CALIFORNIA ENERGY COMMISSION

Clean Transportation Program

FINAL PROJECT REPORT

UPSTATE PLUG-IN ELECTRIC VEHICLE READINESS PROJECT

Prepared for: California Energy Commission

Prepared by: The City of Mt. Shasta, Siskiyou County Economic Development Council, GHD, and Schatz Energy Research Center

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PREFACE

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

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

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

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-10-602, to provide funding opportunities under the Clean Transportation Program for California's diverse regions to develop regional PEV strategic plans. In response to PON-10-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards June 19, 2012, and the agreement was executed as ARV-11-007 on August 28, 2012.

ABSTRACT

The purpose of the Upstate Plug-in Electric Vehicle Readiness Project was to foster greater use of plug-in electric vehicles in our three county Upstate California region by preparing a plan to support infrastructure development. To address the scope of the project, the specific aims consisted of forming a collaborative and regionally representative coordinating council, producing an objective infrastructure deployment and siting plan, and developing an education plan that encouraged fleet adoption, support by transportation boards, consumer interest, and developed guidelines to facilitate an easier permitting process of electric vehicle charging stations.

The major findings of this project suggest that infrastructure siting and deployment in the Upstate California region will demand a greater number of level 3 Direct Current fast charge stations, relative to metropolitan regions, due to the relatively large and rural geographical area, a high number of vehicle miles traveled, and a high throughput of transitory vehicles along a major interstate highway corridor. Due to the collaborative nature of the project's goals the Upstate region benefited greatly from the experience, expertise and methodology developed by the North Coast Region's Plug-in Electric Vehicle readiness plan. This methodology supported an objective result of the infrastructure deployment plan through a predictive modeling program, a refined micro-siting decision matrix, and a regional charging infrastructure ownership example. This objectivity was critical to the successful result of this project because the robust rationale addressed issues of fairness that arose in our coordinating council. The successful conclusions demonstrated by this method in two regions of California suggests that it can be used for plug-in electric vehicle planning in other regions, especially for other rural communities along a major transportation corridor like Interstate 5.

Keywords: Plug-in electric vehicles, electric vehicle supply equipment, greenhouse gas reduction, on-peak, permitting, fleet vehicles, incentives, education, outreach, readiness plan, infrastructure, planning, deployment

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TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

EXECUTIVE SUMMARY

Siskiyou, Shasta, and Tehama Counties make up the "Upstate Region of California" which is preparing for the rollout of Plug-In Electric Vehicles (PEV), in part due to California's commitment to zero emission vehicles. In 2012, Governor Jerry Brown established aggressive PEV and infrastructure targets which call for 1.5 million zero emission vehicles and easy access to infrastructure for all of California by 2025. The early development of PEVs in California has focused mainly on population centers. However, the goal of this project addresses the need to extend the network along primary highway corridors between metropolitan areas and by integrating the state's rural communities through education and planning.

The Upstate Region is a key participant in the expansion of the "West Coast Green Highway" through the leadership of the City of Mt. Shasta. The West Coast Green Highway is in concert with the Electric Vehicle Project, a $230 million US Department of Energy project to deploy electric vehicle charging infrastructure in multiple states including Washington, Oregon, and California. Located at strategic points along Interstate-5, the stations provide charging for Electric Vehicle from Vancouver, British Columbia to Baja, Mexico.

Working with the California Energy Commission and the City of Mt. Shasta, the Siskiyou County Economic Development Council, GHD, and Schatz Energy Research Center coordinated an effort to meet the state targets by identifying stakeholders, conducting educational outreach, composing written guides to streamline local adoption, conducting regionally specific transportation planning, and coordinating a regional advisory council. This coordinated effort has created an infrastructure deployment plan to connect electric vehicle drivers with fast charging stations between Electric Vehicle-friendly communities along Interstate 5 and other major roadways.

The completed Upstate California Plug-in Electric Vehicle Readiness Plan along with the completed Upstate California Plug-In Electric Vehicle Readiness Final Report can be found on the Siskiyou Economic Development Plugin Electriv Vehicles Program Webpage (https://www.siskiyoucounty.org/plugin-electric-vehicles-program)

The conclusions of this planning project indicate that residents and jurisdictions in the California Upstate Region feel generally positive toward PEV infrastructure development, public charging station ownership, permitting guidelines, fleet incorporation, and future adoption. Further, local transportation commissions and regional transportation boards have embraced PEV planning strategies as a method for meeting the State of California's increasingly stringent air quality improvements and greenhouse gas reduction commitments. For every 1 percent increase in PEV adoption we estimate a corresponding 1 percent reduction in greenhouse gas production in our region. Interestingly, Upstate regional stakeholders predict a greater use of public charging stations by visiting tourists than by residents in the near-term due to the "range-anxiety" inherent nature of commuting in a rural area. This perspective is also likely due to the initial experience of two Tesla charging stations in our region where Tesla PEV owners are primarily from the greater San Francisco Bay Area. The transportation planning models predict a robust adoption rate of PEVs (2 percent adoption or 3,500 PEVs in the Upstate region by 2020) that assumes a similar rate of adoption to that of hybrid electric vehicle growth in the consumer and fleet transportation sectors. With continued leadership from the City of Mt. Shasta, the Upstate is ready for planning implementation and PEV infrastructure development starting in 2015.

