San Diego Regional

PLUG-IN ELECTRIC VEHICLE (PEV) READINESS AND INFRASTRUCTURE PLAN

Preparing the San Diego Region for Plug-in Electric Vehicles

California Center for Sustainable Energy and San Diego Association of Governments

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Introduction

By the end of 2012, more than 22,000 plug-in electric vehicles (PEVs) were on California's roads. The San Diego region has become a leader in the adoption of these vehicles, and accounts for roughly 20% of all California plug-in electric vehicle ownership. As more San Diegans purchase PEVs, a regional charging infrastructure network will be necessary for supporting this growing market.

The San Diego PEV Readiness Plan (Plan) identifies barriers to the deployment of PEV charging infrastructure and includes recommendations and resources for overcoming those barriers. This Plan is designed for local government officials, such as planners and building staff, as a resource to assist them in helping their local governments prepare for a growing PEV market.

Why Use This Plan

The San Diego Regional PEV Readiness Plan provides the following best practices and tools:

<Insert a table highlighting appropriate best practices and tools by chapter (with corresponding links) and brief description>.

The San Diego Regional Electric Vehicle Infrastructure (REVI) Working Group and Stakeholders

Background and Purpose

In February of 2012, the San Diego Association of Governments (SANDAG) established the Regional Electric Vehicle Infrastructure Working Group (REVI) with funding awarded by California Energy Commission. One of the primary functions of the REVI is to develop a regional readiness plan that identifies, reduces and addresses regional barriers to the deployment of private and public PEV charging infrastructure. The working group builds on previous PEV readiness efforts dating back to 2009.[i] REVI was established in March 2012 and continued through December 2013. REVI members discussed and addressed barriers to PEV infrastructure deployment.

Organization and Stakeholder Engagement

San Diego REVI working group members include representatives from local and regional public entities, nonprofit organizations, utilities, universities and community colleges, labor union representatives and contractor associations, and the business community. All REVI meetings were free and open to the public.

Each of the 19 jurisdictions in San Diego County was invited to participate as REVI Advisory Member. SANDAG's six sub-regions were asked to provide one voting member each: North County Coastal, North

[i] The EV Project, funded by the Department of Energy, provided subsidies for public and residential charging equipment and installations in the San Diego region. As of September 2013, over 1,400 residential and non-residential charging units had been installed under the project.

County Inland, East County, South Bay, the City of San Diego and the County of San Diego. A complete list of REVI Members and Advisory Members is available in Appendix A of this document.

Regional Barriers to PEV Infrastructure

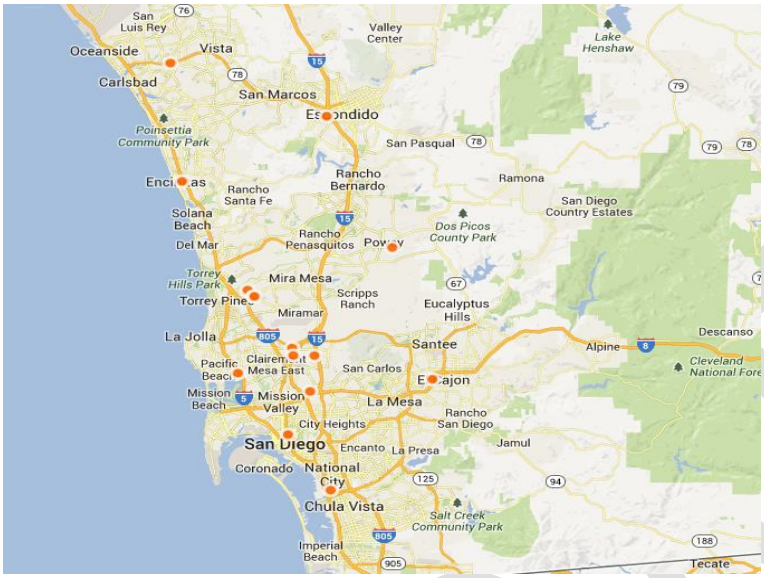
The REVI identified the following barriers to PEV infrastructure deployment. The barriers identified by the REVI are included in the table below.

Barrier	Description
Permitting/Inspection	Lack of streamlined permitting and inspection processes and inconsistent (high) costs across jurisdictions.
Building Codes	Lack of standard building codes that accommodate charging infrastructure or dedicate circuits for charging infrastructure in new construction and major renovations.
Zoning and Parking Rules	Lack of standard regional ordinances that facilitate the installation and access to publicly available charging infrastructure.
Training and Education for Municipal Staff and Electrical Contractors	Lack of knowledge about PEVs and EVSE.
Lack of Public Knowledge of PEV and EVSE	Municipal outreach to Local Residents and Businesses.
EVSE at Multi Unit Dwellings	Consumer lack of knowledge regarding EVSE installation in these buildings. Need to educate and work with HOAs to identify and find solutions to unique building challenges.
Regional Planning for Public EVSE Siting	Regional land use and transportation plans served as a basis to identify optimal public EVSE sites.
On Peak Charging – TOU Utility Rates	A. Need to discourage charging when electricity supplies are in high demand and cost more. Support of time of use (TOU) pricing. B. High demand charges that impact EVSE host utility bills. Expensive metering options to access TOU rates.
Public Agency EVSE Installations	Contracting issues have stalled many public agencies from taking part in EVSE installations.
Commercial and Workplace Charging	Lack of understanding regarding benefits and approaches to understanding workplace charging.
PEVs in Government Fleets	Procurement justification needed for local public fleets. Need to describe PEV benefits, including role in reducing municipal GHGs for Climate Action Plans.

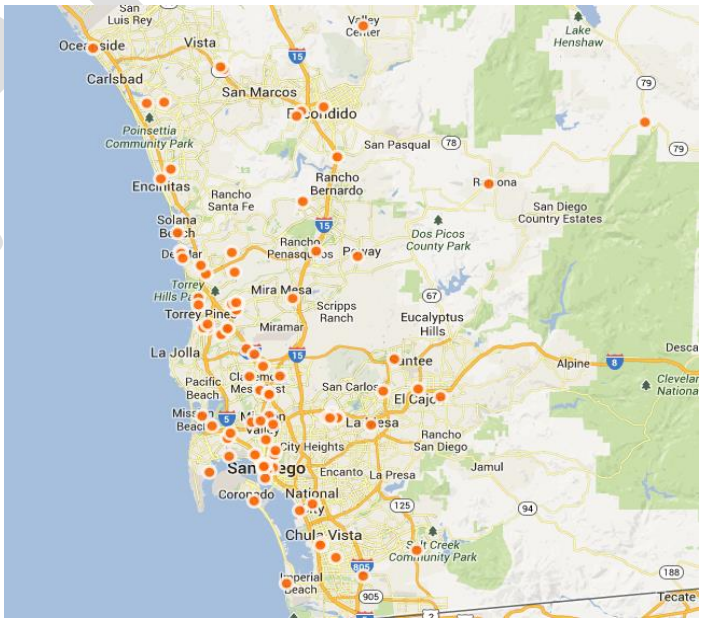
PEVs and Public Charging Infrastructure in the San Diego Region

The following maps illustrate the growth of public charging infrastructure and PEVs in the San Diego region from 2011 through 2013.

