or a J1772 connector can be used with 110-volt power.

Level 2: Level 2 chargers utilize 220/240 volts AC (30– 80 amps) – and require ~ 4-8 hours to fully recharge a BEV. Approximately 10-15 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 $9,000+ depending on hardware design, vandal resistance, communications features, and available multi-port options for accommodating two or more vehicles.

Virtually all newer 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, shown below in Figure 20, have extensive safety features, including automatic power shut-off if the connector is unplugged

Figure 20: Level 2 Charging Connector and Inlet

Source: CALeVIP

DC Fast Charging: DC Fast Chargers enable rapid charging of an EV (from a nearly-empty battery) in 20 – 30 minutes. The current generation of Fast Chargers require an additional charging connecter based on the Japanese "Chademo" standard. These are currently available on the Nissan Leaf, the Mitsubishi i-MiEV 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 2013, and several 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). Beginning in late 2013, an additional DC Fast Charge standard known as the "SAE Combo 2" connector will be introduced for American and European cars. The Chevy Spark and the BMW i3 will be first models accepting the Combo 2 connector. Initially, the current Chademo chargers will not be compatible with the new SAE Combo 2 standard. However, beginning in 2014, many new Fast Chargers are expected to be "dual compatible" with both standards.

Home Charger Installations

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.

1. Customer contacts charger manufacturer to identify preferred equipment (see Resource list below). Charger companies may recommend specific installers.
2. Electrician visits site and determines if customer has adequate electrical capacity for new EV circuit and evaluates meter options and costs.
3. Utility planner visits site (if needed) to evaluate meter location.
4. Customer approves estimate, and signs contract.
5. Customer or electrician orders charger and any related electrical supplies.
6. Electrician obtains permit at the local authority having jurisdiction (usually your local city).
7. Electrician performs work, including meter install if needed, and contact s City for inspection.
8. City inspects and approves installation – or issues notice of correction. Electrician trains customer on use, and job is complete.
9. 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: For information on charging and vehicles, see: 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 is available at www.pge.com/mybusiness/environment/pge/electricvehicles/index.shtml

Vehicle and Charger Rebates: EV charger and vehicle rebates may be available but are subject to change as available rebate funds are limited. The combined total of federal and state rebates is up to $9,000 for plug-in hybrid vehicles (PHEVs) or $10,000 for Battery-Electric Vehicles (BEVs). 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 (Assembly Bill 475) requires that cars occupying designated EV spaces be plugged in to the charger.

EV Information Resources

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

ECOtality is available at www.ecotality.com

General Electric is available at www.geindustrial.com

Local Permitting Requirements: Local Permit requirements and costs vary by municipality in the tri-county Monterey Bay Area. To determine local fees and permit procedures, visit the website of your city or town and search for electrical permits, or if you live in an unincorporated area, see your local county building department website.

APPENDIX C: Impact of PEV Deployment on GHG Emissions in the Monterey Bay Area

The deployment of PEVs represents a significant opportunity to accelerate accomplishment of GHG and criteria pollution reduction goals throughout California, including the Monterey Bay region. Accordingly, the California Energy Commission has requested that PEV Coordinating Councils define the potential contribution of PEVs to GHG reduction in the period 2015-2035. Regions have not been provided with a single approach to estimating the potential future contribution of PEVs but are expected to make regionally appropriate assumptions based on available data sources from the California Air Resources Board (EMFAC database), California Environmental Protection Agency, and other sources as appropriate. As discussed below, as of mid-2013, the Monterey Bay region has one more year in which to fully develop an emissions reduction framework that meets the conditions of the Sustainable Communities and Climate Protection Act of 2008. Currently, there is no standard forecasting approach for PEV impacts on emissions that has yet been developed by the Association of Monterey Bay Area Governments, which is the lead agency for SB 375, or their sister MPOs and other partner agencies. Therefore, the following discussion presents two potential approaches to inform the SB 375 process. The CEC specifically has encouraged this diversity of approaches[24].

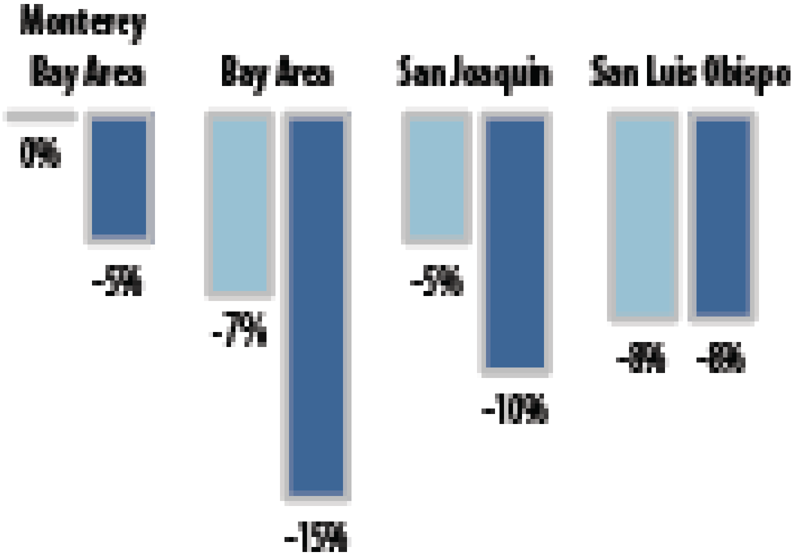
The first approach to GHG estimation is based on projections by the Bay Area Metropolitan Transportation Commission, supplemented by analysis and recommendations from the Bay Area PEV Readiness Plan, developed by ICF International for the Bay Area Air Quality Management District and the Bay Area EV Strategic Council. The second approach to GHG estimation is consistent with methodologies used by the Plug-in Central Coast PEV Coordinating Council, which includes the three Air Districts of Ventura, Santa Barbara, and San Luis Obispo Counties. These two regions adjoin the Monterey Bay to the North and South, respectively, of the tri-county region.

The Sustainable Communities Planning Process in the Monterey Bay Region: The Sustainable Communities and Climate Protection Act of 2008 (SB 375) requires California's metropolitan planning organizations (MPOs) to prepare a sustainable community's strategy to demonstrate how each region will meet its regional greenhouse gas (GHG) reduction target established by the California Air Resources Board. The Association of Monterey Bay Area Governments – representing Monterey and Santa Cruz Counties, together with the San Benito Council of Governments -- are the MPOs for the tri-county Monterey Bay region. Based on an agreement between these Associations of Governments and California Air Resources Board, the tri-county Monterey Bay Area sustainable community's strategy target is a 0 percent per capita increase in GHG by 2020 and a 5 percent per capita reduction by 2035 -- with 2005 as the base year. The Sustainable Communities Strategy and Metropolitan Transportation Plan documents that will describe how the region intends to achieve these targets are in the early

24 Per communication on August 21, 2013 with CEC Program Officer Lindsee Tanimoto.

phase of preparation and are scheduled for completion in June of 2014. Figure 21 below illustrates how the per capita reduction targets compare to neighboring regions.

