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Wise Investment in Electric Vehicle Charging Infrastructure through Regional Planning

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Abstract

Plug-in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (BEV), collectively called Plug-in Electric Vehicles (PEV), are entering the market place with long-time and new auto manufacturers offering their own version of electric car models in the U.S. By the end of 2013 up to 20 different models are expected in the market. Electric drive supporters and early adopters strongly suggest that making public charging infrastructure available and strategically accessible are critical to the growth of the Electric Vehicle (EV) market. But what is the correct level of PEV infrastructure? How does a community or business entity determine an appropriate infrastructure level based upon key factors such as type of vehicle (range limited or un-limited), commute distances, driving patterns, travel destinations, commercial charging systems and willingness of employers to provide workplace charging. "**Wise Investments in Electric Vehicle Charging Infrastructure**" will be defined by a regional planning process that can be adopted across the nation to enable regions and the entities in those regions to understand PEV market forces which will lead to an appropriate level of public infrastructure. The public infrastructure will co-exist with commercial and workplace charging resulting in sufficient quantity of charging units to ensure a solid foundation for a transition to a viable PEV industry across the country.

Keywords: PHEV (Plug-in hybrid electric vehicles), Battery Electric Vehicles (BEV), Electric Vehicle (EV), charging, electric drive, infrastructure

1 Introduction

The PEVs, are staging a very strong market entry with the introduction of the Tesla, Chevrolet Volt and Nissan Leaf in 2011. Toyota, Mitsubishi, and Ford, among others, will be introducing their version of the PEV in 2012. Other automakers that have announced PEV products include Chrysler, BMW, Kia, Mercedes Benz, Volvo and Volkswagen. Discussions continue to percolate around the industry regarding the level of public infrastructure that is necessary to support the early market and to prepare for market growth expected to occur starting 2013. Do drivers need fast charging? How many public sites are necessary for Level I and Level II charging and at which locations? What is the appropriate quantity?

Over-building could cause underutilized assets and will negatively impact revenue when a PEV charge site is not being used. Under-building could deter the market if PEV customers become concerned about availability and accessibility of charging units.

A single, focused review of the regions' needs for PEV infrastructure must be implemented to enable the development and sustainability of PEV market penetration. The region needs a cohesive planning document that can be used by the region's leaders to project charge level requirements, and aggressively pursue the necessary financial support from federal and state sources while working closely with the private sector to eliminate any barriers that might prevent the development of infrastructure in homes, workplace and commercial environments.

This document reviews Southern California's efforts to create a regional infrastructure plan based on preliminary findings that will lead to a prudent and well thought out public infrastructure that will scale to meet incremental market needs.

Examples of information that will be discussed include an early [PEV] Adopters Study that assesses driving and charging behaviors that will indicate mass adoption tendencies, travel patterns and rate selection. The second and third studies look into key non-residential segments and multi-family dwellings to determine the current and future state of PEV charge port requirements, including barriers to implementation, as well as tools needed for an effective PEV education and outreach process.

This report also reviews key guidelines for PEV infrastructure deployment. The guidelines should be updated based on actual market penetration data, vehicle usage patterns, and charge system viability (e.g. DC fast charging).

The need to serve the entire market adds considerable complexity to the discussion. Thousands of customers live in multi-family dwellings (apartments, condominiums) that may have difficulty installing electric vehicle supply equipment (EVSE) either from availability of a power source, to parking location, to high cost of installation. Underserved or environmental justice areas (e.g. low-income and minority) need to be considered as PEVs enter the used car market beginning in 2013. Bottom line, all citizens should be able to enjoy the advantages presented by PEVs to a transportation dependent population.

The questions continue to pile up as one considers the information necessary to make a wise decision. Moreover, this issue becomes even more complex during this time when the market is in its infancy. Will BEV drivers have confidence to drive long distances and will there be charging stations placed appropriately along the route? Will commuters that drive greater than 20 miles each way prefer PHEV and expect employers to provide charging stations at work? Will 120 volt systems be sufficient for home and work place charging due to length of time the vehicle is parked? Will level 2 – 220/240 volt systems provide sufficient charging for the return trip home from a travel destination where one remains parked for longer than 2 hours? How many PHEV drivers utilize public parking just to extend the "electric" range even though gas range is sufficient to reach any reasonable destination?