CHAPTER 1: Introduction

Problem Statement

Plug-in electric vehicles offer many transportation advantages over conventional petroleum fuel vehicles, however, because of fundamental differences in fueling infrastructure, the transition of adopting PEVs for transportation requires a significant investment in planning and infrastructure conversion to meet predicted future demand and prevent stranded assets. The Upstate California region represents many challenges to planning a PEV readiness project that are distinct from many metros' region examples. These challenges include a relatively large and rural geographical area, a high number of vehicle miles traveled, low population density, and a high throughput of transitory vehicles along a major interstate highway corridor. To address these challenges the purpose of this project was to provide educational outreach, develop a regionally coordinated advisory team, and produce a strategic readiness plan to meet PEV transportation goals.

Goals and Objectives

As funded and outlined by the California Energy Commission, the five primary goals of the Upstate Plug-in Electric Vehicle Readiness Project are to:

- Cultivate stakeholders into a collaborative Plug-in Electric Vehicle Coordinating Council (PEVCC)
- Compose an infrastructure deployment plan
- Assess local permitting requirements for installing electric vehicle supply equipment (EVSE) and develop a plan to streamline those requirements
- Evaluate several local vehicle fleets and create a plan to accelerate plug-in electric vehicle adoption
- Plan educational outreach campaign efforts to improve plug-in electric vehicle adoption in Upstate communities and provide an example to other regions

Project Metrics

The following task-based metrics were used to evaluate project success.

- The success of the Upstate Plug-in Electric Vehicle Coordinating Council was measured by 1) adequate representation of stakeholders in the three different counties, Tehama, Shasta, and Siskiyou, that formed the Upstate region and 2) adequate representation from impacted sectors including electricity producers, local elected officials, non-profits, air quality management boards, and transportation boards. Progress was further measured through recording of meeting minutes, feedback from workgroups, and communication updates.

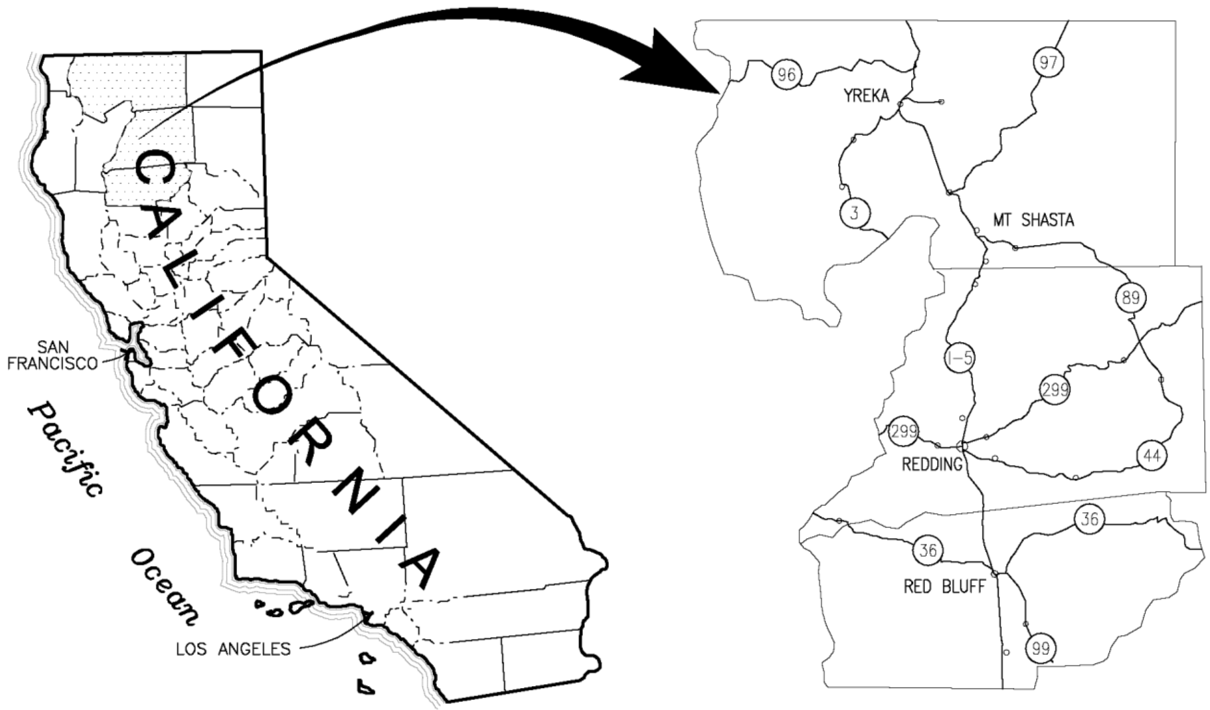
- The success of the Infrastructure Deployment Plan was measured based on 1) identification of candidate charging locations and 2) the likelihood that the candidate locations would address the predicted charging needs and 3) the candidate charging locations would have identified champions to own and maintain planned EVSE.
- The effectiveness of our efforts to streamline permitting were assessed based on how well we met the following objectives: 1) collaborate with original equipment manufacturers, utilities, local planning and building department officials, and EVSE installers to develop guidelines for streamlining EVSE permitting and installation processes in the Upstate Region 2) collect information from other jurisdictions where PEV friendly permitting guidelines have already been developed 3) draw on work done by groups such as the California Plug-in Electric Vehicle Collaborative and Project Get Ready 4) work with the PEVCC and local participating jurisdictions (including the Cities of Yreka, Mt. Shasta, Redding and Red Bluff) to conduct mock EVSE permit evaluations and 5) hold an EV101 workshop to educate regional planning and building department officials in PEV charging infrastructure best practices.
- Our success in promoting PEV adoption in fleets was evaluated based on the following objectives: 1) create a list of public and private entities in the Upstate region with vehicle fleets 2) collaborate with the PEVCC to engage fleet managers and agency decision makers in fleet PEV-opportunity evaluations 3) evaluate two municipal vehicle fleets for PEV transition potential and 4) provide fleet managers with detailed information on the range of equipment options available to meet stakeholders' specific fleet needs.
- Education and Outreach metrics involved the development of an education and outreach plan, preparation of educational materials, and implementation of select education and outreach activities. The education and outreach effort were measured by work done in other communities, conferences attended, and adopting information developed by other organizations to the Upstate Region.