Figure 21: Monterey Bay Area GHG Targets: 2020 and 2035



Note: Daily per capita GHGs from cars and light trucks only. Reduction from 2005 levels.
Source: California Air Resources Board, September 2010

The AMBAG Role in Transportation Planning: As the MPO for the region, AMBAG coordinates the development of the Metropolitan Transportation Plan (MTP) with Regional Transportation Planning Agencies (including the San Benito County Council of Governments, the Santa Cruz County Regional Transportation Commission and the Transportation Agency for Monterey County), transit providers (including the San Benito County Local Transit Authority, Monterey Salinas Transit, and Santa Cruz METRO Transit District), the Monterey Bay Unified Air Pollution Control District, state and federal governments, and organizations having interest in or responsibility for transportation planning and programming. AMBAG also coordinates transportation planning and programming activities with the three counties and eighteen local jurisdictions within the tri-county Monterey Bay Region.

The PEV Readiness Plan, the Metropolitan Transportation Plan, and the Sustainable Communities Strategy: The Metropolitan Transportation Plan is the federally mandated long-range transportation plan for the Monterey Bay Area. This plan lays out a financially constrained list of transportation projects over the following 25 years that will enhance regional mobility as well as reduce greenhouse gas emissions. AMBAG will adopt a new Metropolitan Transportation Plan that incorporates the requirements of Senate Bill 375 in June of 2014. The current Transportation Plan does not include any significant investments in PEV infrastructure. The intent of the Monterey Bay PEV Readiness Plan document is to present information on potential strategies for PEV growth (and consequent GHG reductions) that could further reduce emissions over a "base case" that does include any specific PEV promotion strategies.

Most regions, including Monterey Bay, are planning to derive their GHG reductions mainly from reduced vehicle miles traveled (VMT) via a combination of housing/land-use planning and transportation investments. Because of the low-density character of much of the region, and the limited infrastructure for public transportation, the Monterey Bay region has lower GHG reduction targets than other regions. Also, the Monterey region is designated as "in attainment" for the federal air quality standards, which exempts the region from the Air Quality Conformity Analysis that is otherwise required in the context of regional transportation planning. However, the region has yet to attain all relevant state air quality standards, and further work is necessary to reduce GHG and criteria pollutants. The relative dependence of the region on autos for transportation may have the effect of *increasing* the potential impact of PEV adoption on GHG and air quality (proportionate to other strategies), since VMT reductions are likely to be relatively limited given regional geography, housing and employment patterns, and public transportation infrastructure.

The nine-county Bay Area Sustainable Communities Strategy and Regional Transportation Plan includes several PEV-specific programs that may be appropriate for consideration in the Monterey Bay region. Relevant programs are shown in Table 19. The Climate Initiatives Innovative grants has funded programs such as EV car sharing and an EV taxi program.

Table 19: Summary of Nine-County Bay Area PEV and Related Climate Program Initiatives

Policy Initiative	Cost ($ millions)	Per Capita Emission Reductions
Clean Vehicles Feebate Program*	$25	0.7%
Vehicle Buy Back & PEV Purchase Incentive	$120	0.5%
Regional EVSE Network	$80	0.3%
Climate Initiatives Innovative Grants	$226	TBD

Source: ICF Bay Area EV Readiness Plan. *The feebate program would impose a fee on higher-emissions vehicles and rebate the fee to PEVs and other low-emission vehicles.

The nine-county Bay Area PEV strategy developed to inform the Senate Bill 375 process defines two broad pathways to achieve greater GHG emissions reductions:

- Implement a program that accelerates PEV adoption
- Implement a program that increases charging opportunities, thereby increasing the amount of electricity that displaces gasoline (particularly in PHEVs).

For the Monterey region, there has not yet been identified any funding sources comparable to the Bay Area Metropolitan Transportation Commission program described above, which relies on projected federal funding that is considered likely to be forthcoming but has not yet been formally authorized. For the Monterey Bay region, the GHG emission reductions projected from the introduction of PEVs follows a "medium baseline case" of expected growth in PEVs, reflecting no special additional funding. The projection is based on the midpoint of the California PEV Collaborative's set of projections for statewide EV market growth in the period to 2035.

Over the coming year, the Association of Monterey Bay Area Governments (AMBAG) and their regional partners will be completing their sustainable community's strategy plan. In that context, policymakers may wish to consider how additional GHG reductions beyond the baseline scenario could be achieved through the allocation of additional resources to PEV-related incentives, programs, and policies. To inform this analysis, the following report presents a number of options for PEV-related incentives that have been prepared for the Bay Area Sustainable Communities Strategy development process by ICF International, in fulfilment of a PEV regional planning contract with the Bay Area Air Quality Management District, with oversight of the Greater Bay Area EV Strategic Council.

Accelerating PEV Adoption: Key Incentives

One of the barriers of accelerating PEV adoption is the high purchase price of PEVs. Currently, a combination of the federal tax credit and the state rebate helps to reduce the purchase price of vehicles significantly; however, the long-term availability of these programs is unclear. For instance, the current federal tax credit is phased out for a manufacturer once they reach a threshold of 200,000 qualified PEV sold. This federal tax credit is estimated to phase out for the major automobile manufacturers starting in 2018. In addition, the California Clean Vehicle Rebate Project, which is funded via Assembly Bill 118, is also set to expire at the end of 2015. Although there are efforts in place to extend the incentive programs developed by Assembly Bill 118 (e.g., Assembly Bill 8 and Senate Bill 11), continuation of these programs is also dependent on California Legislature approval. Thus, the availability of future funding from this program is not certain. Therefore, by 2020, the Monterey Bay Area can expect limited purchasing incentives available for PEVs. Depending on vehicle pricing, there may be an opportunity for regional agencies to offer more modest incentives that help continue the acceleration of PEV purchases in the middle- and low-income brackets. The current vehicle buy-down incentives offered through grant programs administered by the Monterey Bay Unified Air Pollution Control District is an example of an existing program that provides direct PEV purchase incentives to qualified fleet operators and provides a rational framework for calculating community benefit in terms of dollars per ton of reduction in GHG and criteria pollutants. Additional funding through this or other programs could have a meaningful impact on PEV adoption if resources were significantly scaled up.