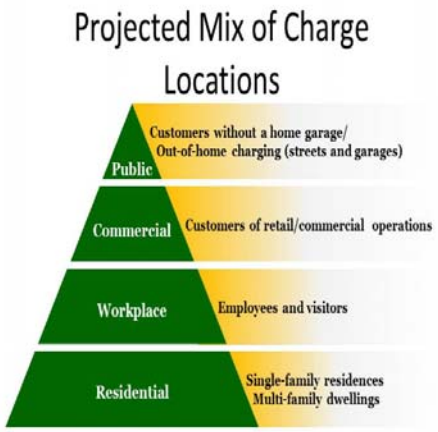
Passenger transportation is regional and on some occasions between regions. Travel patterns are, for the most part, consistent either as a commuter – home to work and return or local as individuals live work and play within the community. Travel destinations can be defined as locations where one tends to stay parked longer than two hours.

Commercial establishments would not be considered travel destinations unless they are a component of a larger destination site (i.e. malls, entertainment parks). When one is parked for less than 2 hours and more likely a maximum of 30 minutes to an hour, then the charge time is limited but more importantly an individual typically departs from these locations and drives directly home thus increasing the time parked at home.

If the majority of PEV consumers will charge at home for a period longer than 9 hours[1], if employers install workplace charging as they recognize employee retention and positive response, and if commercial entities such as IKEA, Walgreens, auto dealers and regional shopping centers are now installing charging systems to attract customers, what will be the role for public charging?

The scenario described in the chart below is the expected charging location sites that will be adopted by the market over the long term. It is

anticipated that largest share of charging will take place at home and work.



2 Public Charging and Regional Planning

The key to successful infrastructure development is to undergo a robust PEV Regional Planning exercise that considers all the factors impacting PEV introduction and charging needs and then establishing a plan of action that can be used by communities and employers to make a wise investment in infrastructure.

The difficulty in planning for infrastructure is the immaturity of the market. Decisions are being made without the ability to analyze long term buyer vehicle preferences and operating profiles. However, enough information can be determined by utilizing existing transportation planning data, early buyer market surveys, and projected vehicle acquisition percentages to implement a well-planned infrastructure installation program. For example, a community can scale infrastructure at travel destinations by adding provisions to install additional infrastructure as the market warrants without the cost of cutting concrete and laying conduit.

The Southern California region has established a PEV Regional Infrastructure planning initiative. This effort is led by Southern California Association of Governments (SCAG) with support from South Coast Air Quality Management District (SCAQMD), South Bay Cities and Western Riverside Council of Governments (SBCCOG and WRCOG) and Southern California Edison (SCE). Grant funding of approximately $500,000 has been received from the US Department of Energy Clean Cities Program and the California Energy Commission. SCE is also contributing three market research initiatives to the regional planning effort valued at approximately $300,000.

A collaborative advisory team has been formed that includes: The City of Los Angeles, Los Angeles Department of Water and Power, WRCOG, University of California Los Angeles (UCLA), SBCCOG, SCAQMD and Ventura County Transportation Commission. In addition, many of the 191 cities in the region will be providing the planning team a list of key travel destinations in their communities.

The project team has developed the following key objectives for the PEV Regional Planning process:

- Develop a clear understanding of the market forces (vehicle and EVSE types, charging specifications, launch date and projected quantities) that will impact the quantity and cost of a regional charge port infrastructure (CPI) system.
- Conduct an in-depth literature review of existing data and determine additional information needed to move forward with a regional infrastructure plan.
- Analyze available driver behavior information, develop appropriate recommendations and apply those recommendations in the development of a final infrastructure level and budget.
- Analyze region-specific travel patterns in various representative subregions in the Southern California area and prepare model subregional plans describing these analyses.
- Conduct meaningful education and outreach to support the successful deployment of regional charge port infrastructure using lessons learned and from the PEV Coordinating Council members' education and outreach efforts that have been in place for the past 18 months.
- Develop region-specific guidelines for PEV infrastructure deployment for single and multi-family unit housing stock, workplaces, fleets, commercial and public sites, and fast charging units in strategic locations.