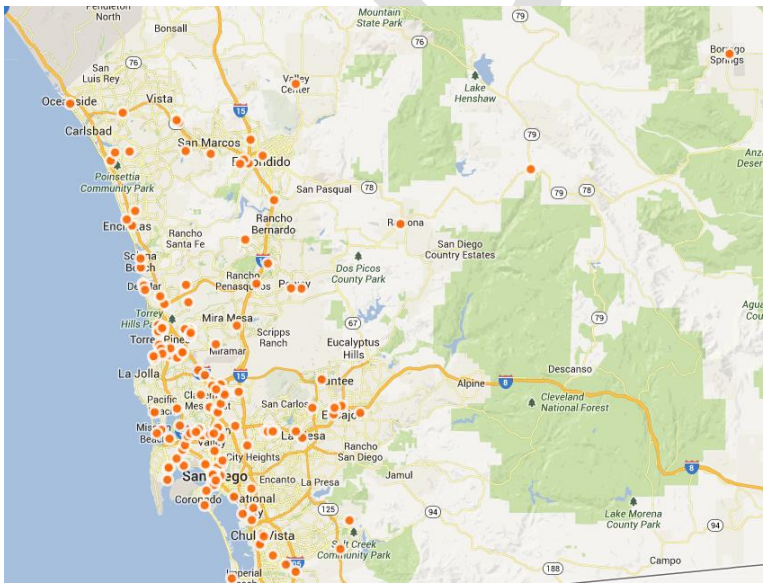
2012 - Public Charging Stations



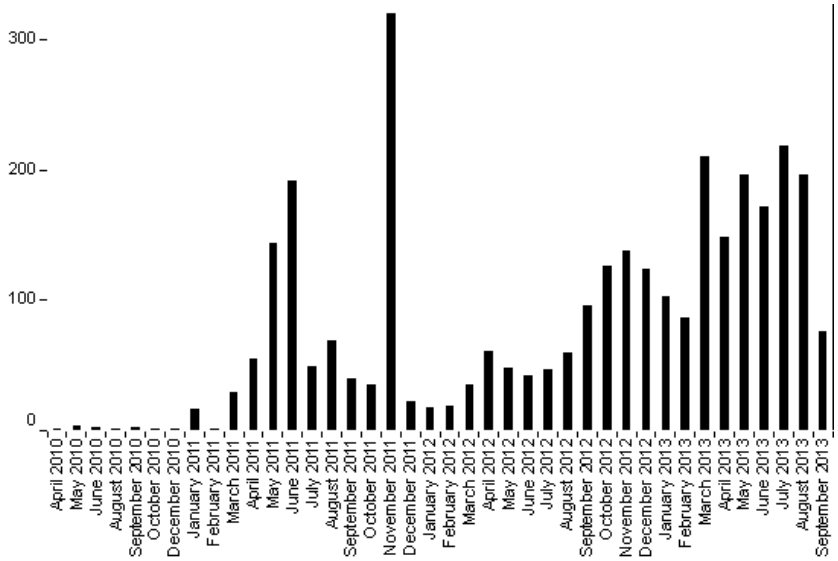
2012 - Public Charging Stations



2013 – Public Charging Stations



This graph indicates the growth of PEV sales in the San Diego region. Please note that the spike in 2011 is due to the introduction of an all-electric car sharing fleet, car2go.



The chart below shows the number of commercially available vehicles beginning from pre-2011 to present. Before 2011, there was only one PEV on the market, the Tesla Roadster, now there are over 16 PEVs in the market. [i]

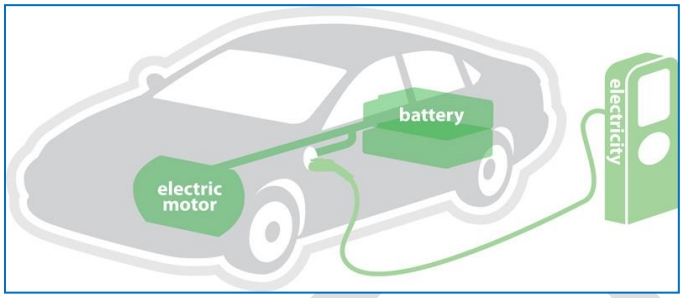
Commercially Available Vehicles			
2010	2011	2012	2013
1	3	9	16

December 2010 **February 2012** **July 2012**

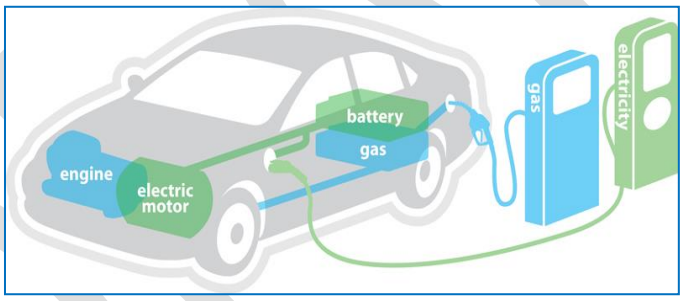
The Basics of Plug-in Electric Vehicles and Charging Infrastructure

Vehicle Types

Battery electric vehicles (BEVs) are fueled entirely by electricity stored in the on-board battery. These vehicles are often also referred to as zero-emission vehicles. BEVs typically have a range of 60-120 miles on a single charge.



Plug-in hybrid electric vehicles (PHEVs) are fueled by both a battery and another fuel source, usually gasoline powering an internal combustion engine. These vehicles run on electricity from the on-board battery until the battery is exhausted, then switching to an alternate power source. PHEVs typically have a much shorter electric range than fully electric BEVs, and a standard wall outlet may be sufficient for overnight charging.



The table below shows the available light-duty PEVs on the market as of September 2013.

Battery Electric Vehicles		Plug-in Hybrid Vehicles
BMW Active E	Honda Fit EV	Chevrolet Volt
Chevrolet Spark	Scion IQ EV	Ford C-MAX Energi
CODA Sedan	Tesla Model S	Ford Fusion Energi
Fiat 500e	Mitsubishi i-MiEV	Honda Accord Plug-in
Ford Focus Electric	Nissan LEAF	Toyota Prius Plug-in
Ford/Azure Dynamics Transit Connect Electric	Smart fortwo electric drive	
Toyota RAV4 EV		

Charging Infrastructure

There are three types of vehicle charging available. The table below describes the type of vehicle charging in relation to the number of miles per hour of charge and where to charge. The time need to charge a PEV depends on two primary factors, the size of the battery and the size of the onboard charger. As a rule of thumb, BEVs have a larger battery compared to PHEVs. The onboard charger is located in the vehicle and determines the amount of power that can enter the vehicle.

Type of Vehicle Charging	Miles of Driving Range per Hour of Charge	Where to Charge?
Level 1 (120 volt)	3 to 4	Standard three-pronged outlet
Level 2 (240 volt)	8 to 20	At home, workplace, or public charging
DC Fast Charger	50 to 60	Public or commercial sites only

Types of charging equipment

Level 1 charging infrastructure consists of a charging cord set provided as standard equipment with every plug-in vehicle (see image to the right of the page). This charging cord can plug into any standard 120 volt outlet.

Level 2 charging infrastructure is a device that either plugs into or is hardwired into a 208/240 volt circuit. Level 2 charging consists of a dedicated charging unit, which is often referred to as electrical vehicle supply equipment (EVSE). Pictured on the left of the page, is an EVSE and below is a table that displays the most common types of Level 2 installation styles:

Level 2 Installation Style	Installation Method	Considerations
Floor-mount (Bollard style)	Mounted to the ground and wired through the base	Generally requires concrete work along with underground trenching
Wall/Pole mount	Installed on any wall or pole and can be wired through a garage wall	Offers flexible placement options and takes up less floor space than a floor mount

The Electric Drive Transportation Association (EDTA), a U.S. industry association, maintains a website of over 40 UL-certified EVSE products at http://goelectricdrive.com/index.php/find-an-ev-charger. EVSE manufacturers may also provide a contact list of certified contractors for installing charging equipment.