Increasing Charging Opportunities to Increase Electric VMT

Consumer surveys indicate that the limited range of BEVs (50-100 miles) is a barrier to BEV purchasing. PHEVs generally have a lower all-electric range and therefore deliver lower emissions benefit, while providing the consumer convenience of unlimited range at a higher purchase price than comparably equipped BEVs. The GHG emission reduction benefits attributable to BEVs and PHEVs are a function of many variables; but primarily vehicle miles travelled (VMT) in all-electric range. Determining electric VMT for BEVs and PHEVs differs. For BEVs, analysts often assume lower overall VMT based on vehicle range; for PHEVs, analysts make assumptions on percentages of total VMT that is all-electric. By increasing opportunities to charge PEVs through an incentivized infrastructure program, a region can maximize emission reduction benefits of PEVs by displacing petroleum with electricity. While most PEV drivers charge at home, PEV drivers can extend their all-electric range as workplace and other public charging opportunities are increased. In addition, a focused program to increase charging opportunities in multi-unit residential developments can increase the number of people who are willing to purchase a PEV, by eliminating one of the barriers to adoption.

Developing a Baseline for PEVs – Bay Area Metropolitan Transportation Commission Assumptions vs. EMFAC 2011

One of the challenging aspects of demonstrating GHG reductions from incentive programs is knowing the baseline from which to measure results. EMFAC is a tool designed by the California Air Resources Board to estimate vehicle emissions, and this was used for the Monterey regional PEV estimates. However, an alternative approach has been developed for the nine-county Bay Area that Monterey stakeholders may wish to consider. The Bay Area Metropolitan Transportation Commission chose a different approach because EMFAC2011 does not include baseline assumptions regarding vehicle fleet emissions shifts as a result of the Advanced Clean Cars Program. This California Air Resources Board program impacts the percentage of zero emission vehicles that automakers are required to sell in California out to 2025. To exceed these minimum levels required by California Air Resources Board, Metropolitan Transportation Commission developed a baseline for vehicles and emissions using EMFAC2011 with several modifications described below. Also, the baseline for GHG emissions from light-duty vehicles in the Bay Area was developed using well-to-wheels emission factors rather than the tailpipe emission factors reported in EMFAC, to more accurately define the full emissions reductions achieved through the shift to PEVs.

The following subsections outline the methodology employed to develop the baseline vehicle populations, including PEVs, and associated GHG emissions in the nine Bay Area counties. Generally, Metropolitan Transportation Commission used a combination of data from EMFAC2011 and California Air Resources Board documentation for the Advanced Clean Cars Program; these data were supplemented by assumptions developed to account for regulations such as Pavley Standards, the Low Carbon Fuel Standard, and the zero emission vehicle Program.

Baseline Vehicle Fleet Growth Under Metropolitan Transportation Commission Assumptions

The number of vehicles reported in EMFAC2011 for the nine Bay Area counties was used to develop a baseline vehicle population. The analysis was limited to light-duty vehicles, including light-duty automobiles and light-duty trucks (LDT1 and LDT2). New vehicles sales in the Bay Area were estimated based on statewide projected sales in 2011. Based on EMFAC and sales data from the California New Car Dealers Association, the Bay Area is estimated to account for approximately 21 percent of vehicle sales in California. The baseline also assumes vehicles sales will increase at an annualized rate of about 0.5 percent out to 2035, based on growth rates extracted from EMFAC.

Also included in the baseline is the assumption that PEVs must be deployed to meet the requirements of the zero emission vehicle Program, which requires automobile manufacturers to introduce zero tailpipe emission vehicles in volumes that increase over time. The program may also be implemented using emission reduction credits, which vary depending on factors such as emission control technology used and vehicle range. The baseline uses California Air Resources Board documentation—which describes the most likely compliance scenario,[25] a mix of transitional zero emission vehicles, BEVs, and hydrogen fuel cell vehicles (FCVs)—and the

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25 Appendix B, Draft Environmental Analysis for the Advanced Clean Cars Program, CARB, December 2011. ICF International also drew from an ARB Staff Presentation dated November 16, 2010 entitled "ZEV Regulation 2010, Staff Proposal", available at http://www.arb.ca.gov/msprog/zevprog/2011zevreg/11_16_10pres.pdf

assumption that transitional zero emission vehicle s would all be PHEVs. Also included in the baseline is the assumption that the percentage of zero emission vehicles sold in the Bay Area is proportional to the percentage of total light-duty vehicles sold in the Bay Area compared to the entire state. This is a fair-share assumption; the Bay Area can expect that near-term PEV sales will be proportionally higher than other regions in California, however the Bay Area may not sustain higher PEV sales for the entire 25 years of this projection (2010-2035).

By using information presented by California Air Resources Board on the updated zero emission vehicle Program, penetration of PHEVs, BEVs and FCVs were estimated out to 2025. Beyond 2025, PEV sales as a percent of total vehicle sales are assumed to remain constant, since there is no regulatory driver for increased PEV sales post-2025. Table 20 below shows the penetration rates reported as new vehicle sales.

Table 20: Percent New Vehicle Sales for Bay Area Baseline

Year	% New vehicle sales		
	PHEV	BEV	FCV
2020	5.2%	2.2%	0.6%
2035	9.2%	3.7%	2.5%

Source: ICF Bay Area EV Readiness Plan.

The zero emission vehicle Program includes provisions for original equipment manufacturers to earn credits for over-compliance,[26] as measured by grams of carbon dioxide per mile. These over-compliance credits can effectively reduce the zero emission vehicle requirements for automakers out to 2021, thereby decreasing the total number of PEVs required to be deployed by any given original equipment manufacturer. However, for the purposes of this exercise, this analysis assumes that manufacturers would not use this as a compliance option.

A vehicle turnover profile extracted from EMFAC to calculate the total number of PEVs (i.e., vehicle stock or total PEV population as opposed to new vehicles) is applied over time. The turnover for PEVs may be different than for conventional vehicles, however, there is no convincing data at present to modify the fleet turnover profile.

Baseline GHG Emissions – Options for Analysis

GHG emissions attributable to light-duty vehicles in the Bay Area are estimated on a lifecycle basis. From the standpoint of developing PEV-related scenarios for the sustainable community strategy, it would be an apples-to-oranges comparison if the baseline did not account for the upstream emissions of electricity used as a transportation fuel. The GHG reduction benefits of PEVs on a strictly tailpipe emissions basis is much more significant. Although the emissions were calculated on a lifecycle basis, CO_2 emissions were only considered as opposed to equivalent CO_2 emissions in the estimates.

The GHG emissions attributable to light-duty vehicles are a function of vehicle fuel economy, the corresponding emissions factor(s) for the fuel(s) used, the VMT, and the vehicle lifetime.

26 See Section 1962.2(d)(6)(C) of the Final Regulation Order for the Zero Emission Vehicle Regulation: 2018 and Subsequent Model Years for more information.