3 Market Research

Recognizing the value of gaining as much market insights as possible, SCE embarked on three market research projects that will look into early buyers, multi-family dwelling challenges and the knowledge that surrounds SCE's non- residential customers. The objective of the studies is to provide information to the regional planning process and develop awareness so that SCE and the region can maximize PEV knowledge in these markets to support its education and outreach initiatives in 2012 and 2013.

The non-residential/non-single family home charging study would provide a comprehensive assessment of key segments across different charging scenarios to inform the development of effective PEV oriented education and outreach tools. The study would also provide a read on existing charging stations, future charging stations, and barriers to installation (knowledge-based or physical restrictions). The early buyer study is a behavioral and attitudinal based assessment of PEV Early Adopters.

3.1 Table

Table 1: SCE Market Studies

Study Name	Background	Research Objective	Proposed Approaches
Early Buyer Study	SCE has a new role as the electric fuel provider for customers with plug-in electric vehicles who will charge their cars both at and away from home. As PEV adoption increases, it will be important that SCE evolves the customer based insights (knowledge around early PEV buyer charging behavior and charging needs that support their travel patterns) that inform its PEV Readiness efforts.	To conduct both a behavioral and attitudinal assessment of early PEV buyers (i.e. Early Adopters). Its purpose is to establish early indicators of mass adoption charging (in-home and away from home) and driving behavior while identifying underlying motivations.	1. Diary study with early buyers of PEVs 2. Review real time data from available sources 3. Comparison of perceived vs. actual data
Non-Residential Education/Outreach Needs Assessment	As PEV adoption increases over the next several years, there will be a greater demand for non-residential charging locations in SCE's service territory. Early SCE forecasts show close to 14K non-residential charging stations across 5.5K locations (including commercial, industrial, government, and various institutions i.e. hospitals, military and universities/colleges). Charging scenarios across these segments would include workplace, visitor/public and fleet. Given this, there is now an opportunity and need for SCE to refine and evolve its education and outreach efforts in this area.	Provide a comprehensive assessment of key non-residential customer segments that will serve to inform the development of effective PEV oriented education and outreach tools.	1. Focus groups that cover key segment/priorities and charging scenarios 2. Nonresidential customer survey
Multi-Family Units Education/Outreach Needs Assessment	As PEV adoption increases over the next several years, there will be a greater demand for multi-family unit residential charging locations in SCE's service territory. With over 1.2MM multi-family units, there is an opportunity to proactively understand what successful PEV education and outreach tactics look like in the	Provide a comprehensive assessment of key multi-family unit customer segments that will serve to inform the development of effective PEV oriented education and outreach tools.	1. Focus groups to cover target segments 2. Multi-Family Unit Customer Survey

Its purpose is to establish early indicators of mass adoption charging (in-home and away from home) and driving behavior while identifying underlying motivations. See table below.

3.2 Initial Market Research Findings

As of January 2012, SCE has completed the first phases of both the Non-Residential and Multi-Family Units Education/Outreach Assessments. This first phase represents the qualitative exploration ("Discovery" work) around these target segments. Phase one findings will inform the development and design of phase two work that will provide a quantitative validation and subsequent recommendations.

Phase One highlights:
Preliminary findings show significant interest among key segments to install charging infrastructure. The motivations to install are primarily benefit driven:

- Marketing/competitive advantage
- Supports environmental/sustainability initiatives
- Tax breaks/incentives
- Lower fleet fuel costs
- Providing employee benefit
- Promotes positive company image

- Providing convenience/amenity
- "PEV's are the future/inevitable"

The research also indicates numerous real or perceived installation barriers:

- Unknown associated costs
- Unknown/unacceptable ROI
- Limited space/loss of premium parking
- Permitting/inspection hassles
- Liability concerns
- Vandalism/theft concerns
- Unknown future of PEV's (i.e. charging demand)

These unveil educational needs, information key to utilities such as SCE as it evolves and refines its education and outreach efforts.

Finally, it underscores the need for a regional infrastructure plan, both flexible and creative in its approach. One that perhaps sees an infrastructure "eco-system" in which the efforts of both the public and private sector are working in tandem.

3.3 SCAG Regional Planning

SCAG drafted a Planning Scope of Work which is provided here to serve as an example of a Statement of Work that can be deployed by other planning organizations.