Geographic Scope

The Upstate region represents the gateway from Oregon and the Pacific Northwest into California along the major transportation corridors of InteIrstate-5 and Highway 97 (Figure 1). Running North/South, the Interstate-5 corridor is the largest transportation thoroughfare by vehicle count in the Upstate region and runs approximately 175 miles from the Oregon border in Siskiyou County through Shasta and Tehama Counties before continuing south to the border of Mexico. The Upstate regional roadway network of streets, roads, and highways (not including Interstate-5) is approximately 5,600 centerline miles in length. Further, this roadway network does not include roads on public lands maintained by the United States Forest Service and Bureau of Land Management which represent approximately 60 percent of the land in Siskiyou County. In total, the Upstate region represents a large total surface area of approximately

13,000 square miles or 8 percent of California.

Figure 1: The Upstate Region's Counties and Major Highways



Source: GHD, 2014

Project Team

The California Energy Commission provided the funding for this project through its Alternative and Renewable Fuel and Vehicle Technology Program, which issued solicitation PON-10-602 to provide funding opportunities for California's diverse regions to develop regional plug-in electric vehicle strategic plans.

The City of Mt. Shasta is an alpine community located in the Shasta Cascade area of Northern California. Mt. Shasta is the tourism capital of Upstate California and residents prioritize quality of life, the environment, and a strong sense of community. Further, the city has been keenly interested and has worked diligently for many years on the development of "green" technologies, businesses, and practices. The city conducts government affairs in an open and creative process and encourages new sustainable energy developments to protect the pristine outdoors for which the city is reputably known. The City does not possess the internal staff capacity, nor is it chartered to work on a multi-county effort, thus they choose to use the Siskiyou County Economic Development Council as the program administrator for the entire project

The Siskiyou County Economic Development Council Siskiyou County Economic Development Council (SCEDC) is a private non-profit organization which has a long (25 year) history of working with local and regional jurisdictions through grant administration, infrastructure development, regional planning, and other economic and community development activities. A short selection of past (and current) projects includes Brownfield work with the Environmental Protection Agency, Energy Efficiency retrofits with the California Energy Commission, Infrastructure and Technical Assistance projects with Housing and Community Development, Regional Planning with the United States Department of Agriculture. The SCEDC collaborates frequently with other organizations such as the Upstate Economic Development Council, Superior California Economic Development, and the Governor's Office of Economic Development. The SCEDC administered the award on behalf of the PEVCC and coordinated all efforts with local municipalities.

SISKIYOU COUNTY
ECONOMIC DEVELOPMENT

The Schatz Energy Research Center at Humboldt State University was the technical lead on this project. The Schatz Energy Research Center (SERC) was founded in 1989 with a mission to promote the use of clean and renewable energy resources. SERC recently finished acting as the technical lead on the North Coast Plug-in Electric Vehicle Readiness Project under Energy Commission Agreement Number ARV-11-006. Over the years SERC has been involved in extensive research, planning, design, and analysis activities for the development and implementation of sustainable energy systems, including energy efficiency, solar, wind, small hydro, biomass, and hydrogen and fuel cell technology for portable, stationary, and transportation applications.

SCHATZ ENERGY RESEARCH CENTER

More recently SERC partnered with the Redwood Coast Energy Authority to develop a strategic plan for renewable energy development in Humboldt County (Energy Commission Contract Number PIR-08-034). SERC guided all technical tasks.

GHD is an engineering consulting firm with offices located throughout the globe, including an office in Eureka, California. GHD is a key subcontractor in the North Coast Plug-in Electric Vehicle Readiness Project. GHD will provide technical consulting services, with a special focus on EVSE permitting, installation and inspection, engineering and cost estimating, and consumer charging behavior data collection, as well as contributions to the PEV infrastructure deployment plan. GHD is one of the world's leading engineering, architecture, and consulting companies. Established in 1928, GHD employs more than 6500 people across five continents and serves clients in the global markets of water, energy and resources, environment, property and buildings and transportation. Staff in GHD's Eureka office have skills and interest in the deployment of PEVs and EVSE and have an established working relationship with SERC.