To estimate the GHG emissions attributable to conventional vehicles using gasoline, PHEVs, BEVs, and FCVs, the carbon intensity values, and the energy economy ratios shown in Table 21 below were used. For the most part, these values are either taken directly from or modified based on the Low Carbon Fuel Standard documentation. The following adjustments and modifications were made:

- For reformulated gasoline, the Low Carbon Fuel Standard were accounted for by subtracting the GHG reductions attributable to the baseline deployment of PHEVs, BEVs, and FCVs in the Bay Area and adjusting the carbon intensity of reformulated gasoline to reflect the remaining reductions required to comply with the regulation. As a result, the carbon intensity of reformulated gasoline decreases post-2020 to reflect the implementation of Low Carbon Fuel Standard.
- For electricity, the carbon intensity of PG&E's generation mix[27] were calculated and used as a proxy for the entire Bay Area. Compliance with the Renewable Portfolio Standard were accounted for in the calculation of the carbon intensity for electricity and included the assumption that PG&E would meet the 33 percent goal by 2020; as a result, the carbon intensity post-2020 was adjusted accordingly.
- In the case of hydrogen consumption in FCVs, values in 2020 were adjusted assuming that 50 percent of the hydrogen consumed was generated via on-site steam reformation using methane and that the remaining 50 percent was generated via on-site reformation using renewable feedstocks.

Table 21: Carbon Intensity Values Used in Regional Emissions Analysis

Fuel	Carbon Intensity (g CO2-eq/MJ)		EER[28]	Notes
	2010-2020	**2021+**		
Gasoline	96.09	87.43	--	Updated in 2020 to account for Low Carbon Fuel Standard reductions
Electricity	99.24	79.27	3.4	PG&E generation mix; updated in 2020 for the Renewable Portfolio Standard
Hydrogen	142.20	87.20	2.5	Adjusted in 2020 assuming: 50% on-site NG reformation and 50% on-site reformation w/ renewable fuel

Source: ICF Bay Area EV Readiness Plan.

For simplicity, this analysis assumes a constant annual VMT of 12,333 miles. This value was taken from EMFAC2011 based on vehicle age. For PHEVs, this analysis assumes that 30 percent of the VMT would occur "all-electric" miles. The annual GHG emissions for years 2015-

27 PG&E 2009 Projected Resource Mix, available online at http://bit.ly/J0S6Ma

28 See Table 5 in Proposed Regulation Order Subchapter 10, Article 4, Subarticle 7. Low Carbon Fuel Standard, Section 95485, October 2011.

2035 in 5-year increments are shown below in Table 22 and reported in units of million metric tons.

Table 22: Baseline GHG Emissions from Light-duty Vehicles for the Bay Area

Year	GHG Emissions			
	PHEV	**BEV**	**FCV**	**Total Light-duty Vehicles**
2015	0.060	0.006	0.002	25.825
2020	0.178	0.021	0.006	19.315
2025	0.422	0.060	0.036	17.162
2030	0.670	0.096	0.074	15.927
2035	0.862	0.123	0.106	15.432

Source: ICF Bay Area EV Readiness Plan.

Review of Program Options to Accelerate PEV Adoption

A variety of programs have been proposed to achieve GHG reductions as part of Plan Bay Area, the nine-county region's Sustainable Communities Strategy document. These approaches could be considered by Monterey Bay stakeholders as means to achieve a level of PEV adoption that is greater than baseline rates projected based on existing state and federal policies and incentives. The programs reviewed below include Vehicle Buy Back and PEV Incentives, and regional charger network expansion.

Vehicle Buy Back and PEV Incentive Program

Despite the near-term success of PEVs in the state and region, sales are still relatively small and represent just 0.5 percent of total new light-duty vehicle sales. There is also some uncertainty regarding the medium- to long-term availability of the federal PEV tax credit and the California state rebate. Furthermore, one of the main drivers today for PEV sales, particularly for PHEVs, is the HOV lane access incentive. However, these are currently limited, and future growth in sticker availability would erode the benefit by subjecting HOV lanes to congestion similar to regular lanes. PHEVs eligible for the green sticker are limited to the first 40,000 applicants through January 1, 2015, and BEVs are eligible for the white sticker and qualify through January 1, 2015. As of March 2013, nearly 11,000 green stickers have already been issued in California.[29]

A combination of incentives to purchase PEVs and to buy back older vehicles could extend the market for PEVs into a broader range of income classes and accelerate fleet turnover. The first adopters of PEVs have been higher income individuals who own their homes. Thus, there is a need and opportunity to extend the opportunity to individuals with relatively lower incomes.

[29] CARB Mobile Source Program is available at http://www.arb.ca.gov/msprog/carpool/carpool.htm. Accessed March 28, 2013.

Further, Americans are holding on to their cars for nearly two years longer than the historic average. This will impact the turnover of the fleet significantly and may slow the purchase of new vehicles, including PEVs. Depending on the fuel economy threshold set by the program, the combination vehicle buyback and incentive program would potentially increase demand in middle- and lower-income brackets that might otherwise delay car purchasing, purchase a new conventional vehicle, or purchase a used vehicle.

Given the longer-range uncertainty of the incentives for PEV purchasing, Metropolitan Transportation Commission has proposed a vehicle buyback program. The program, scheduled to start in 2020, will be designed as a trade-in for older vehicles that meet a certain fuel economy threshold (as measured via fuel economy). The consumer would only be eligible for the trade-in if the new vehicle being purchased is a PHEV or BEV. The incentive amount will vary with the fuel economy of the vehicle being traded in (measured in mpg) as well as the vehicle type being purchased (e.g., PHEV or BEV).

Assumptions and Methodology

There are two aspects of a vehicle buyback program which can reduce GHG emissions: the first is attributable to the accelerated turnover of vehicles and the second is due to the accelerated deployment of PEVs. To estimate the GHG benefits of the accelerated turnover of vehicles as a result of the program, this analysis uses an estimated fuel economy improvement of 0.5 percent. The fuel economy improvement was estimated based on displaced older vehicles in the fleet (>10 years old).

To estimate the GHG benefits of the increased deployment of PEVs, the analysis starts with the question of how many vehicles would need to be deployed to achieve X percent of GHG emission reductions? Based on the number of deployed vehicles, this analysis will estimate the average annual increase in new vehicle sales that would be required to achieve the total PEV deployment.

This initial analysis assumes that deployed vehicles would be split 50/50 between PHEVs and BEVs.

This analysis assumes incentive level would average about $1,000 per PHEV and $2,000 per BEV.

Analysis Steps

- Decrease number of vehicles older than 10 years based on estimated PEVs deployed as part of program.
- Estimate fuel economy improvement based on accelerated turnover.
- Calculate GHG emissions of improved fleet fuel economy.
- Calculate GHG emissions of increased PEVs deployed.