Compared to Level 2 infrastructure, the installation of DC fast charging infrastructure is complex and requires commercial grade electrical capacity. The equipment costs are usually more than $10,000 and installations of a single unit can cost up to $50,000.

Access to public charging infrastructure

Many publically available charging stations require membership cards to access the charging equipment. ChargePoint and Blink are examples of membership networks that require card access.

Finding public charging infrastructure

Drivers typically utilize websites or mobile applications to locate public charging stations. PEV drivers can find these charging locations by using several online sources including:

Charging Infrastructure Source	Description	Website
Alternative Fuels Data Center Station Locator	Displays hours of availability and number of charging units per site. Allows end users to add new stations.	http://www.afdc.energy.gov/locator/stations/
PlugShare	Available online or by a mobile application. Users can leave reviews on public chargers and have their own residential chargers displayed on the map.	http://www.plugshare.com/
Recargo	Available online or by a mobile application.	http://www.recargo.com/search
CarStations	Drivers can filter their search by charger type or brand. Available online or by a mobile application.	http://www.carstations.com

Each branded charging network (i.e., Blink, ChargePoint, eVgo, etc.) has its own application to help its members find network-specific charging locations. Some networks are working together to offer a single source of information. One example is Collaboratiev.com, a website being developed to include both Blink and ChargePoint locations and is scheduled to be released in 2014.

Locations of public charging stations in the San Diego region

Over <update number before publication> public charging sites serve the San Diego region.

<Insert a map of existing charging locations in the San Diego area, color-coded by PEV adopters with dots indicating where stations are located and clustering of EVSE = CVRP>

Regional Plug-in Electric Vehicle Infrastructure Existing Conditions

The San Diego region's plug-in electric vehicle infrastructure has evolved since 2009. Local governments, home owners, multi-unit property managers, and local businesses have all played a critical role in influencing the current PEV landscape.

Local Governments

Local governments continue to influence the rate of adoption and infrastructure expansion for PEVs. This influence isn't always deliberate but in fact, is often unintentional or secondary to other, activities, planning efforts, or regulatory compliance.

As regional and local land use planning, design criteria development, and GHG emissions reduction plans are developed, PEVs continue to be integrated into these efforts in a number of different ways. This integration has resulted in building permit streamlining, training for staff, and public charging stations. The San Diego region has worked collaboratively to leverage resources, opportunities, and to better understand and overcoming challenges to institutional and public PEV adoption and EVSE installations.

Local governments can influence EVSE installations by continuing to improve and streamline building permit processes and by integrating EVSE installations or pre-wiring for installation into project conditions or through public charging stations. Public agencies can help disseminate and distribute available training and collateral informing staff, contractors, property owners and residents of existing opportunities. As infrastructure becomes increasingly more readily available and permitting time and costs are reduced, PEV adoption will continue to grow; local governments play a critical role in PEV adoption.

Single-Family Residences

The EV Project charging behavior data clearly indicated that most PEV drivers charge their vehicles at home. Many PEV drivers with single-family homes will find a standard household outlet (120 VAC) available for charging near where their vehicle will be parked. However, some PEV owners install a dedicated Level 2 (240 VAC) EVSE to charge their vehicle. The installation of a Level 2 charger requires a permit from the local jurisdiction and SDG&E notification.

Expediting the EVSE permitting and installation process for home owners and approving new construction projects with infrastructure already in place, will help to reduce barriers to home charging and will further PEV adoption. Training and information tailored for home owners is also essential to easing concerns and informing PEV drivers.

Multi-Unit Dwellings

Multi-unit dwellings, or MUDs, continue to present barriers to PEV drivers. As noted above, most drivers charge their PEVs at home; however MUDs offer a unique set of challenges. Shared utilities, parking designations or restrictions, as well as design and infrastructure hurdles, make EVSE installations more complex.

SDG&E has worked with local property managers and MUD PEV drivers to establish best practices, offer workshops, and to develop case studies of local MUD EVSE installations.??

MUD EVSE installations will continue to be a challenge for all of the reasons already listed, but with continued work by SDG&E and by integrating EVSE into permitting and planning processes and language this process will become more streamlined. As EVSE installations become easier, PEV adoption rates among MUD residents should increase.

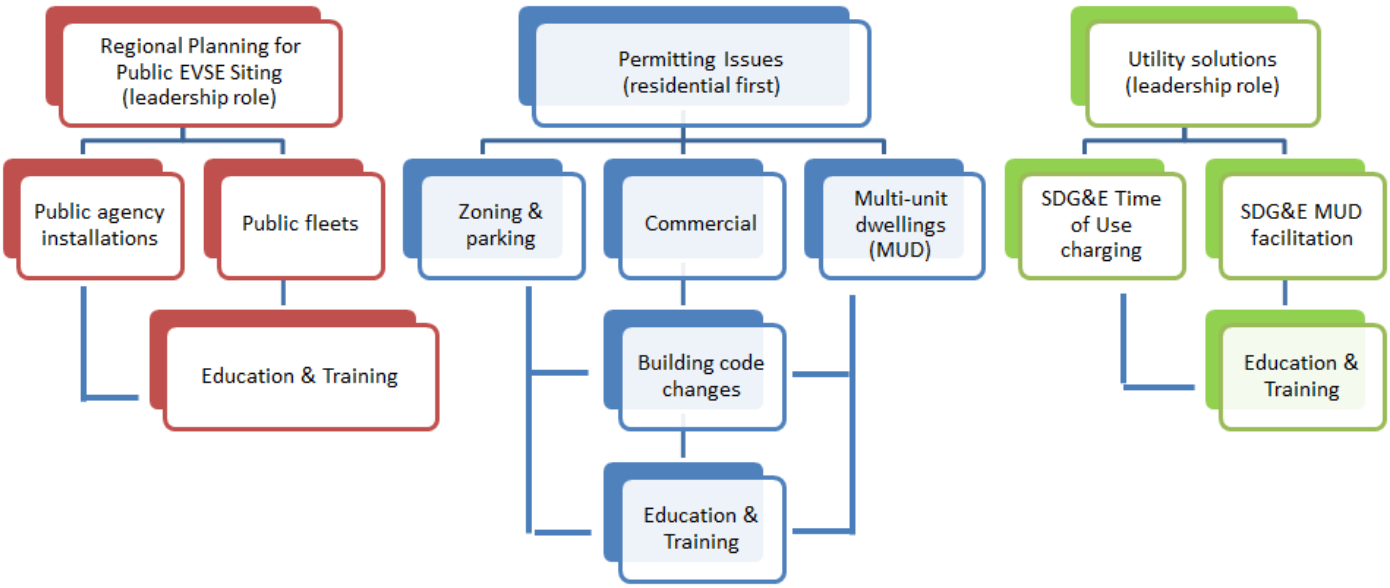
Workplaces, Retail and Public Locations

PEV drivers can be limited to the range of their vehicle. Although most veteran PEV drivers are aware of the range of their vehicle, others are plagued with range anxiety which can stifle one's use of or even decision to purchase a PEV. A number of local retailers, workplaces and public destinations now have EVSE available to their customers, employees and the public. Expanding charging options for PEV drivers will continue to play a critical role in broadening the range and number of PEV adopters.