In addition to the primary team above there were project partners that committed match funding through in-kind cost sharing and staff time. These partners include: the County of Siskiyou, Upstate California Economic Development, and the regional investor-owned utilities, Pacific Power, Pacific Gas and Electric Company (PG&E), and the Redding Electric Utility. Pacific Power provides electrical power to Siskiyou and a portion of Shasta County; PG&E provides power to Tehama, Butte and the majority of Shasta County, and Redding Electric Utility provides power to the City of Redding. All three of these utilities are working to reduce their greenhouse gas emissions, green up their power mix, and provide cleaner, more efficient options for their customers. As electricity providers, they will each play a significant role in the successful promotion and adoption of PEVs. They are or can be actively involved in education and outreach and infrastructure planning activities. All utilities participated in the Upstate Region PEV project by providing technical data, assistance, guidance, and in-kind match funding.

Background

Plug-in Electric Vehicles and Associated Charging Equipment

Plug-in electric vehicles (PEVs) are propelled by electric motors powered by rechargeable battery packs. Electric vehicles first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. The internal combustion engine has been the dominant propulsion method for motor vehicles for almost 100 years, but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types. During the last few decades, environmental impact of the petroleum-based transportation infrastructure, along with the peak oil, has led to renewed interest in an electric transportation infrastructure. The PEV landscape of today is evolving at a rapid pace. Rising gas prices and heightened concerns over climate change have led to an increase in demand for more efficient, less polluting vehicles, while recent advances in technology have led to the ability to supply PEVs in volume. This convergence of supply and demand has created a growing marketplace for PEVs.

Electric vehicle configurations include Hybrid Electric Vehicles (HEV), Plug-in Hybrid Electric Vehicles (PHEV), and Plug-in/All-Electric Vehicles (PEV). PHEVs can be driven a certain distance on all-electric power (typically 10 to 40 miles), and then can be driven substantially further (for example, 200 to 300 miles) in gasoline hybrid-electric mode. PHEVs can be plugged in to recharge their battery banks. Battery all-electric vehicles can be driven a certain range on all-electric power (typically 70 to 100 miles), and then they must be plugged in and recharged. This study addressed both types of PEVs.

For reference, EVCS are available at three different power levels that support different rates of PEV charging. The permitting requirements for the three different charging levels vary due to differences in the character of the required electrical service. The three charging levels are defined as follows:

- Level 1 charging provides alternating current (AC) electricity to the PEV from a 120-volt (V), 20 ampere (A) circuit.
- Level 2 charging provides AC electricity to the PEV from a 240 V circuit with currents up to 80 amp.[1]
- Level 3 charging is also referred to as DC fast charging, provides direct current electricity to the PEV and the AC feeder capacity to the EVCS is typically 208 or 480 V, 3 phase with currents up to 400 amp.

These three charge levels are referred to throughout this document.

Regional Characteristics

Siskiyou, Shasta, and Tehama Counties make up the "Upstate Region of California" which is a rural section of the state that faces unique PEV adoption issues compared to metropolitan areas. The three counties combined population is approximately 285,000. In context, this makes the Upstate region one of California's least populated areas, yet it represents a critical transportation corridor between California and Oregon via Interstate 5. Interstate 5, a main travel corridor that runs from British Columbia through Washington, Oregon, and California, intersects the three counties, connecting south-bound travelers to California's largest population centers and makes the upstate region a key component in the West Coast Green Highway development.

The City of Redding (Shasta County) represents the region's largest population center with more than 62 percent of the Upstate's population based in the metro region. For that reason, Shasta County has several electric charging stations existing, while