Estimated Program Investment and Results

The costs of the program are two-fold: (1) the monetary value of the incentives deployed and (2) the costs of administering the program. Costs of the incentives were determined by multiplying the number of PHEVs and BEVs deployed (assumed 50/50 split) as part of program by incentive level ($1,000 and $2,000, respectively). The administration costs were assumed to be 5 percent of the costs of the incentives; this is consistent with the level of administrative support required for programs such as the Hybrid Truck and Bus Voucher Incentive Program and the Clean Vehicle Rebate Project.

The benefits of the program will enable the deployment of about 47,000 additional PEVs on the road in the Bay Area by 2035 compared to the estimated 535,000 PEVs in the 2035 baseline scenario. This is a modest annual increase of about 0.5 percent in new vehicle sales attributable to the buyback incentive program. This increased deployment of PEVs will result in:

An estimated reduction of 414 short tons of CO_2 daily in 2035, a 0.5 percent reduction in daily per capita emissions compared to the 2005 base year. A total escalated cost of the program is estimated to be $120 million.

Regional Charging Network Expansion

Expanding the regional PEV charging network has the potential to increase the proportion of all-electric miles driven by PHEVs, to increase the utility of BEVs, and to increase the attractiveness and utility of the BEV as a primary vehicle, in turn increasing electric miles as a share of total fleet miles.

PHEVs differ considerably in their all-electric range – from about 10-40 miles. For instance, the Toyota Prius Plug-in has an all-electric range of 11 miles; the Ford C-MAX Energi has an all-electric range of 21 miles; and the Chevrolet Volt has an all-electric range of 38 miles. Most charging occurs at home. However, by providing additional, conveniently located public charging, particularly at workplaces, the proportion of PHEVs driving in electric mode will increase.

In 2010 the average distance traveled to work for Bay Area commuters was 13 miles; these miles only include the distance between home and work and do not factor in any side trips, errands, or other trips that may extend the daily distance traveled. Thus, the average round-trip distance in the Bay Area in 2010 was about 26 miles. With increases in the sales of PHEVs with less than 25 miles of range, and several more PHEV models with similar ranges entering the market soon, there is significant potential to extend the all-electric miles traveled in the region.

The objective of enhanced public investment in EV chargers is to establish a much more robust regional public network of EVSE that would increase all-electric miles for PHEVs and make BEVs a more attractive option as a primary vehicle (especially through more comprehensive deployment of Fast Charging). Based on recent experience with sales and marketing efforts to deploy non-subsidized EV chargers, there has been limited uptake of EVSE at workplaces. Therefore, an enhanced program of public investment or subsidy would be designed to overcome these barriers. The assistance could be provided to interested employers, retailers, parking management companies, and others that qualify.

The Bay Area Metropolitan Transportation Commission currently plans to launch a Regional EVSE Network Incentive Program by 2015. In the interim years, program guidelines will be developed, and there will be opportunities to assess the results of the current market development efforts by companies such as NRG, Chargepoint, and Powertree. The AMBAG siting analysis prepared for the Monterey Bay region will provide guidance to regional stakeholders regarding favored areas for additional EVSE deployment. Again, the goals of an EVSE incentive program would be to:

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

Assumptions and Methodology for Increased All-Electric Miles Based on Increased EVSE Deployment

In the baseline, it was assumed that 30 percent of miles traveled by PHEVs would be in charge depleting mode or electric miles. Based on the increased availability of EVSE throughout the Bay Area, this percentage is increased to 41 percent. Given the focus on expanding workplace charging, where vehicles are often stationary for eight hours, the Metropolitan Transportation Commission program assumption is that regional EVSE network incentives would focus on expanded Level 1 EVSE charging (75 percent) compared to Level 2 EVSE (25 percent).

With an upper limit of 16 kWh for the battery size of a PHEV, the time to recharge to full capacity is about 7 hours for a Level 1 charger, and 3 hours for a Level 2 charger. This analysis assumed costs of $250 for Level 1 EVSE installed and $2,100 for Level 2 EVSE installed.

To determine the GHG emission reductions from EVSE deployment throughout the region, an emissions calculator was developed for the Bay Area to:

Modify the percentage of VMT in all-electric mode from 30 percent to 41 percent.

Determine the GHG emissions reduction.

- The GHG emissions attributable to PHEVs are determined – this is a mix of electricity and gasoline based on how many miles each vehicle spends in each mode.
- The GHG emission reductions are determined as the difference between the emissions attributable to the PHEV versus the emission that would have otherwise occurred using a conventional gasoline vehicle.

There were no changes made to the VMT.

On a strictly linear basis, about 20-25 percent of all PHEVs would require access to EVSE at any given time to achieve the increased electrification goal of this strategy. However, by 2035, it is assumed that EVSE will have improved capabilities and that it will be possible to plug-in multiple vehicles to a single charge point and stagger the charging so that each vehicle returns to full state of charge.

Costs

The costs of EVSE are a function of the level of charging (i.e., Level 1 or Level 2) and the total number of chargers required, shown below in Table 23. A ratio of about 1 EVSE for every 5 vehicles is estimated by 2035, which is consistent with charger-to-vehicle ratios estimated by Electric Power Research Institute for workplace and public charging opportunities and research conducted by ICF regarding charging optimization.[30] The estimated number of EVSE are then multiplied by the installed EVSE costs (medium estimate).

Table 23: Total Cost of L1 and L2 Chargers, 2020 and 2035

Year	Number of Chargers		Total Cost ($millions)
	L1	**L2**	
2020	10,800	3,600	$10.2
2035	62,800	20,900	$59.7

Source: ICF Bay Area EV Readiness Plan.