EVSE installations at workplace, retail, and public locations will continue to expand the existing charging network and will give PEV drivers options similar to those available to traditional vehicles. Local governments, SDG&E, contractors, business and property owners continue to work together to address installation barriers. Contractor and business owner training, education, and outreach continue to be crucial to making the business decision for EVSE. The permitting processes and construction and electricity costs also are concerns for local business owners and can hinder EVSE installations. Local governments can also provide infrastructure on public property as a means to lead by example (for employees and customers) and to help fill gaps in the charging network.

Regional Barriers to EVSE Deployment & Key Recommendations

Through earlier PEV planning and siting efforts (i.e., EV Project) several barriers had already been identified as obstacles to regional charging infrastructure installation and PEV adoption (see *Regional Barriers to PEV Infrastructure* section above). The REVI defined these and discussed new or expanding barriers to PEV deployment and grouped the eleven barriers into three priorities categorizing complementary or parallel efforts together. The flow chart on the following page illustrates the prioritization of the barriers. This section defines the priority categories and the activities, resources and outstanding hurdles to addressing each of the barriers.



Regional Planning for Public EVSE Siting

Overview

The EV Project established a stakeholder working group for regional collaboration and prioritization for public charging planning and siting. This was the first regional planning effort to establish priorities for installation of PEV charging infrastructure. Together, the EV Project Stakeholder Advisory Committee (ESAC) was able to produce infrastructure siting maps that guiding the EV Project efforts in placement of public charging stations (*Regional Planning for Public Charging in San Diego* fact sheet is included in Appendix B).

The REVI has built upon the regional planning efforts initiated by the EV Project and identified challenges, successes and outstanding issues for continued PEV adoption and EVSE deployment. Collaborative planning for regional charging infrastructure is necessary to establishing a cohesive and interconnected charging network. Assessing priority siting locations, establishing optimal land use, access, and understanding driving behaviors isn't limited to the boundaries of a single city or public agency. Defining the needs and establishing ideal locations to support EVSE and benefit PEV drivers has to be done on a larger scale to be effective and functional.

The Electric Power Research Institute (EPRI) pyramid below illustrates charging priorities for PEV drivers and aligns with regional sitting to date. The base of the pyramid shows that PEV drivers primarily charge at home; this is the most reliable, comfortable, and cost effective option. The region has seen the most infrastructure installed residential locations.

Secondary to home, work is the most common driving destination. Workplace charging offers PEV drivers a reliable charging option during the work week at a location already part of their daily routine; charging at work won't add new stops or change existing travel patterns and allows for more charging options. The REVI has recognized the challenges and barriers associated with workplace and retail charging as a result of the EV Project and continue to try and facilitate more EVSE opportunities through new or innovative possibilities; often using local or statewide examples and resources.

Lastly and most necessary for continued PEV adoption, is public charging. Public charging makes up the smallest portion and sits at the top of the pyramid. Public charging represents the least available charging option for PEV drivers. Public charging stations offer PEV drivers the same conveniences that traditional gas vehicles drivers have. Making EVSE publically available in more locations also helps to reduce range anxiety and makes transitioning to PEVs easier. Public charging is faced with the most barriers to both PEV adoption and regional planning and installations. Working together with other local public agencies has expanded the resources and experience available to address regional EVSE availability.

Classifying local land use statistics for PEVs

Understanding local land uses and driving habits helps to identify optimal locations for charging stations and appropriate type of charging equipment (EVSE). The following table describes the different charging equipment, and the type of venue or destination a PEV driver would use the charging stations.

EVSE	User Profile	Typical Venues	Charging Time	Miles/1 Hr Chrg
Level 1 (EVSE)	Parked for 6-8 hours	Street/Meters	1-2 hours	3-4
		Parking Garages	2-10 hours	
		Cultural/ Sports Centers	2-5 hours	
		Airport (long-term)	8-72+ hours	
		Hotels/Recreation Sites	8-72 hours	
Level 2 (EVSE)	Parked for 2-4 hours	Shopping Centers	0.5-2 hours	8-20 (depending on vehicle on-board charger)
		Airport (short-term)	< 1 hour	
		Street/Meters	1-2 hours	
		Parking Garages	2-10 hours	
		Cultural/ Sports Centers	2-5 hours	
		Airport (long-term)	8-72+ hours	
		Hotels/Recreation Sites	8-72 hours	
		Interstate Highways	< 0.5 hours	
		Commuting/Recreation Roads	< 0.5 hours	
DC Fast Charge (DCFC)	Quick stop for 5-30 minutes	Shopping Centers	0.5-2 hours	50-60
		Airport (short-term)	< 1 hour	
		Interstate Highways	< 0.5 hours	
		Commuting/Recreation Roads	< 0.5 hours	

Adopted from the Bay Area and Monterey Bay Area—Plug-In Electric Vehicle Readiness Plan (p. 24)

Land use/parking analysis for EVSE

<Adopt the Luskin Center's steps in "PEV land use assessment" and describe the assumptions used in identifying potential parking availability. For example, assumptions may include counting MUDs in terms of individual units, not individual buildings; assume there is a parking space for every employee at a workplace.>

PEVs in local government fleets

The REVI has identified public fleets as having a critical role in the adoption of PEV technology. To support fleet managers and assist policy makers with this transition REVI has developed tools to help guide agencies through the adoption process. Further, converting some or all of a government's fleet and establishing best practices for vehicle replacement can help local governments attain their municipal GHG emissions reductions goals and strategies. Converting local agency fleets to cleaner vehicles is one way to encourage PEV adoption throughout the region. Institutions such as the Port of San Diego and University of California-San Diego are leading by example; they have already begun replacing fleet vehicles with PEVs.

PEV adoption can be an attractive option for government fleets for a variety of reasons. Fleet managers are motivated by reduced fuel and maintenance costs; planners and policy makers may identify with the reduction in municipal GHG emissions reductions. PEVs in government fleets play an important role in meeting emissions reduction targets established by AB32. Climate Action Plans and other sustainability plans and goals include GHG reductions from municipal operations, including fleet emissions, as a means to achieving their GHG reduction targets. PEVs are one way to help reduce such emissions. The Sustainable Communities and Climate Protection Act of 2008 (SB375), specifically targets GHG emissions from passenger vehicles, California's single largest emissions source. SANDAG's Sustainable Community Strategy includes increased use of alternative fuels in local government fleets as well as expanded charging infrastructure. The governor's ZEV Action Plan also calls on local governments to increase PEV adoption.

Despite the high up-front costs of PEVs and charging infrastructure, integrating PEVs into a fleet can actually save the agency money in maintenance and fuel costs. Many financial incentives are also available to help offset the costs for PEVs such as the CVRP and Hybrid Truck and Bus Voucher Incentive Project (HVIP). To establish whether the investment for PEVs is the best option for a fleet, it is important for fleet managers to carefully consider which vehicles fit their needs. This choice will depend on these factors:

- Route predictability
- Distance travelled by each vehicle per day
- Vehicle maintenance and service costs
- Use of central parking facilities

Consideration of these factors can assure fleet managers that new PEV additions to their fleet will help optimize their fleet's operations and meet the local government's sustainability goals.

Public agency fleets should work with SDG&E to plan for PEV adoption and charging. The utility can help fleet managers determine charging speed and demand charge fees to keep costs down while meeting operation needs. SDG&E is also crucial for siting and installing EVSE for fleet charging. Placing EVSE strategically near electrical utility equipment can reduce the cost of installation and knowing the impacts of increased demand on local distribution equipment will ensure uninterrupted service.