3.3.1 PEV Infrastructure Deployment Plan

In order to develop a reasonable estimate to assess the number and location of charge locations, the SCAG Team is addressing the following issues:

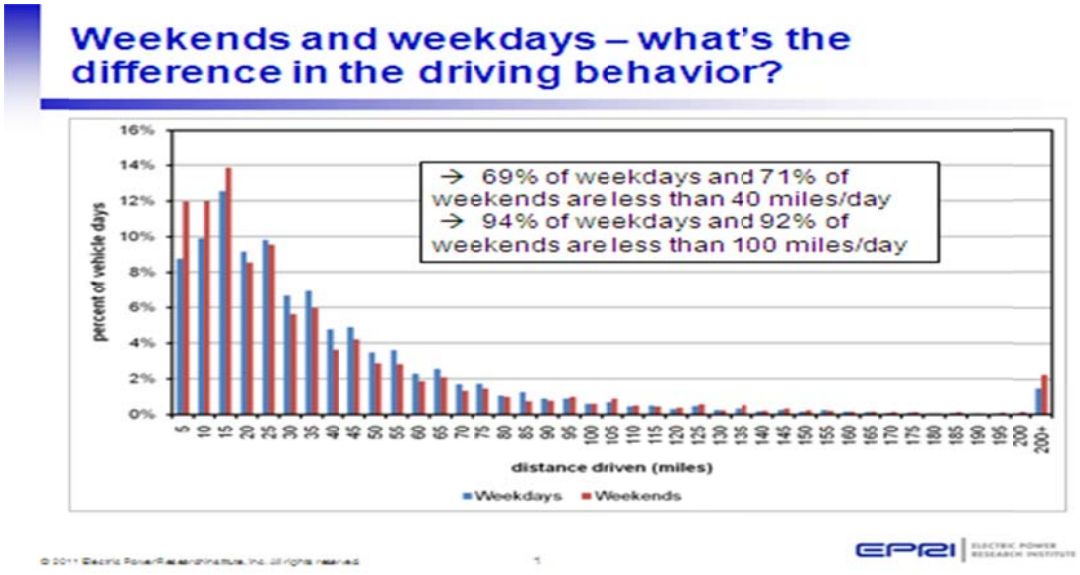
- 1990's infrastructure locations and usage patterns
- Region's travel destinations
- Publicly available commercial charge ports
- Market analysis of actual and projected PEV usage patterns
- Charge system levels - DC fast charging/battery exchange - potential impact on charge quantity
- Workplace support for PEV infrastructure and the issues that would impact a workplace decision
- Understanding the complexity of putting charge systems in multi-family units

The SCAG project partners have established the following near term guidelines for PEV infrastructure deployment. The guidelines will be updated quarterly based on actual market penetration data, vehicle usage patterns, and charge system viability (e.g. DC fast charging).

- Upgrade 1990's infrastructure based on current and expected usage patterns
- Understand key travel destinations and travel patterns
- Track the usage patterns of the ARRA funded DC fast charge systems especially driver response to fill level with the 15 to 30 minute "fast charge" time frame.
- Understand the market differences between PHEV and BEV and why the consumer chooses one over the other
- Workplace simplicity - need to consider 120 volt parking lot access points, linked with a few level two systems for short trips and guests
- Support multifamily unit access with creative technical solutions such as credit card billing systems
- Ensure that the region has planned to provide service to all markets - underserved, environmental justice
- Enable fleet applications by considering "public" recharge locations for fleets that need mid-day recharge locations near urban core versus those that can re-charge behind the fence at night
- Continue focus on mitigating on-peak PEV charging through rate education, price signals and eventually demand response technologies. This may also include the use of battery storage and renewable energy such as wind and solar.

3.3.2 Critical Actions

- Collection of consumer charging behavioral data in support of this effort -The proposed project will include both a behavioral and attitudinal assessment of PEV early adopters to establish early indicators of mass adoption charging (in-home and away from home) and driving behavior while identifying underlying motivations.
- Include an assessment of potential workplace and fleet charging among non-residential utility customers - The proposed project will obtain information including the number and location of existing charging stations and plans to install charging stations. When reconciled with other data points (i.e., commute patterns, employment center locations, etc.) this will



provide implications on where supplemental public charging may be needed for away from home charging stations.