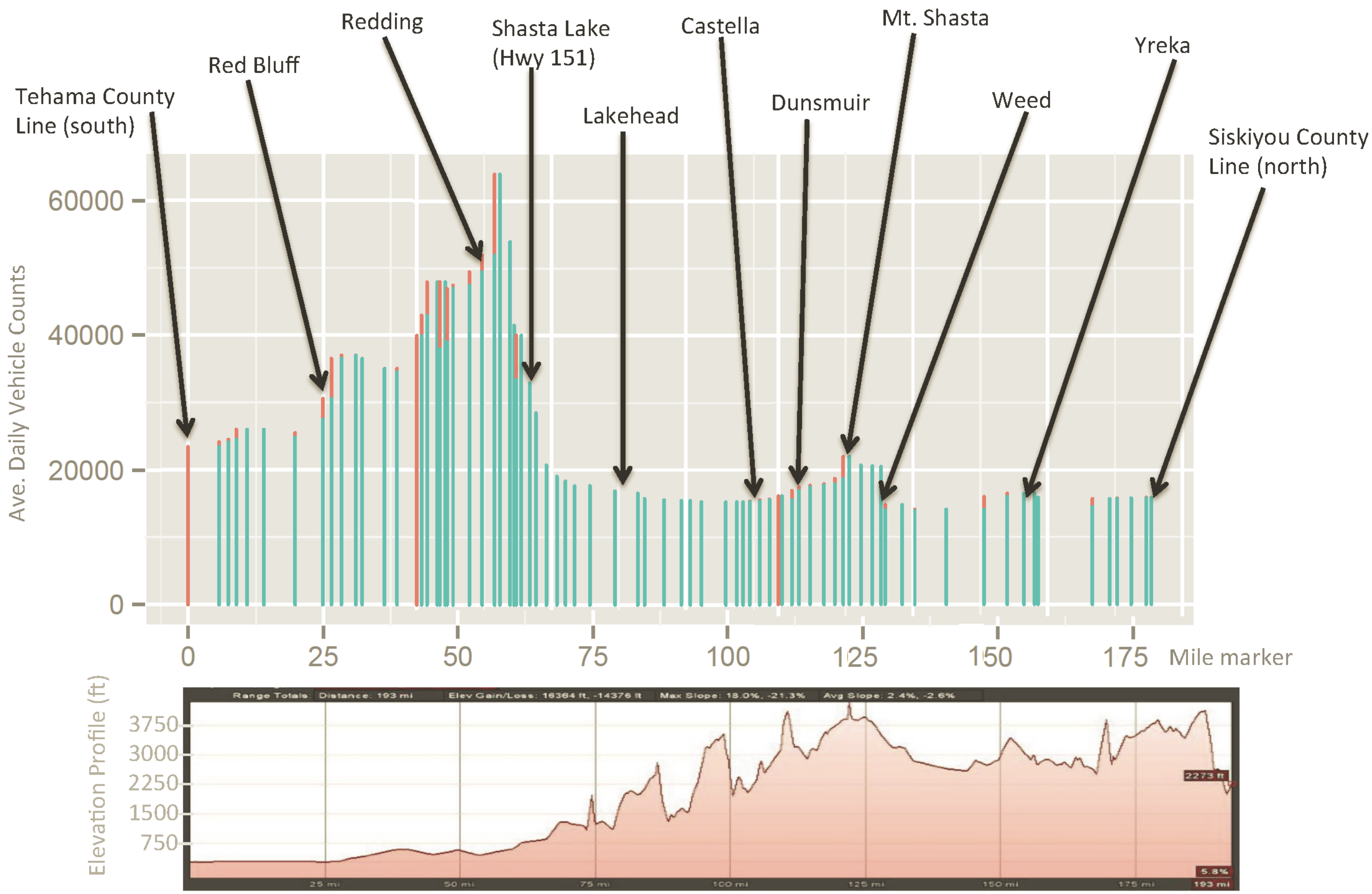
[1] Typically, Level 2 charging occurs at 30 A; however, up to 80 A is allowed under the Society of Automotive Engineers J1772 Standard

neighboring Siskiyou County (north) and Tehama County (south) have none (aside from private Tesla chargers).

Tehama County is a part of the Sacramento Valley known for its productive agricultural commodities. Shasta County has extensive forests, which cover over one half the land area with commercially productive forest systems. The southern two thirds of Shasta County is relatively low in elevation (sub 750ft) compared to the north part of the county that begins to climb in elevation, reaching over 3000ft in some areas. Upon entering Siskiyou County by Interstate-5 near the city of Dunsmuir, the elevation continues to climb reaching high points over 3,750ft and lows around 2,250ft. From towering Mount Shasta (elev. 14,179 ft. / (4,322 m)) near the center of the county, to lakes and dense forests, as well as desert, chaparral, and memorable waterfalls, the county is home to world-famous trout-fishing rivers and streams. Much of the county is densely forested with pine, fir, incense-cedar, oak, and madrone.

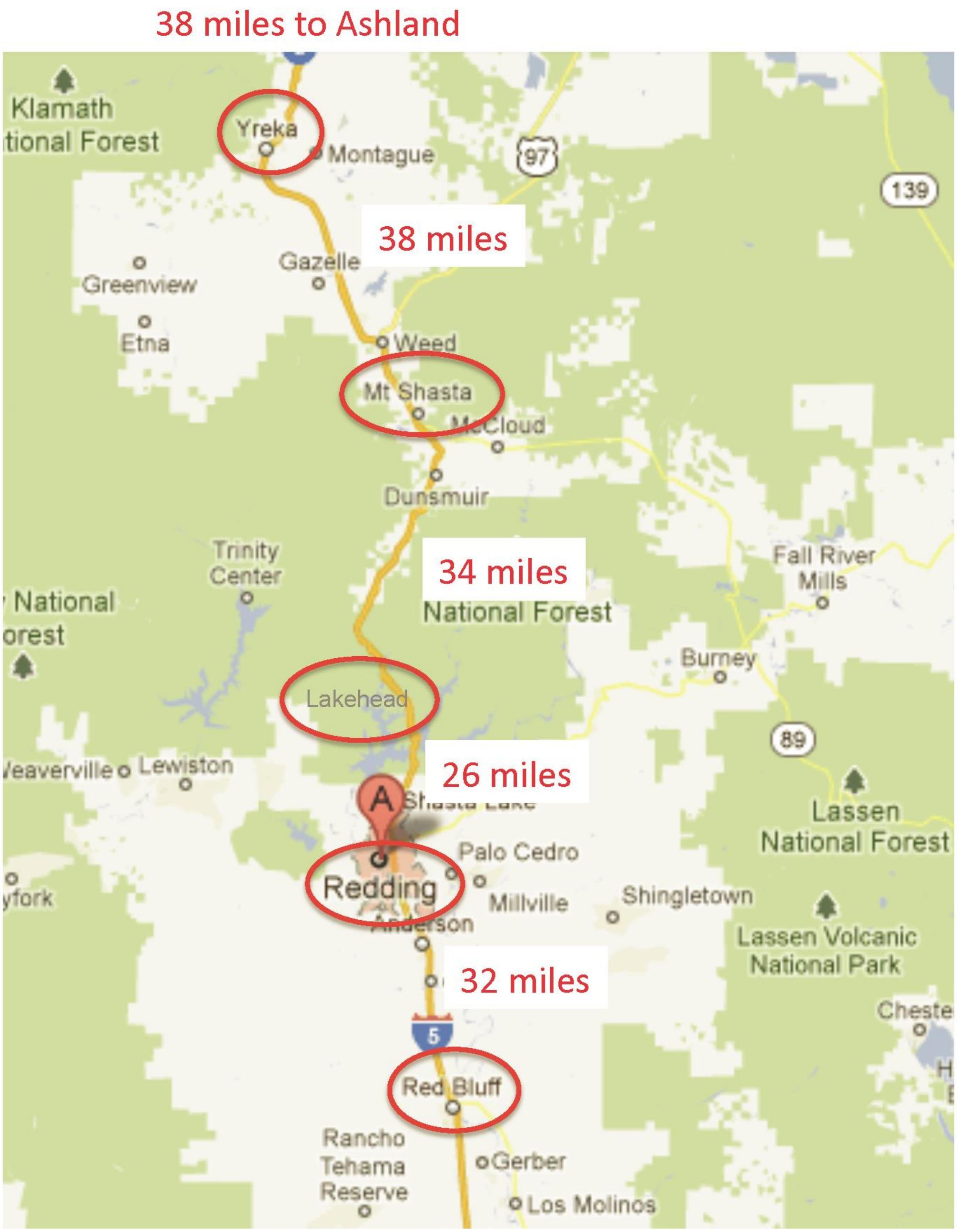
The major characteristic of the Upstate region along the Interstate-5 corridor is a large change in elevation and traffic counts between Shasta County and Siskiyou County (Figure 2). In Shasta County, mountains to the east, north, and west surround the City of Redding. Fortunately, the relatively short distance between communities along Interstate-5 may help mitigate the elevation challenges on electric vehicle range efficiency through the installation of public charging stations (Figure 3).