The REVI developed a fact sheet that includes *Resources for Fleet Managers in San Diego* and is included in Appendix B.

Public electric vehicle charging stations

Public charging stations and an integrated charging network are critical to regional PEV adoption. Reducing range anxiety and providing more opportunities for drivers to charge their vehicles will support increased PEV adoption rates. The REVI has identified the lack of available public charging station as a barrier to regional EVSE deployment and PEV adoption. Local governments play a crucial role in expanding the regional charging network and ensuring connectivity among major driving corridors.

Public EVSE installations have proven to be more challenging than originally anticipated by the EV Project. Infrastructure, electricity costs, accessibility, operation and maintenance needs have all hindered the installation of public EVSE.

The REVI developed an RFP template (see Appendix C) to aid local governments, public agencies, and businesses with the procurement for installation and operation of electric vehicle charging stations. PEVs are an emerging technology to many agencies. San Diego's local governments are in varying stages of integrating PEVs into their fleets, planning or operational processes and facilities. The REVI developed equipment specifications, contractor minimum qualifications, and a general scope of work as a means to help minimize work, reduce risk and liability to the agency, and provide consistent language vetted through other local agencies for the installation and maintenance of public charging stations.

Education and Outreach

Public agency knowledge or understanding of PEVs has historically been limited. The REVI identified this as a barrier and has developed a number of fact sheets as tools for local government staff as they begin to integrate this technology in their planning documents, building permitting processes and policy development. In addition to those already listed, fact sheets for *Getting Started* and *Resources for Public Agencies in San Diego* have been included in Appendix B.

Permitting for EVSE

Overview

The permitting process can be very influential in encouraging or hindering the installation of EVSEs. The San Diego region does not currently have a singly, region-wide standard permitting process. Differences among local jurisdictional processes and requirements for electrical permits and building inspections have been acknowledged by the REVI as a barrier to EVSE installations.

Obtaining a permit for EVSE installation is often an owner's first step to establish their PEV ecosystem after purchasing a vehicle. Public and commercial sites wishing to host EVSE must also begin the installation process with permitting. Cities and jurisdictions want to make sure that PEV drivers safely install their equipment. And drivers or organizations wishing to install EVSE at their workplace should have access to all available information permitting and building officials need when reviewing an application. Easy access to information and guidance documents should be available through a website or handout.

Although much has been done to support streamlined permitting, inspection and installation processes for EVSE, a number of issues remain. The REVI continues to support efforts for further permitting and installation process streamlining.

This section describes critical components of the permitting and installation processes as well as identifies opportunities to expand EVSE installations and best practices for specific charging situations.

Permitting EVSE installations at single-family residences

PEV drivers primarily choose to charge their vehicles at home. Installing EVSE at a single family home most often requires a permit issued from the local permitting agency. Proper permitting helps to inform SDG&E of the additional electrical needs on local infrastructure and ensures the safety of the equipment.

The REVI has developed *Electric Vehicle Charging Stations Installation Guidelines: Residential and Commercial Locations* as a resource and provides detailed information on the permitting and inspection process for single-family EVSE installations.

It is important to note that there are often fees required when applying for a permit. PEV drivers should always check with the local permitting agency for specific permitting and inspection costs.

The following table outlines the permitting application process.

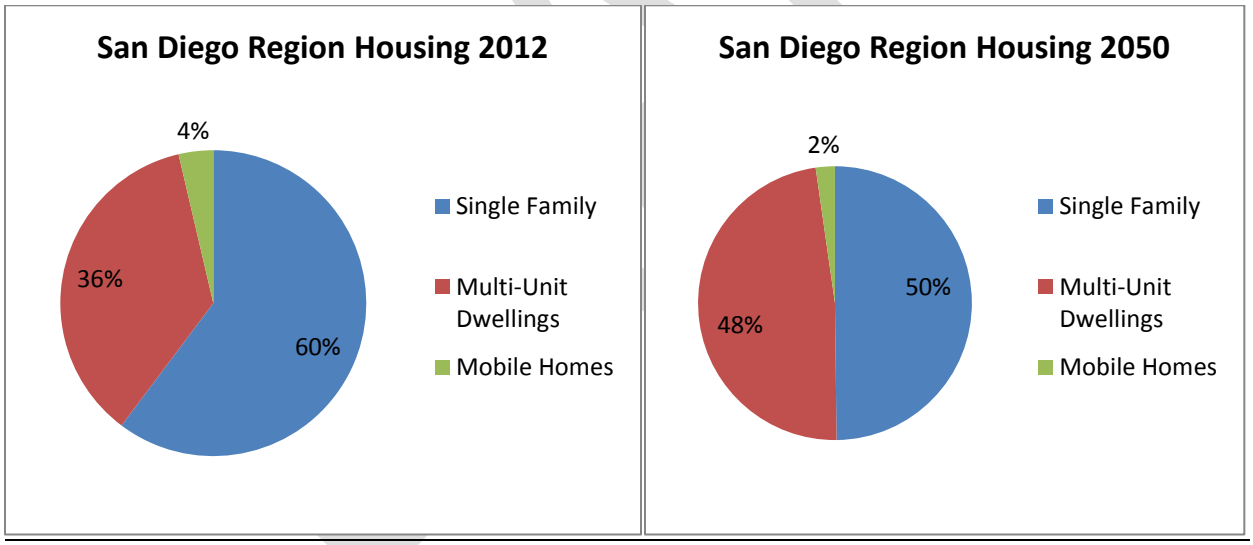
Documentation*	Description
Permit application	Electrical permit or special permit for EV chargers [to be identified by jurisdiction]
EVSE Manufacturer's Information	The manufacturer's installation instructions and EV charger specifications.
Site Plan	Identify the complete layout of existing parking space(s) and proposed location of EVSE parking space(s) with respect to existing building and structures.
Electrical Load Calculations	Home electrical load calculation that estimates if an existing electrical service will handle the extra load from a residential EVSE and wiring methods based on the California Electrical Code (CEC). Note that CEC Article 220 requires load calculations if the existing service panel is rated less than 200 amps.
Electrical Plans	Single line diagrams showing the system, point of connection to the power supply and the EVSE.
* Documentation will be specific to each jurisdiction	

The permitting process for residential chargers in the San Diego region has been considerably streamlined since the early days of the EV Project. Most notably, the City of San Diego adopted Information Bulletin 187 *How to Obtain a Permit for Electric Vehicle Charging Systems* (May 2012). The City of Oceanside also issued guidelines (January 2013) to assist permit applicants in streamlining the permitting, installation and inspection process for residential EV Chargers. Both of these resources have been recognized as a regional best practice by the REVI (and are included in the Permitting and Installation guidance document).

San Diego and Oceanside are the only two jurisdictions in the region that developed this type of guidance and standardized permitting process. The lack of standard permitting requirements impedes the EVSE installation process for homeowners, electrical contractors and property managers. REVI has recommended that streamlined installation and inspection processes be adopted throughout the region.

Charging at multi-unit dwellings

Multi-unit dwelling (MUD) is a generic term for a spectrum of multi-unit residences including but not limited to apartment buildings, attached and detached housing units within a community, high rise buildings, mobile home communities and others. In 2012, multi-unit dwellings made up 36% of the housing stock in the San Diego region. By 2050, SANDAG predicts this number to increase to nearly half of the housing stock. With roughly 80% of PEV charging taking place at home, reducing the barriers to installing EVSE at MUDs will be critical for supporting future PEV adoption.