- The final deliverable would be a regional charge port infrastructure strategic plan including the location identification, quantity and investment required to install the infrastructure beginning in 2014. The study will include a map of the existing and proposed infrastructure sites and a timeline for deployment.

The project will integrate previous studies, workplace engagement, transportation studies, and estimates of PEV deployment. Various studies have been performed to provide region-specific assessment to support infrastructure deployment. The Electric Power Research Institute (EPRI) performed a study which focused on the quantity and type of charging infrastructure. UC Davis' Plug-in Hybrid and EV Research Center explored Market and Operational Assessments of BEVs and PHEVs. SCE and EPRI also analyzed the market in a study called "Characterizing Consumer's PHEV and BEV Electric Infrastructure Expectations" in May 2009. UCLA has also completed a study on the charging needs and challenges of multi-family residential units. Several sub-region studies were undertaken by local Councils of Government such as the Local Use Vehicle Demonstration Project done by the SBCCOG. UCLA has developed a market penetration volume analysis that will help update some of the predictive modelling associated with clustering, workplace charging, and customer preferences. The team is collaborating with UCLA and other organizations to further understand the evolving PEV market, ensure that knowledge is captured, adopted and applied to the region's PEV-Readiness initiatives.

- While the energy impact of electric transportation will be negligible in the early adoption years, SCE estimates that by 2020 it may account for up to 5% of SCE's total annual load. New rate designs will provide economic incentives for PEV owners to charge their vehicles off-peak. Owners of limited range PEVs who want to minimize petroleum consumption but have round-trip "range anxiety" will seek daytime charging opportunities which may have significant load impacts on the grid.

The study will outline specific guidelines and best practices for efficient PEV infrastructure deployment, provide data which supports the infrastructure analysis and location identification, and contain various policy recommendations for PEV-friendly building and public works in the region and the state.

A cornerstone of any planning effort for PEV Readiness is developing a reasonable forecast of PEV adoption in the region. The SCAG project will utilize previous market estimations developed by SCE, EPRI (see below) and UCLA supported by current market penetration data to develop a forecast for infrastructure estimation. The current production plans for three PEV models for U.S.

sales through 2014 are approximately 730,000 units. It is expected that approximately 10% of the total U.S. forecast sales during the 2011 to 2014 timeframe will be purchased in Southern California.

3.3.3 Additional Benefits of Regional Infrastructure Planning

SCAG's 2012 Regional Transportation Plan (RTP) and Sustainable Communities Strategy (SCS) will include various strategies to reduce GHG emissions including potentially PEV-friendly policies and incentives such as preferred parking or pricing strategies such as vehicle miles travelled, fees and tolling. SCAG will incorporate information and policy options from the RTP/SCS into the regional PEV study as appropriate.

SCAG can quantify the GHG emission reductions based on the estimated regional shift to PEVs. SCAG utilizes the EMFAC model, which is produced by the California Air Resources Board, to quantify GHG emissions. SCAG could work with our partners to include varying estimates of PEVs within the fleet mix. Furthermore, the SCAQMD recently released a new statewide land use emissions computer model called the California Emissions Estimator Model (CalEEMod) developed in cooperation with other air districts throughout the state.

CalEEMod is designed as a uniform platform for government agencies, land use planners and environmental professionals to quantify potential criteria pollutant and greenhouse gas (GHG) emissions associated with construction and operation from a variety of land uses, such as residential and commercial facilities. The model quantifies direct emissions from construction and operation (including vehicle use), as well as indirect emissions, such as GHG emissions from energy production, solid waste handling, vegetation planting and/or removal, and water conveyance. The model incorporates Pavley standards and Low Carbon Fuel standards into the mobile source emission factors. Further, the model calculates the benefits from implementing mitigation measures, including GHG mitigation measures recently developed and approved by the California Air Pollution Control Officers Association (CAPCOA). The model could be used as well to quantify the GHG benefits of shifting to EVs.

SB 375 addresses the reduction of motor vehicle emissions through innovative planning and land use decisions. Strategically locating infrastructure charging facilities will further enhance sustainable planning practices through the use of green technologies. SCAG has included a narrative about the potential for PEVs to reduce greenhouse gas emissions in the 2012 Regional Transportation Plan and Sustainable Communities Strategy.

Recognizing the value of PEV penetration to the region, SCAG is reaching out to key partners to explore and define economic benefits. It is recommended that regional planning effort recognize and document the potential economic value.