Impact of Proposed Bay Area PEV Investments on GHG Reduction

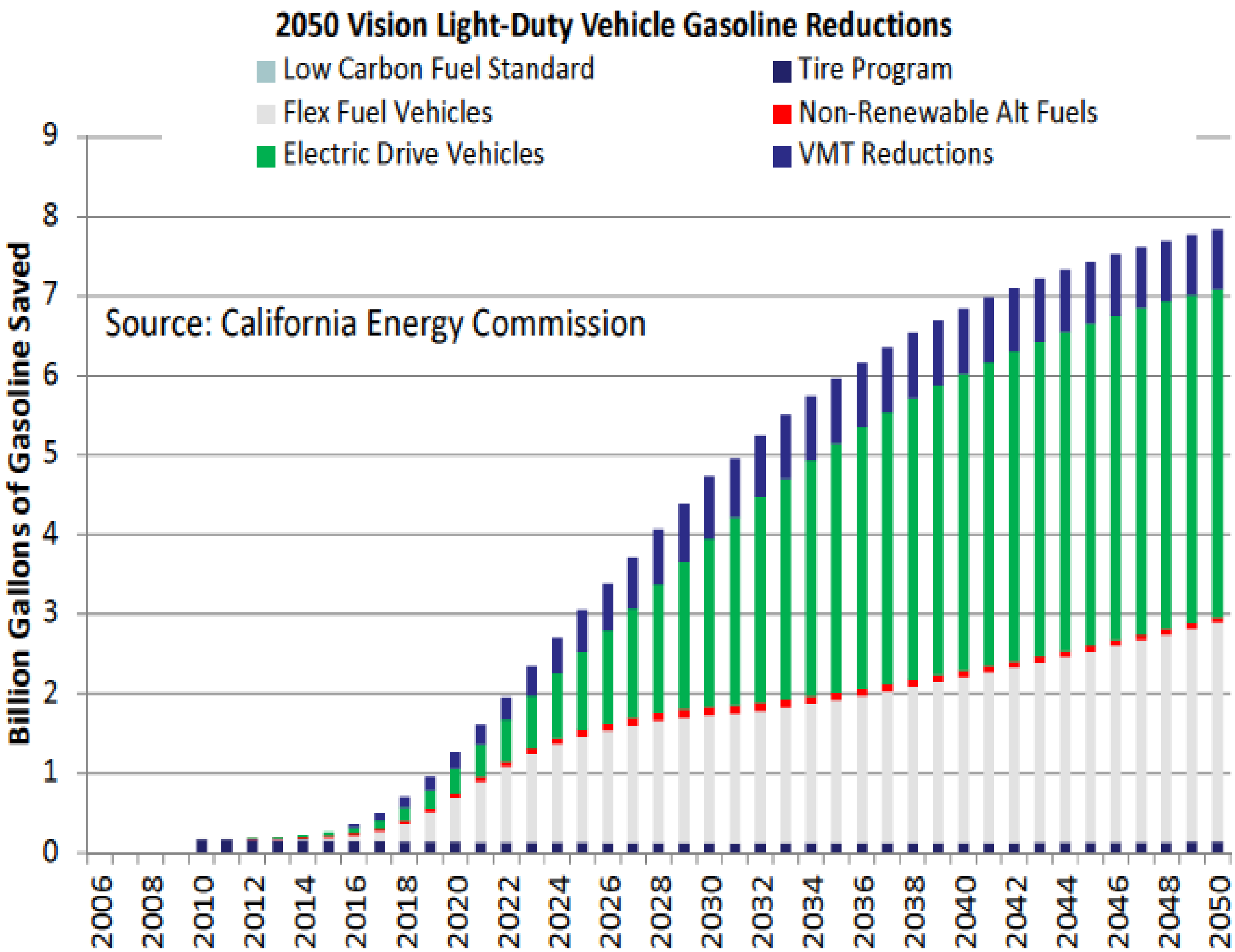
In the nine-county Bay Area context, the combined results of the programs described above are estimated to provide a GHG reduction of 60 short tons and 239 shorts tons of CO_2 daily in 2020 and 2035, respectively. These represent 0.1 percent and 0.3 percent reductions in daily per capita emissions compared to the 2005 base year, respectively. A total escalated cost of the program is estimated to be $80 million.

Monterey Bay PEV Impact on Emissions: Analysis Based on the Plug-in Central Coast Approach

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. The California Air Resources Board has a multi-dimensional strategy for achieving these goals, including mandated emissions reductions for internal combustion engine (ICE) vehicles, the low carbon fuel standard, VMT reduction through land use shifts, modal shifts, and other means, and – crucially – a large-scale shift to electric drive vehicles via the zero emission vehicle mandate and corresponding PEV ecosystem development efforts. The cumulative effect of these policies 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,* shown below in Figure 22, California Air Resources Board and the California Energy Commission developed the following strategic pathway to the requisite reductions -- illustrating that the preponderance of savings are projected to come from electric drive vehicles.

30 D. Bowermaster, Electric Power Research Institue. How Much Electric Vehicle Charging is Needed? California Plug-in Electric Vehicle Collaborative Meeting, August 2012.

Figure 22: 2050 Alternative Fuels Vision



Source: California Energy Commission, 2050 Alternative Fuels Vision

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 natural gas is the subject of ongoing debate and analysis, as methane leakage rates from natural gas extraction have not yet been clearly determined.)

Most importantly, as California's grid becomes greener through the implementation of the Renewable Portfolio Standard, which calls for 33 percent renewable electricity by 2020, the GHG intensity of each kilowatt hour of electricity will decline. Thus, EV's will become cleaner as California's grid grows greener. Table 25, published by the CEC, indicates the environmental advantage of electric fueling.

Table 25: 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	**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 CEC-600-2007-004-REV

As summarized above, Battery Electric Vehicle (BEV) emissions are estimated by California Air Resources Boardto 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.[31] (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

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

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 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.[32]

Assumptions for GHG Reduction Analysis for the Monterey Bay Region: BEV vs. PHEV

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 estimate is 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 the forthcoming BMW PHEV will provide nearly 100 miles of range, while the Mitsubishi Outlander PHEV will provide 31 miles of battery range. This contrasts with the smaller range of the recently introduced Prius Plug-in (which has only 13 miles of all-electric range), and the Ford Energi PHEV, with 21 miles of range.

The breakout of PHEV and BEV sales is difficult to predict going forward. As of early 2013, recent California Vehicle Rebate Program data showed Southern California PEV sales trending toward PHEV dominance, while Bay Area PEV sales showed continuing strength in the BEV category, reflecting shorter driving distances for some residents. For the Central Coast and Monterey Bay region, a 50/50 split of PHEV/BEV is projected, trending toward a 2 to 1 split in PHEV/BEV by 2020 as more PHEV models enter the market and prices drop. PHEV miles are projected to be 70 percent all-electric miles, reflecting improved charging infrastructure which will enable more frequent and convenient recharging. It is believed that consumers who pay an extra $5,000 to $10,000 for a PHEV vs. a conventional ICE are highly motivated to maximize their all-electric mileage, and that public charging (especially workplace charging) will be a key variable in enabling a high proportion of electric VMT.

For the purposes of summarizing the emissions profile of BEV vs. PHEV, 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.