Figure 2: The Upstate Region Traffic Counts and Elevation Profile



Source: SERC, 2014

Figure 3: The Upstate Region Population Centers within <40-mile Plug-in Electric Vehicle Ranges



Source: Adapted from Google Maps by SCEDC, 2014

CHAPTER 2: Project Approach, Methods, and Results

Plug-in Electric Vehicle Coordinating Council

Purpose of the Upstate Plug-in Electric Vehicle Coordinating Council

The Upstate Plug-in Electric Vehicle Coordinating Council is comprised of the key project partners that were used to maintain clear and consistent communication amongst all local stakeholders and establish a permanent framework for ongoing regional PEV promotional efforts, including implementation of the readiness plan and strategies. As a part of the project, the PEVCC formed a brief funding and sustainability plan to maintain the PEVCC and to actively pursue the implementation of plans and strategies developed through the project after the grant period is completed.

Upstate Plug-in Electric Vehicle Coordinating Council Mission Statement: The members of the Upstate Region PEVCC will work together to promote and accelerate the local adoption of PEV technology as a key strategy for linking various parts of the West Coast and the State of California with PEV infrastructure and further develop the renewable energy resources in our region to meet our community's transportation needs.

Workgroups

The stated goals of the Upstate PEVCC are to participate in workgroups focused on project specific areas, suggest community points of contact, and provide feedback on contractor interim draft reports. Each workgroup was made up of appropriate representatives from relevant member entities and coordinated with topic experts from outside entities as needed. PEVCC workgroups included:

- **Fleet management:** Participants assisted in contacting local government and private vehicle fleet managers, as well as vehicle providers.
- **EVSE permitting, installation, and inspection:** Participants assisted in contacting local building officials, utilities, and building-trade and engineering professionals.
- **Publicly accessible charging infrastructure:** Participants assisted in contacting local businesses, campus facility management staff, City and County public works and parking-management staff, and EVSE equipment vendors.
- **Technology evaluation and off-peak charging:** Participants included utilities and assisted in contacting educational institutions, research and engineering professionals, and vehicle and EVSE vendors.
- **Community education and outreach:** Participants included local community college and assisted in contacting non-profits, Rotary Clubs, local municipalities, and local media.

Upstate PEVCC Activities and Accomplishments

The Upstate PEVCC is made up of representatives from entities throughout the region including:

- Siskiyou County Local Transportation Commission
- Siskiyou County Board of Supervisors
- Tehama County Department of Transportation
- Tehama County Air Pollution Control
- Shasta Regional Transportation Authority (Shasta County)
- Upstate Economic Development (Redding, Shasta County)
- Superior California Economic Development (Redding, Shasta County)
- City of Redding (Shasta County)
- College of the Siskiyou's (Siskiyou County)
- City of Yreka (Siskiyou County)
- City of Mt. Shasta (Siskiyou County)
- Caltrans (District 2)
- Pacific Power (Siskiyou County)
- Redding Electric Utility (Redding, Shasta County)
- Pacific Gas and Electric (Tehama County)

The first Upstate PEVCC kick-off meeting occurred on June 26, 2013. The Upstate PEVCC met a total of seven times during the project period. Workgroups were scheduled to meet on an as needed basis. Project staff sent monthly progress updates and project highlights to the CEC and the PEVCC and other interested parties between PEVCC meetings. The project updates provided a brief status report on the project as a whole and on the five workgroup topics. Meetings were scheduled to seek feedback from the PEVCC and create a greater discussion between individuals with diverse expertise and backgrounds relating to the Upstate PEV readiness project. The PEVCC provided key feedback on interim report drafts from the workgroup topics, considered fleet adoption in their respective organizations, and helped grow the membership of the Coordinating Council during the project period. Specifically, members of the Upstate PEVCC helped coordinate and facilitate the EV101 workshop on March 25, 2014 and suggested including agencies such as transportation planning commission staff and air pollution control staff that shared similar goals as the PEVCC.