The SCAG team will include members of the Southern California Plug-in Electric Vehicle Collaborative (SoCalPEVCC). This Collaborative was formed to support the State's efforts to deploy electric vehicles with a common education and outreach program and the establishment of an appropriate level of PEV infrastructure across the state.

SCAG can utilize the EMFAC model to estimate GHG and criteria pollutant emissions and the SCAQMD's model, CalEEDMod is also a good resource for the study. In addition to these models, a great deal of information will be available from SCAG including the Census Transportation Planning Package (Home to Work) for 1990, 2000 and 2006-2008, the 2001 Household Transportation Survey and potentially an updated survey in 2011 or 2012. The transportation survey would have data for all persons 5 years and older for approximately 15,000 households across the region. Lastly, SCAG has data by transportation analysis zone for key socioeconomic data including income, ethnicity, age, gender and if they are disabled.

It has been determined that the awareness of PEV issues/values/costs is low based on SCE's extensive outreach including community visits, workshop questions, SCE contacts and SCE customer and dealer focus groups. This is especially true when one goes beyond the early adopter market that is typically environmentally and technically conscientious with the financial resources to participate. With the awareness low, extensive education and outreach will be required. The planning study supports extensive education and outreach that will build from the solid outreach

and education base established by SCE, SoCalEV Ready, SCAQMD, UCLA and others.

The following critical path action items have been developed by the SoCalPEVCC to support the market transition from early adopter, limited infrastructure deployment, to mass market PEV appeal and a reasonable number of charge locations based upon the Regional Infrastructure plan.

1-2 years
- Review actual operator behavior and charge system usage
- Review vehicle usage - commuter, second family car, etc.
- Review market penetration data
- Update and revise assumptions that play into the model
- Open dialogue and outreach to workplaces

3-5 years
- Aggressively pursue a reasonable level of funding from state and federal sources to support an appropriate documented level of public charge systems
- Support workplace charging to the maximum extent possible
- Build an appropriate level of public infrastructure at key travel destinations
- Implement education and outreach programs to the mass market, beyond the early adopters
- Prepare for underserved and MFU market to increase as used PEVs penetrate the market

5-10 years
- Update the regional plan every 2 years based on hard data and experience
- Build out the next level of infrastructure based on the above

4 Sample Detailed Scope of Work

Purpose: To develop a Regional PEV Readiness Plan with complementary model subregional plans that advance strategies for the accelerated and streamlined deployment of EVSE, establish best practices for "PEV-ready" building and public works guidelines, and help to streamline EVSE permitting, installation, and inspection processes in workplaces and private and public fleets.

Task 1: Administration
This task will be completed in accordance with the scope of work prepared by _____.

Task 2: Model Subregional PEV Readiness Plans
The second task of the study is to develop model subregional readiness plans that will provide complementary data and information for the regional CPI plan. The subregional plans will serve as models for other subregions to conduct in the near future.

Work Products:
The key work products for this task will be two Subegional PEV Readiness Plans including best practices and guidelines. The Subregional Readiness Plans will include additional supporting documentation such as a Literature Review Report, Subregional PEV Supply and Demand Study, and a Housing Stock Readiness Assessment.

Task 3: Regional PEV Readiness Planning
The third task of the proposed regional study is to develop a Regional PEV Readiness Plan that would address the electric vehicle charging needs of this region's diverse population beginning in 2014. The first step in this task would be to conduct a literature review to ensure the project does not duplicate efforts and builds off of existing work. The next steps would include surveying consumer charging behavior including employer/workplace engagement, as well as determining strategic locations for residential single and multi-family dwelling units, commercial and public areas, and fast charging units. The Regional PEV Readiness Plan would also include a map of strategic charge port locations, quantification of the investment required to implement the strategy and a timeline for implementation. This plan would outline specific guidelines and best practices for efficient PEV infrastructure deployment, provide data which supports the infrastructure analysis and location identification, and contain various policy recommendations for PEV-friendly buildings and public works in the region and the state including the deployment of pre-installation checklist and post-commitment streamlining.