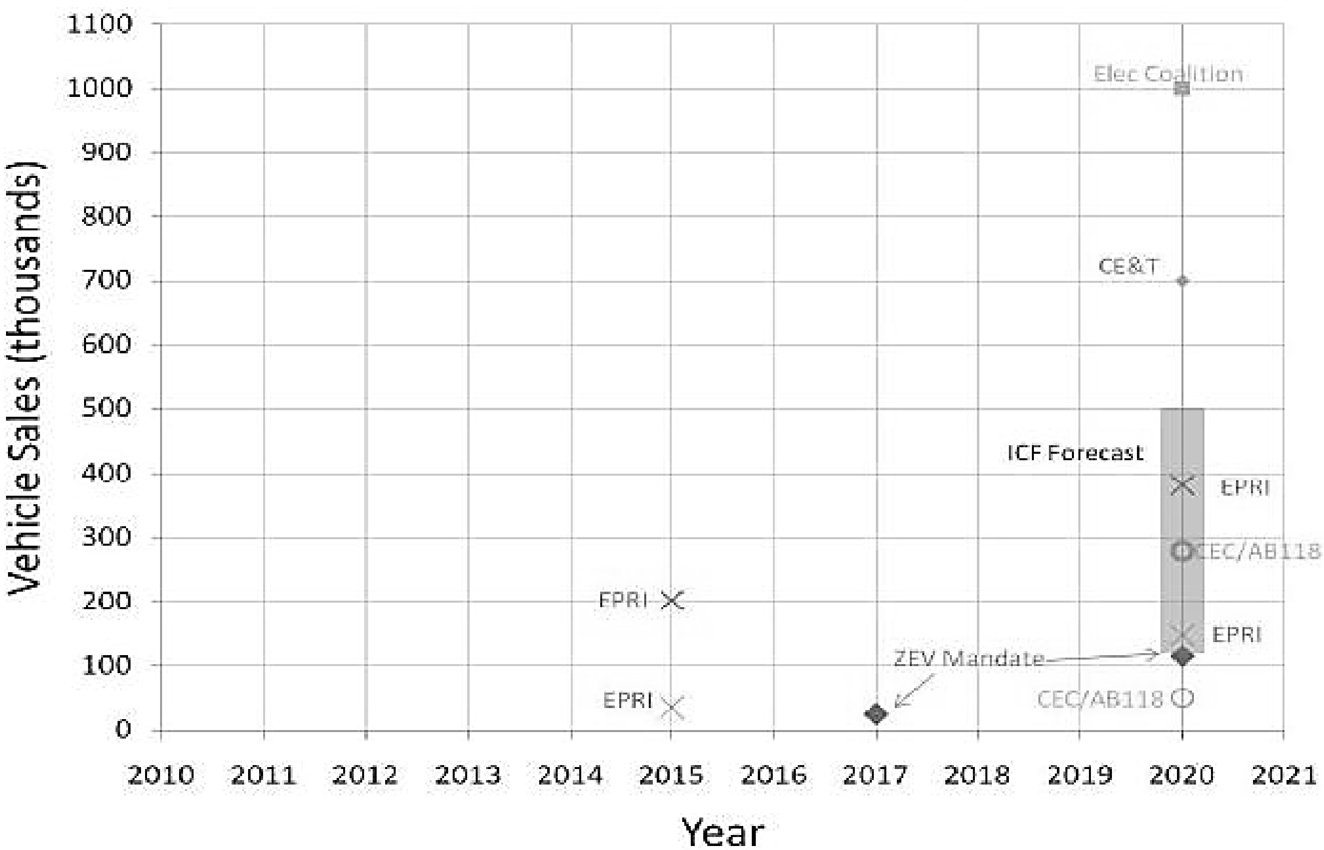
Additional assumptions pertaining to VMT trends and aggregate GHG impacts of PEVs vs. improved ICE emissions trends are explained further below.

32 Ibid, p. 17.

California PEV Sales Projections: Projecting PEV adoption rates is an inexact science at best, as illustrated in the ICF Consulting and California PEV Collaborative charts in Figure 23 below, that demonstrate the range of expert views, and the potential elasticity of demand under different economic and policy scenarios analyzed by Electric Power Research Institute, the CEC, the Electrification Coalition, and ICF International. 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[5]. 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, with the current fleet turnover at 12 years and lengthening. An ongoing economic downturn could permanently lengthen the replacement cycle and promote greater retention of dirtier vehicles.

Figure 23: EV Adoption Rate Forecasts

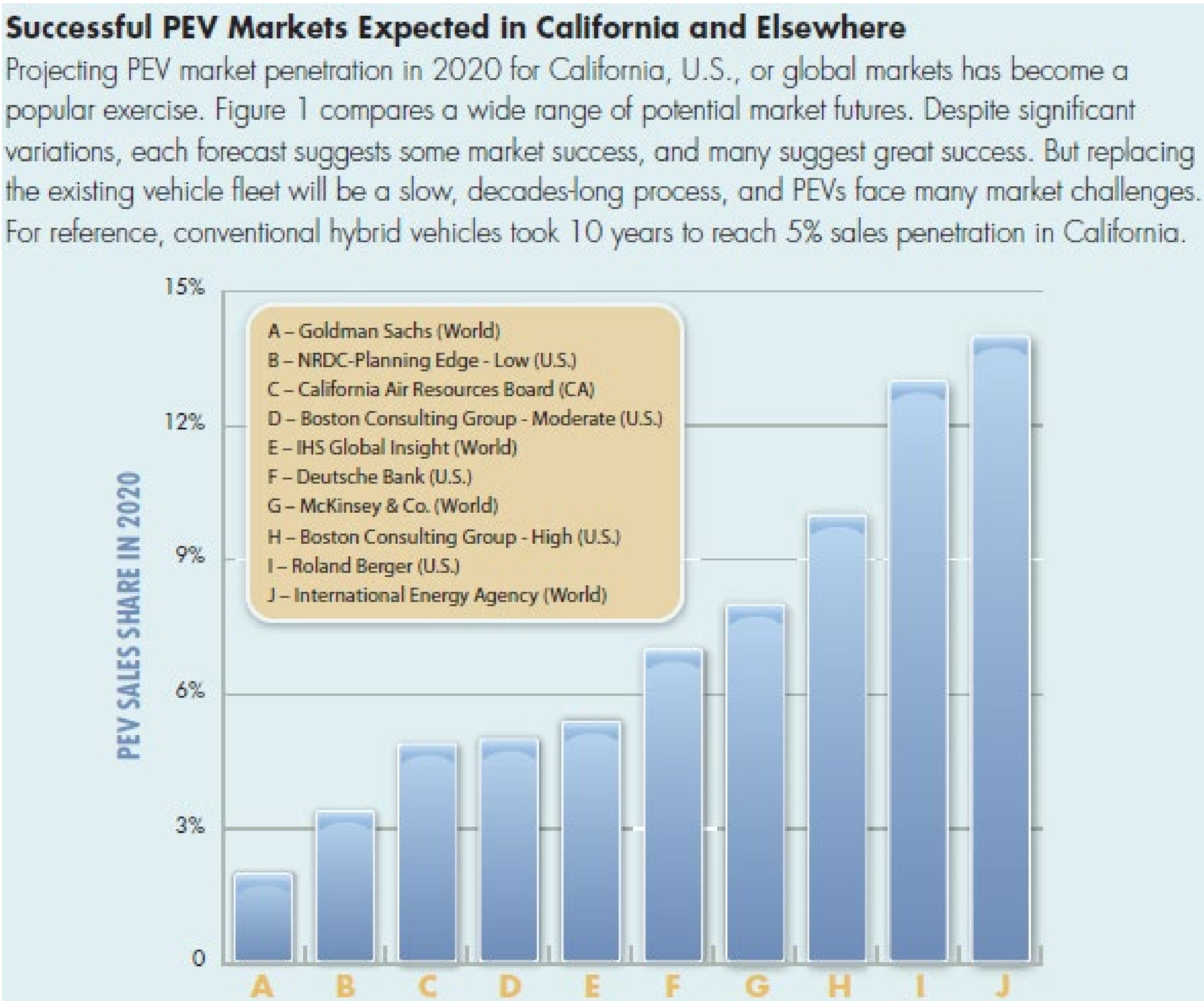


Source: ICF International

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 has simply publicized the broad range of scenarios that have been issued by different research organization, leaving it to stakeholders to make estimates they believe most appropriate. Figure 24 below illustrates the range of estimates by leading research organizations.