Funding and Sustainability Plan

A brief funding and sustainability plan was formed to continue the efforts of the Upstate PEVCC. More specifically this plan strategizes on how to actively pursue the implementation of planning assets developed through the Upstate PEV readiness project beyond the current California Energy Commission grant period. Funding and sustainability planning strategies include:

- Incorporating staff from alternatively funded agencies, and organizations that share similar goals and commitments. Examples these agencies and organizations include, but are not limited to, transportation commissions, utilities, air pollution control boards, and economic development non-profits. In this manner, the stakeholders are contributing to a professional capacity and can contribute staff time to sustain PEVCC goals through the ups and downs of granting cycles.
- Utilizing a cooperative or a business improvement financial district model, made up of charging station owners, to self-assess a fee to fund and sustain the PEVCC. This funding model could not only sustain the PEVCC but also help improve the greater Upstate charging network. Improvement examples may include sharing similar signage, EVSE types, maintenance costs, tourism opportunities, and future planning efforts.
- Encouraging other economic development organizations in the Upstate region to pursue PEVCC related grants, zero emission vehicle education, and energy resiliency goals.

Infrastructure Deployment Plan

Macro-Level EVSE Deployment Plan

The purpose of the Macro-Scale EVSE Deployment Plan is to develop guidelines for the number and type of electric vehicle chargers needed throughout the Upstate region to support a given penetration of plug-in electric vehicle s in the regional vehicle fleet. The macro-scale guidelines consider charger siting at the level of a city or a neighborhood. A subsequent section in this report (Building Department) details the results of a micro-scale analysis, which builds on the macro-scale results and recommends placement of EVSE at the level of individual parking stalls.

Model Development

The challenge of the macro-scale siting task was to recommend the deployment of EVSE throughout the region for varying levels of PEV adoption. The project team accomplished this by answering the following key questions. How many chargers are needed for a given penetration of PEVs? Where should the chargers be located within the region? Should Level 2 chargers or Level 3 chargers (also known as DC fast chargers) be installed? How can the deployment be achieved in a cost-effective manner given limited resources for new infrastructure?

Answering these questions required that the following considerations all be considered:

- How many PEVs do we expect in our region?
- Where within the region will the PEV drivers live?
- When do PEV drivers make their daily trips? Where and how far do they go?
- How long do drivers spend at each stop in their tour?

- If drivers have a choice of EVSE to use, which will they choose?
- How do drivers impact each other's access to EVSE?
- How will drivers who must charge (to complete their tour) be impacted by other drivers who elect to charge despite having no immediate need for the energy?
- How do drivers adapt to their circumstances (for example, by seeking EVSE elsewhere)?
- How will a given deployment of EVSE improve the experience of drivers? Can we quantify the improvement (for example in terms of the number of hours of delay experienced by drivers)? If so, by how much does the EVSE improve their experience?

Building off work conducted for the North Coast Plug-in Electric Vehicle Readiness Project, the Upstate PEV research team managed the complexity of this problem by applying a detailed simulation model called the Plug-In Electric Vehicle Infrastructure, the PEV Infrastructure model. PEV infrastructure is capable of simultaneously balancing all the above considerations. The approach is called "agent-based modeling", and it provides a flexible and powerful framework for evaluating the impact of infrastructure on PEV drivers' experiences.

Building any agent-based model consists of the following key steps:

- Step 1: Create a virtual environment.
- Step 2: Create virtual agents with a set of rules describing how to interact with the environment and with each other.
- Step 3: Place the agents in the environment and let the system evolve according to the rules.
- Step 4: Observe what happens.

In the case of PEV infrastructure, the environment is the Upstate regional road network, including any configuration of EVSE infrastructure we'd like to evaluate. The agents are the PEV drivers (drivers of conventional vehicles are not simulated). Drivers interact with the environment according to the following rules:

- Every driver is given a vehicle with configurable properties such as type (battery all-electric vehicles (BEV) vs. PHEV), battery capacity, and fuel economy.
- Each driver follows a unique daily itinerary composed of times and destinations defining when and where he or she will attempt to travel.
- If drivers need energy to complete their next trip (or, in some cases, to complete the remaining trips in their itinerary) then they attempt to charge. PHEV drivers are assumed to never need a charge because they have a gasoline backup with established refueling infrastructure.

- Both BEV and PHEV drivers also attempt to charge even if they don't need the energy; this occurs according to a random process.
- Drivers choose which EVSE to use based on minimizing their cost. If a driver must make an unplanned stop or is delayed, the driver's time is valued at a rate of $12.50/hour.[2]
- Both BEV and PHEV drivers have a charger at home and elect to charge at the end of the day according to a random process.

The model simulates one day of driving and any delays or changes to driver itineraries are tracked.[3] At the end of a model run, the experience of individual drivers can be examined, or the entire run can be summarized by a variety of metrics (for example, the total number of drivers who experience delay in their itinerary).