Work Products:
The key final work product would be a Southern California PEV Readiness Report including a map of recommended charge port locations, which would encompass the additional work products

developed throughout the process including the following:

- Literature Review Report that discusses existing literature and relevant data sets
- Data Needs Report that lists data needs as well as possible approaches for acquiring needed data and information
- Report on the Projected Penetration of PEVs in Southern California
- Non-Residential/Non-Single Family Home Charging Assessment
- Early Buyer Study
- Southern California PEV Readiness Plan
- Regional map of recommended PEV infrastructure needs

Task 4: Outreach and Consultation
The fourth task of this effort is to develop an outreach and education plan that would accelerate PEV adoption in private and public fleets. The outreach would build on the successful PEV 101 workshops held in the SCE territory and continue to build public awareness about the benefits of PEVs.

The regional plan will be able to take the lessons from the outreach to date and establish education and outreach approaches that will be necessary to support the mass market beginning in 2014. The proposed project seeks to promote economic growth and sustainable jobs in the region and the state.

Work Products:

- Final outreach materials (presentations, brochures, web material)
- Final Mission Statement
- Final Charter
- Agendas and Minutes from the meetings

5 Guidelines for consideration

5.1 Level 1 (120v) Charging

Federal Tax Credits/rebates for PEV residential infrastructure will be eliminated or reduced in 2012. Without these credits, PEV consumers may opt to utilize dedicated 120 systems at home especially because they can get a full charge in their batteries within 9 hours, the average time a PEV is parked at home. Preliminary data from locations such as London, have also shown that the battery is not typically depleted in BEVs and even with PHEVs with smaller batteries, these vehicles can be fully charge using the 120 system during the evening hours. This also suggests that workplace and home charging may be ideally suited for 120 charge systems thus reducing acquisition, installation and maintenance costs. The key will be the incorporation of smart durable plugs so that energy consumption can be captured for road and carbon tax calculations. Smart 120 systems are now being developed.

5.2 Commuter Distances

"Life for commuters can be heaven or hell. They report an average one-way commute time of 26 minutes (over an average distance of 16 miles). But the variance is huge: On the best days, the average commute is 19 minutes; on the worst days, 46 minutes. That means traffic, at its worst, can double the average commute time, adding 27 minutes each way[2]."

Nationally, the average commuter distances are ideal for a BEV with a 100 mile range and most PHEVs with 35-40 mile range will provide all electric driving to and from home. The question is what is the break point for a commuter to consider a PHEV or a BEV? We suggest that if a commute is 20 miles or less one way the individual is a candidate for a BEV. If greater than 20 miles each way practicality will set in and the majority of the market will opt for a PHEV or possibly a hybrid. Thus, workplaces need to survey the employee base carefully to determine the number of charge systems that will be required in the near future and long term.

"Nearly three-fourths of respondents (74%) drive 40 miles or less to work daily and therefore would be well served by a plug-in hybrid electric vehicle (PHEV) with a 40-mile range. Survey participants stated that they drive an average of 22.2 miles to work per day. Nearly all plug-in vehicles have been developed to exceed consumers' daily driving distance by providing a minimum of 30 miles of all-electric range under optimal conditions. The exception is the Toyota Prius Plug-in Hybrid Vehicle, which has an electric range of 15 miles[3]."

5.3 DC Fast Charging

Very little is known about the value proposition for DC fast charging system. In Tokyo, DC fast chargers are used as emergency backup for home charging system. However they are very seldom used. The value to a community may be that a single DC fast charging system might be appropriate as a security or emergency charge

location. This single installation may forestall the installation of a number of Level II systems thus reducing capital and operating costs. Having made this statement it is also worth considering a DC system as an attraction to a travel destination or a key revenue generating area in the community.

DC fast charging may play a role in region to region travel thus extending the total miles travelled as an electric vehicle in and out of the region. Little is known about the acceptance of regional long distance travel for BEVs and when one is considering this opportunity one must consider the charge levels that can be accomplished at each stop (due to battery management and life considerations). How often will an individual be willing to travel between regions if they know they can only receive an 80 to 90% charge after waiting 15 to 30 minutes and then will need to do the same again in the next 60 to 80 miles. Because of the acquisition, installation and long term maintenance expense, careful consideration should be given before fast charging is incorporated for inter-regional travel. If a community wants to install such a system at a "travel destination" that exists between regions as an enticement to have travellers stop and spend it might be worth consideration.