Barriers to EVSE at MUDs

Installing an EVSE in an MUD presents a number of challenges. The table below summarizing barriers faced for EVSE installations at MUDs, some of these barriers are being addressed directly through support from SDG&E, while others are challenges to be address on the customer side of the meter. SDG&E has been a leader in supporting MUD EVSE installations and tackling utility-side barriers. The utility holds quarterly workshops on MUD EVSE installations, participates in statewide and national efforts, and serves as a resource for property owners, local governments, and residents.

Barriers Facing EVSE installations at Multi-Unit Dwellings	
Barrier	**Description**
Cost	Installation costs can range anywhere from $2,000 to $10,000. A building that has sufficient panel capacity and an existing conduit running from the panel to the PEV parking space will likely only incur charging station, permit, and electrician installation/assessment costs, resulting in a lower cost installation. On the other hand, a building with limited panel capacity, no conduit, and a parking space located a significant distance from the electrical panel, will likely incur higher installation costs.[ii]
Power Supply	Transformers supplying multifamily buildings typically have 10% to 15% excess capacity, or overhead, which is enough to sustain a few electric vehicles. However, as PEV adoption grows and vehicles are equipped with higher charging loads, these transformers may be insufficient to handle wide scale conversion to electric vehicles.[iii]
Proximity to Metering Equipment	Service panels for MUDs can be located at substantial distances from where the charging station is to be installed.[iv]
High Rise Units	In downtown San Diego, meter rooms are often located on the upper floors of high rise units and conduit space is limited. Challenges are faced in installing additional conduit and/or encountering physical limitations (e.g., drilling through concrete floors).[v]
Parking	Parking is not standard across MUD building types. In some MUDs parking is bundled into the rent or sale price of the unit. In other buildings it is unbundled or paid for separately. Unbundled parking spaces can be assigned on a first-come first-serve basis, or they can be unassigned. A charging station tied to a bundled parking space could be added value to a future tenant; however, a charging station on an unbundled or unassigned spot may pose challenges for assigning costs to individual owners. Choice of spaces also must address issues with proximity to metering equipment as addressed above.[vi]
Electricity Rates and Meters for Common Areas	Parking garages/lots are typically on a common meter. This means, electricity provided in parking garages and other common areas is paid by the property manager or homeowner association (HOA) and then billed to residents through HOA fees or rent. This creates a challenge in allocating charging costs to individual owners.[vii]
Homeowner Associations (HOAs)	HOAs cannot prohibit or restrict the installation of a PEV charging station. Senate Bill 880 codified this and other provisions for charging installations in common areas. However, HOA boards may still resist installations. Lack of information regarding charging station installations remain a significant barrier.

[ii] Peterson, David. Addressing Challenges to Electric Vehicle Charging in Multifamily Residential Buildings June 2011, UCLA Luskin School of Public Affairs.

[iii] Ibid.
[iv] Bianco, James S. Power Share System for Electric Vehicle Service Equipment, 2012.
[v] Pointon, Joel, SDG&E. Clean Cities US Department of Energy, Electric Vehicle Spring 2011 Quarterly Discussion webinar presented on March 28, 2011.
[vi] Peterson, David. 2011.
[vii] Pointon, Joel. 2011.

REVI has developed a factsheet to help address the barriers to EVSE installations at MUDs that are outside of the utility's role. This factsheet is a resource for local governments that are assisting with the siting of EVSE at MUDs, residents, building managers, homeowner associations, and apartment associations.

Charging at Condos, Apartments, and Community Living Areas fact sheet can be found in Appendix B.

Charging at commercial and public sites

While most charging for PHEVs and BEVs happens at home and work, charging stations at commercial and public locations complements a driver's daily commute needs, offers flexibility in their travels during the day, and maximizes electric miles driven. As PEVs become more prevalent, the demand for diverse EVSE options will increase. Some factors for consideration when determining the feasibility of providing chargers at commercial and public locations are detailed in the REVI *Workplace Charging for Businesses in San Diego* and the *Electric Vehicle Charging Station Installation Guidelines: Residential and Commercial Locations* fact sheets included in Appendix B.

Some examples for publicly-owned and retail EVSE sites where vehicles tend to be parked for an average of two hours include:

- Government workplaces
- Transportation stations (e.g., light rail, subway, bus, ship/ferry terminals, airports)
- Public parking facilities
- Recreational, natural, and cultural facilities (e.g., sports parks, pools, parks, beaches, museums, libraries, theaters, etc.)
- Non-profit sites (e.g., houses of worship, clubs, cultural centers)

The financial viability, motivations and benefits, of hosting EVSE have been analyzed by CCSE and documented in the San Diego Regional Non-Residential Charging Study (see Appendix C).

Charging at the workplace

The San Diego region has a large and still growing population of PEV drivers likely to require charging during the workday. The workplace is where drivers spend most of their time outside of the home. Expanding workplace charging opportunities for PEV drivers will allow more commute flexibility and maximize their electric vehicle miles traveled. Employers may consider several reasons for offering charging stations at work. The REVI developed *Workplace Charging for Businesses in San Diego* as a resource for local businesses to use when assessing the potential for installing charging stations.

Workplace charging continues to be burdened when weighing determining the value proposition of EVSE to their business, employees, and customers in relation to the immediate and ongoing costs for the charging stations. CCSE has developed a report assessing the value proposition for San Diego businesses to offer charging stations and has been included in Appendix C. Documenting and sharing workplace charging experiences; lessons learned with regional stakeholders can help encourage other employers to offer workplace charging.

Charging station installations

Workplace charging installation is first and foremost a cooperative effort. The California Plug-in Electric Vehicle Collaborative has developed the *Workplace Charging Communication Guide* (www.evcollaborative.org/communication-guides) as a communication tool. The REVI developed *Electric Vehicle Charging Station Installation Guidelines: Residential and Commercial Locations* with details for streamlining and understanding the EVSE installation process (Attachment B).

Standardized regionally-recognized standard permit processes and procedures for commercial and workplace EVSE installations and expedited permitting could reduce the time, costs and confusion associated with workplace charging. This is an opportunity for further consideration by the REVI.

Zoning and parking policies for PEVs

Zoning and parking policies help prescribe where and what types of development can occur within each jurisdiction. Zoning and parking requirements play a critical role in the adoption of EVSE. Parking requirements defined by individual zoning ordinances or existing developments offer challenges to property owners or project developers when trying to identify optimal charger locations and capacity for such stations. Often parking spaces are limited and can't be specified for PEVs only due to minimum parking requirements or accessibility.

Zoning ordinances

As described above, zoning ordinances offer an ideal mechanism for local governments to define opportunities for EVSE installations through development. Currently, none of the jurisdictions in San Diego County have mandatory EVSE development requirements. The REVI identified the need for statewide requirements to adequately incorporate such language into local zoning ordinances.

The City of Los Angeles and the City of Lancaster both have adopted language addressing EVSE in their zoning ordinances. Further, OPR released the ZEV Guidebook which includes information for

Accessibility for PEV parking

The Americans with Disabilities Act (ADA) has specific access requirements to ensure all drivers have access to parking. ADA requirements have presented a number of challenges to EVSE installations. There are currently no mandatory requirements for incorporating EVSE specific parking spaces in development projects. Individual jurisdictions can develop standards for application within their own boundaries if they so choose.