Figure 24: Successful PEV Markets Expected in California and Elsewhere



Source: PEV Collaborative

Given the broad range of credible PEV sales estimates, the potential PEV contribution to SB 375 emissions reduction targets is principally a goal setting exercise, rather than historical trend analysis. Many macro-economic factors -- notably gas prices, household income, unemployment, and interest rates – as well as PEV model pricing, features, and availability – are leading factors in PEV adoption, and are difficult to predict many years in advance. Therefore, Plug-in Central Coast has established an aspirational goal that 10 percent of vehicles sold in 2020 will be PEVs. This same goal is used for analytic purposes in the Monterey Bay region.

In Table 26 below, greenhouse gas emissions (GHG) for the Monterey region are calculated in grams of carbon dioxide equivalent 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, Pavley regulations, and Environmental Protection Agency 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 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 (percent total VMT by ICE) = Regional Emissions from ICE

(Vehicle Emissions per Mile for PHEV) x (percent total VMT by PHEV) = Regional Emissions from PHEV (Vehicle Emissions per Mile for BEV) x (percent 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.

Table 26: Monterey Bay Region: GHG Emissions in Kilograms CO2

Year	Projected Total VMT for Region	ICE Only		"High" EV integration			
		Kilograms per VMT	Total GHG Emissions "ICE only Scenario"	Total PHEV (Volt)	Total BEV (LEAF)	Total GHG Emissions	GHG Decrease from "ICE only Scenario"
2013	3,445,066,867	0.28171	970,509,787	11,258,030	1,060,557	956,411,098	14,098,689
2014	3,476,320,514	0.26979	937,876,511	16,511,809	1,547,629	917,642,451	20,234,060
2015	3,507,857,694	0.253795	890,276,743	21,382,757	2,004,677	865,197,512	25,079,232
2016	3,539,680,979	0.238125	842,886,533	25,920,590	2,430,765	813,879,459	29,007,074
2017	3,571,792,965	0.23375	834,906,605	29,929,110	2,824,938	799,482,180	35,424,425
2018	3,604,196,270	0.229375	826,712,520	33,517,893	3,186,224	784,655,734	42,056,785
2019	3,636,893,539	0.225	818,301,046	36,674,544	3,513,632	769,392,604	48,908,442
2020	3,669,887,437	0.219375	805,081,557	39,099,867	3,806,153	749,373,137	55,708,420
2021	3,703,180,656	0.21875	810,070,768	42,283,322	4,062,760	746,166,219	63,904,550
2022	3,736,775,911	0.218125	815,084,246	45,207,479	4,282,405	742,547,866	72,536,379
2023	3,770,675,942	0.2175	820,122,017	47,864,522	4,464,021	738,508,232	81,613,785
2024	3,804,883,514	0.216875	825,184,112	50,246,492	4,606,523	734,037,302	91,146,810
2025	3,839,401,417	0.21625	830,270,556	52,345,280	4,708,805	729,124,889	101,145,667
2026	3,874,232,467	0.215625	835,381,376	54,152,627	4,769,739	723,760,634	111,620,742
2027	3,909,379,504	0.215	840,516,593	55,660,120	4,788,179	717,933,999	122,582,594
2028	3,944,845,395	0.214375	845,676,232	56,859,192	4,806,619	711,677,933	133,998,299
2029	3,980,633,032	0.21375	850,860,311	57,741,115	4,825,059	704,982,726	145,877,584
2030	4,016,745,335	0.213125	856,068,850	58,297,005	4,843,500	697,838,511	158,230,339
2031	4,053,185,249	0.212500	861,301,865	58,852,895	4,861,940	690,694,295	170,583,093
2032	4,089,955,745	0.211875	866,559,374	59,408,785	4,880,380	683,550,079	182,935,848
2033	4,127,059,824	0.211250	871,841,388	59,964,675	4,898,820	676,405,864	195,288,603
2034	4,164,500,511	0.210625	877,147,920	60,520,565	4,917,260	669,261,648	195,288,603
2035	4,202,280,859	0.210000	882,478,980	61,076,455	4,935,700	662,117,432	207,641,357

Source: Association of Monterey Bay Governments

Senate Bill 375 emissions reductions are calculated on a per capita basis. However, total emissions will reflect the estimated population growth of the tri-county region. For reference purposes, the region's most recent population estimates, shown in Table 27 and Table 28, are included here from the 2008 AMBAG regional forecast. These estimates will be updated in the 2014 sustainable community's strategy process.

Table 27: Population Growth for the Tri-County Monterey Bay Region: 2005 – 2035

Regional Population							
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**203**
Population	740,048	774,781	808,560	840,366	868,459	895,577	920,713
Households	238,232	251,323	263,670	274,782	285,433	294,803	303,656
Household	3.1	3.1	3.0	3.0	3.0	3.0	3.0
Housing Units	257,848	271,918	285,159	297,035	308,410	318,412	327,877
County Population							
Monterey	422,632	445,309	466,606	483,733	499,341	515,549	530,362
San Benito	57,324	62,431	68,471	76,140	83,383	89,431	94,731
Santa Cruz	260,092	268,041	273,983	280,493	285,735	290,597	295,621

Source: Association of Monterey Bay Area Governments: Monterey Bay Area Regional Forecast 2008

Table 28: Monterey Bay Region - Average Annual Growth by County

Monterey Bay Region - Average Annual Growth by County						
	2005-2010	**2010-2015**	**2015-2020**	**2020-2025**	**2025-2030**	**2030-2035**
Monterey County	1.1%	1.0%	0.7%	0.6%	0.6%	0.6%
San Benito County	1. 8%	1.9%	2.2%	1.9%	1.5%	1.2%
Santa Cruz County	0.5%	0.5%	0.5%	0.4%	0.3%	0.3%
Region	0.94%	0.87%	0.79%	0.67%	0.62%	0.56%

Source: Association of Monterey Bay Area Governments: Monterey Bay Area Regional Forecast 2008