5.4 Availability of Commercial Charge System to the Public

Commercial systems are the potential salvation for communities attempting to make an investment to become PEV ready. Commercial sites will be developed for reasons that are different than a community to meet public needs. Commercial sites will be used to support PEV customer (dealers), attract and hold customers in the store longer (Walgreens), be seen as a "Green" company (IKEA) or to attract customer to PEV and related products (Best Buy, Lowe's, Home Depot). These locations will most likely be open when PEV owners are out and about thus reducing the number of public charge stations. Regional planners should do a complete inventory of current and projected public charge locations on commercial property prior to determining the number of chargers needed on public property.

5.5 Multi-family Dwellings (MFD)

MFD are by far the biggest challenge to PEV infrastructure decisions as they are the biggest challenge for PEV buyers and EVSE installers. Certain cities – San Francisco and Santa Monica, serving as examples, have the majority of their respective populations living in apartments and condos. The residences in these communities deserve to have access to PEVs and the necessary charging location. Because some MFD cannot be made PEV infrastructure acceptable due to vehicle location versus power access to the complex, tenant versus building billing policies or just plain cost to install, it may be impossible for a MFD tenant to have access to his/her own charging system. Thus it may be appropriate for a city to install charging systems on public property that can be utilized by these tenants. For example, a public garage near a transit depot can be used for commuters during the day and serve as a location for charging systems for MFD dwellers during the night time. It is also important for MFD tenants, home owner associations and building owners to review carefully new building codes that are being developed for new residential and MFD construction.

Solutions for MFD PEV Charging infrastructure include:

- Provide smart 120 Volt outlets that can wirelessly transmit consumption data
- Offer tenants an opportunity to install units in public location with smart card reading systems
- Contract with Electric Vehicle Service Providers to install and manage systems

5.6 On-Street Charging and Parking Locations

On street charging/parking location seems like a new way for a community to support PEV market transition. However, as this decision is being made some consideration should be given to the following questions: Will the city be charging for the spot and the electricity? (consider the need for revenue) Is the street near a travel destination that would attract a long term parker? (city malls are one example) Does the location therefore need a Level II or will a Level I charge system suffice? Will the PEV drivers that park at the charging/parking location be travelling from a distance to the spot or does it only serve local drivers that probably do not need to recharge before going home? Do you need charging/parking

to support MFD tenants that are too far from public parking garages? Have you considered ADA requirements for the charging/parking locations and what is the impact on other ADA parking spots? Bottom line, PEV owners can park in existing parking locations as any other vehicle and only need a charge "location" if they are no longer in range of their home or work charge port location.

5.7 Utility Participation in Regional Planning

It is recommended that regional planning includes the utility(s) that serve the region. PEV infrastructure installation may have an impact on the electric distribution system. Utilities are responding to PEV penetration by performing distribution impact analyses with focus on the local circuit and its impact as systems are installed in residential and commercial applications.

"SCE works with vehicle OEMs and charging equipment manufacturers to encourage the development of products that meet the needs of PEV customers and also interact well with the electric system. While there is competitive pressure for vehicle OEMs and EVSE manufacturers to offer products with faster residential charge times, this may result in unintended consequences for the distribution grid. Since the CPUC requires utilities to track all PEV-related costs, 18 the cost of sizing the distribution system to handle progressively faster charge times may eventually be borne by PEV customers through higher PEV rates and demand charges. To avoid impeding PEV market development, SCE will continue to encourage manufacturers to assess the total system and customer costs when designing PEV charging equipment. The utility will also encourage the marketplace to provide customer choice with low-cost 20, 30, and 40 amp charging solutions. SCE will likewise promote the deployment of an appropriate charge level mix when interacting with potential operators of public charging stations—whether private enterprises or municipal governments[6]."

6 Summary

Regional planning when combined with current market research is critical to make a wise investment in PEV infrastructure that is funded with public dollars. Consider current market immaturity, develop systems that are scalable as the market expands and clearly understand the usage patterns. A DC fast charge system may just be what the doctor ordered. In some environments, Level II may be necessary at some key travel destination due to length of stay but Level I may be ideal for long term parking needs such as hotels, airports or places of employment.

References

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[6] Plug-in Vehicle Strategy and Roadmap, Southern California Edison, December, 2011

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