The state Office of Planning and Research (OPR) issued draft Accessibility Guidelines for public comment and review. The REVI discussed the draft guidance documents and submitted comments in response (included within Appendix C). This guidance was the first offered by the state but still doesn't include mandatory language for EVSE installations.

The City of San Diego has developed Technical Policy 11-B which addresses parking accessibility to electrical vehicle charging stations. The REVI has identified this guidance as a best practice for use in the region.

PEV signage

The California Manual on Uniform Traffic Control Devices (CA MUTCD) has been updated by Caltrans (Traffic Operations Policy Directive13-01) to include PEV signage. The policies included within the policy standardize the signage and pavement markings for zero emission vehicles (ZEV). Although this policy does not mandate parking requirements for ZEVs or other PEVs it does regulate the way they are identified.

Zoning and parking policies will continue to be a regional barrier to PEV adoption. The REVI will continue to monitor activities in state and local government activities although has determined that until there is mandatory state direction, this will continue to be an ongoing challenge.

Building code changes

Updating local building codes to accommodate EVSE is a long-term regional goal. Costly retrofits and infrastructure requirements for PEV charging can be a significant barrier to adoption. Mandatory building codes can help support PEV adoption by requiring pre-wiring for charging equipment and a percentage of parking spaces dedicated to PEVs.

The first step toward making building codes more EVSE-friendly is to increase the level of understanding of how building codes are updated among jurisdictions. Local governments have also expressed interest in learning from best practices deployed elsewhere across the state. Existing statewide code can be utilized strategically to avoid the difficult process of writing new code.

California's Green Building Standards Code (CALGreen) is Part 11 of Title 24, California's statewide building code, and provides guidance on voluntary measures that public agencies and municipalities can adopt to encourage PEV charging readiness in new construction. It is at the discretion of local governments to adopt any or all of these measures as mandatory. Currently, no jurisdictions in the San Diego region have adopted the voluntary EVSE-specific code. Future updates to CALGreen and Title 24 will likely inform regional building code policy in the long-term.

CALGreen is California's first set of statewide green building standards. It was developed as a result of the California Green Building Initiative and the Global Warming Solutions Act of 2006 (AB 32), which aimed to reduce GHG emissions to 1990 levels by 2020. Because buildings are the second largest contributor to GHG emissions in California, next to the transportation sector, CALGreen seeks to reduce their environmental impact. Appendix C includes a list of EVSE specific CALGreen building code sections and examples of mandatory building codes.

Local jurisdictions can support EVSE deployment through changes to their building code. An effective first step would be to adopt the established voluntary EVSE-specific CALGreen code. This would require pre-wiring for EVSE for all newly constructed residential and non-residential buildings. All commercial development would require designated PEV-only or low-emission vehicle parking spaces. Standard project conditions or conditions of approval language are another means to integrate codified mechanisms that support EVSE installations.

The following are recommended actions for local government officials to facilitate PEV charging:

- Adopt the CALGreen EVSE codes for residential and non-residential new constructions.
- Redefine a "low-rise" building to be six stories or fewer when adopting CALGreen.[viii]
- Require new construction projects to pre-wire or lay conduit with the capacity for future wires or cables.
- Require new commercial and industrial construction to provide a minimum number of parking spaces be PEV-ready.
- Require new single-family or MUD construction to provide a minimum number of parking spaces be PEV-ready.

Education and Outreach

To facilitate increased EVSE installations in single-family residences, multi-unit dwellings, retail locations and at the workplace, it is important that all relevant stakeholders (e.g., electrical contractors, property owners, the utility, and local government staff) are fully aware of EVSE infrastructure installation requirements and potential challenges. The permitting process requires local government staff and electrical contractors to be fully trained and informed to ensure a rapid and seamless inspection and installation processes.

PEV training for local government staff

A number of training and workshop opportunities have been available and tailored to the specific needs and interests of local government staff. The PEV readiness workshop (June 2012) and the PEV Community Readiness training session (January 2013) are just two opportunities that were available to local public agencies. As training needs are identified, the REVI has worked with training providers and other knowledgeable resources to bring information to the region. Detailed training resources and opportunities for municipal staff are included in the REVI developed fact sheet included in Appendix B.

Training opportunities for local contractors

Local contractors are often exploring opportunities to expand the scope of their services to remain current and capable of meeting the needs of the existing market. Learning how to install EVSE is one way of doing this. Electrical contractors are an important part of the EVSE deployment process, and as PEV adoption rates increase, local contractors should be able to support these installation tasks.

The Electrical Vehicle Infrastructure Training Program (EVITP) provides training and certification for contractors and electricians interested in installing EVSE. The program is coordinated by the DOE and the IBEW/NECA and is being offered at community colleges and local electrical training centers. The main curriculum focuses on training electricians on the best industry practices for EVSE installations.

Clean Cities offers informational videos to learn more about EVITP and EVSE installations on their YouTube channel, which can be found on their website: www1.eere.energy.gov/cleancities/evitp.html.

[viii] CALGreen code pertains to "low-rise" buildings, which are defined as three stories or fewer. Extending this building designation to six stories or fewer would increase the number of eligible buildings to accommodate EVSE.

Details on the EVITP and other training opportunities available to local contractors are available in the REVI developed fact sheet included in Appendix B.

First responders

First responders encounter PEVs, whether it is on the scene of an accident or to assist a stranded motorist. Knowledge about the technology and how to safely remove a passenger or tow it off the road is vital.

The Freeway Service Patrol (FSP) is a free service provided by SANDAG, Caltrans, and the California Highway Patrol that helps get stranded motorists back on the highway. The Advanced Transportation Technology and Energy Program (ATTE) at Miramar Community College administered a specialized training to the FSP drivers to ensure they were properly equipped when they encounter a PEV on the road.

A number of training resources and opportunities are available for first responders and included in the fact sheet developed by the REVI and included Appendix B.

Utility Solutions

Overview

As more PEVs are being plugged in at home, work and fleet facilities, the volume and distribution of electricity load demand will be affected. Current estimates show existing infrastructure as sufficient to accommodate off-peak charging in the near-term; however, electricity transmission and distribution may face challenges as demand increases in areas where there is a of high concentration of PEV adoption. Transformers and local distribution equipment may require upgrades in certain neighborhoods or near fleet facilities or workplaces with a high volume of charging.

Utility notification protocol

Establishing protocols for utility notification is vital to ensuring safe and reliable electricity service. Early PEV adoption has historically been in neighborhood clusters, increasing demand on the local transformer and the likelihood that it will be affected. Communication with SDG&E can guarantee the appropriate steps are taken to ensure electrical service is uninterrupted.

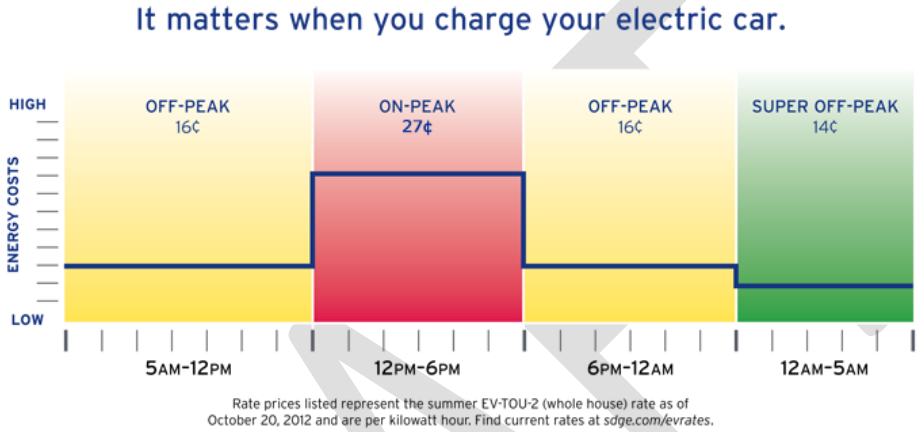
Utility notification also is crucial to measuring PEV charging behavior. Though SDG&E does not require residential customers to notify them of their PEV purchase, they do have two methods for establishing communications with PEV owners: 1) PEV owners can opt-in at time of purchase through the vehicle manufacturer, or 2) When PEV owners apply to change their utility rate. Utility notification is not required for commercial EVSE installations either. However, it is common practice for commercial property owners and local contractors to contact SDG&E early on in the installation process.

SDG&E Time-of-use rates

To minimize the impact of PEV charging to the grid, utilities can implement various rate structures to incentivize off-peak charging. The added electricity demand of charging a PEV may drastically increase electricity costs to residential customers with traditional tiered pricing. It also does not address the time

of energy use. Time of Use (TOU) rates incentivize night or off-peak charging. Some utilities offer TOU rates specific to PEV owners, which allow them to charge early in the morning or late at night to avoid adding further demand to the grid is at its peak use.

SDG&E offers customers two EV TOU rates: 1) EV TOU 2 combines all electricity consumed by a household on a single meter; all PEV and household electricity would use the same meter and benefit from high electricity usage during off-peak hours, and 2) EV TOU allows households to install a separate meter for their PEV, tracking PEV electricity usage separately from the rest of the home. The following chart reflects SDG&E's TOU rates.



To fully benefit from TOU rates, it is beneficial for PEV owners to install a second meter dedicated to the EVSE; it helps to differentiate electricity used by household electronics and appliance and PEV charging. A California investor-owned utility report has found that there are significant energy benefits when PEVs can set an "end charge" time. Customers that program their vehicle's "end charge" time allows the vehicle start charge times to be staggered throughout the evening minimizing grid impacts and increasing system reliability.

Minimizing grid impacts

Consumer outreach

For any of these strategies to be effective, it is vital that consumers receive the information they need to feel comfortable participating. Consumer outreach and education must align with the rate of PEV adoption to be effective. Partnerships with local governments, Original Equipment Managers (OEM), dealerships and other stakeholders can help disseminate and provide consumers with the resources they need to make safe, cost effective, and sustainable choices. These partnerships also establish the collaborative relationships needed to further PEV readiness in the region.

Renewable energy options for PEV owners

PEV owners may have alternative electricity generation options. There are renewable and smart grid technologies that could lessen the impact of EVSE's on the electricity grid.

Using battery storage from solar panels is a common way for PEVs to reduce their grid impact and electricity costs. The San Diego Zoo has installed ten stand-alone solar canopies with a 90 kilowatt solar

voltaic system and five EV chargers. The solar voltaic system also has 100 kilowatt hours of battery storage, which helps to charge electric vehicles and offset peak power demands on the grid.

Owners of solar photovoltaic systems can pre-wire their system to allow EVSE to draw power directly from the battery storage.

Remaining questions

Predicting the future of utility policies remains challenging, however, the integration of PEV charging with renewable energy sourcing may not be far off. Many utilities have already implemented or exploring the possibility of a separate "green" energy option. Smart grid technologies continue to evolve and are an ideal sector for growth. SDG&E has been involved in pilot projects to explore these and other possibilities to managing PEV charging into the future.

Education and Outreach

As described previously, for safe, reliable and cost-effective integration of PEVs in the region, a continued effort towards informing and training PEV drivers, fleet managers, government staff and others about electricity rates and other opportunities available and of interest to all regional EVSE stakeholders about SDG&E's solutions for PEVs. Consumers and local government officials should be encouraged to visit SDG&E's website to learn more about electric vehicle rates. SDG&E is actively pursuing outreach through its website, public education workshops, informational inserts with the statewide Clean Vehicle Rebate Project (CVRP), and brochures for San Diego car dealerships selling PEVs. SDG&E has been at the forefront of MUD property management and tenant outreach and education, and developed best practices for MUD stakeholder engagement.

For more information on how SDG&E can help PEV owners and local government officials, visit: http://www.sdge.com/electric-vehicles.

The Road Ahead

Overview

The San Diego region has taken great strides towards integrating PEVs and EVSE into existing policies, processes, and lifestyle, but there is still a long way to go. The EV Project was the critical building block to establishing the San Diego region's charging network. The REVI provided a platform for expanding that effort and for identifying and overcoming barriers for installation and obstacles to broader PEV adoption. There are still a number of challenges and barriers stifling EVSE installation and hindering PEV adoption. To ensure progress continues to be made, continued collaboration is crucial for an cohesive regional charging network and for consistent and streamlined deployment.

Charging equipment and vehicle technologies continue to evolve at a rapid pace and it is necessary to understand the equipment demands as well as the needs and wants of the public. Monitoring and applying policies uniformly will help all of the public agencies, contractors, PEV drivers, local businesses and manufacturers address gaps, emerging trends and future needs.

Increased PEV Presence

The San Diego region has taken great strides in becoming a leader in PEV adoption and in establishing a charging network. The wide adoption of this technology offers industry leaders an incentive for continuing to use the region's well established infrastructure for new opportunities. Further, with such a strong PEV market, emerging concepts or technologies could easily be tested on a regional scale for a more realistic trial.

Estimating the Future Demand for EVSE in the Region

The future demand for EVSE in the San Diego region is direct correlates with the estimated future adoption of PEVs. It is clear that PEV ownership has witnessed a rapid increase in the past three years. In 2010, eight rebates were issued through the CVRP in San Diego County. More than 650 Diego rebates were issued in 2011, over 780 in 2012, and as of July 2013, San Diegans (regional) have accounted for more than 960 rebate applications. Though the number of rebates may not be entirely representative of PEV adopters, it serves as an excellent indicator of the PEV adoption rate.

Future PEV growth estimates vary; some projections indicate that the California PEV population could reach 100,000 by 2014-2015 and 500,000 by 2018-2020. A critical factor in asserting future PEV adoption is the decline in PEV purchase prices associated with falling battery costs. In addition, the California Air Resources Board (CARB) ZEV mandate affirms that State PEV sales should reach 50,000 per year by 2019 and 150,000 per year by 2022.[15]

If these predictions are correct, there is a strong case for more EVSE in public spaces. Charging with Level 1 equipment at home will likely satisfy the average daily driving needs of a PHEV driver, according to National Household Travel Survey data. However, BEV drivers must be allotted more diverse options for charging. Level 2 charging at home is critical for a BEV driver, but may not be accessible for those that live in multi-unit dwellings. Therefore, it is vital to place EVSE at locations in which BEV drivers will stay for long periods of time: workplaces and other public places such as schools, retail centers, gyms, and medical locations. This will enable BEV drivers to complete their daily commute and possible side trips without fear of depleting their battery.

DC fast charging infrastructure would also need to be expanded throughout highway corridors in order to better suit the long-range driving needs of PEV owners. According to a University of California, Irvine study, DC fast charging provides a "safety net" for BEVs that need charging immediately.[16] The study estimates that a network of 290 strategically located fast chargers throughout California would enable 98% of drivers to adopt BEVs based on average daily vehicle miles traveled.