PEV infrastructure is a stochastic model, meaning that a variety of processes and decisions within the model are based on random chance. The possible outcomes of these processes and decisions are described by probability distributions. The primary purpose of including stochastic processes in PEV infrastructure is to avoid reaching conclusions that are overly customized to suit one scenario. Instead, the model is run many times with the same set of initial conditions and the average benefit of a given EVSE infrastructure is calculated.

The Upstate PEV team took great care to use the best available regional data sets to ensure that PEV infrastructure simulations were as realistic as possible. These data are described in the following section.

Data Driven Planning

The quality of the results of the PEV infrastructure model is inextricably tied to the quality of the inputs used to initialize the model. For example, the driver itineraries must be carefully developed to represent a realistic set of trips that follow known driving patterns specific to the Upstate Region. This section identifies several of the most important data sets and describes how they were used in this research.

Travel Demand

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2 The value of $12.50/person-hour is based on the Caltrans Economic Analysis Branch and is used by the state of California to account for the economic value of delaying travelers. Information on this can be found on the Caltrans Transportation Planning Site (http://www.dot.ca.gov/hq/tpp/offices/eab/benefit_cost/LCBCA-economic_parameters.html).

3 In PEV infrastructure, delay is defined as any late arrival to a destination in a PEV driver's itinerary. If a driver becomes stranded, an automatic delay penalty is added to the driver to account for the time needed to recover from the stranding event. A penalty of four hours is added if chargers are accessible but in use and therefore unavailable; a penalty of six hours is added if the driver cannot access any chargers due to limited range.

The most critical component to building a set of realistic driver itineraries for PEV infrastructure is determining where drivers go when they travel. Fortunately, regional travel demand data is available for Shasta County in the form of the four-step Shasta County Travel Model. The Shasta County Travel Model has been developed and refined for the Shasta Regional Transportation Agency for use in a variety of transportation planning activities in Shasta County. The four-step model uses current and projected land-use, demographic data, and local traffic counts to forecast traffic trends to the years 2020 and 2040.

Staff at Shasta Regional Transportation Agency furnished travel demand counts from Shasta County Travel Model to the Upstate PEV team. The Shasta County Travel Model divides Shasta County into 732 travel analysis zones (TAZ) and provides a daily trip count between every pair of zones. Trips are further categorized by type (for example, travel between home and work, home and other, and so forth).

Unfortunately, it was not possible to obtain travel demand data for the counties of Siskiyou and Tehama;[4] therefore, the Upstate PEV team developed an adapted four-step travel demand model for these two counties that simultaneously integrated these two counties with Shasta County.

The major cities and towns in Siskiyou and Tehama were the basis for defining the new TAZs. The total daily productions and attractions for each TAZ were estimated based on a linear regression of productions in the Shasta County Travel Model, using population and employment as independent variables. The trip distribution step used friction factors based on the California Household Travel Survey and constrained the solution to observe the external-internal trip distributions passing through the gateways to the Shasta County Travel Model along the Shasta/Siskiyou and Shasta/Tehama borders. Additionally, trip counts from Caltrans along the major highways at eight screen line locations were used to further constrain the distribution step.

The result of the travel demand modeling process was a region wide estimate of trips between every TAZ disaggregated by trip purpose and by time of day (peak vs. off-peak).

Travel Analysis Zones

The TAZs in the Shasta County Travel Model data set have an extremely high resolution; some TAZs are the size of a city block. For reasons of computational efficiency and simplicity of communicating results, the Upstate PEV team chose to

4 A request was made to Doug MacIver at Caltrans for outputs from the statewide travel demand model. Caltrans denied our request due to their low degree of confidence in the model developed in 2005. The update to the 2005 model (for which they would have been willing to provide results) was still under development and therefore the Upstate PEV team was unable to procure statewide travel demand data for this analysis.

aggregate the original TAZs into 57 larger zones for use in the PEV infrastructure model. We based our aggregation decisions on two key criteria:

- The aggregated TAZs should follow municipal boundaries so that model recommendations and results can be easily communicated to city planners.
- The occurrence of popular, non-residential destinations (like places of work or retail buildings) within a given TAZ that are not within convenient walking distance of each other should be minimized. The purpose of this criterion was to mitigate the simplifying assumption that a PEV charger sited in a TAZ is equally accessible to anyone in that zone.

Once the 57 TAZs were geographically defined, the trip counts from the original Shasta County Travel Model data were aggregated into the new TAZs by summation. Then the TAZs based on 16 cities and towns in Siskiyou and Tehama were added to produce a final set of 73 TAZs.

Household Travel Surveys

While regional travel demand data is necessary to build realistic driver itineraries, there are some critical missing components to this data set. It does not provide information about exactly when trips are made, how long drivers spend at their destinations, where the drivers live, or what trips are chained together into a daily tour. The National Household Travel Survey (NHTS) and California Household Travel Survey (CHTS) can fill in many of these missing components.

The NHTS is a survey conducted by the U.S. Department of Transportation. The last survey year was 2009, when over 150,000 households participated. The CHTS was recently updated in 2012 and contains responses from over 40,000 California households. Every respondent provides a log of all travel in a day, including non-automotive modes. Each log details the time of departure, time of arrival, time spent at the destination (dwell time), distance traveled, and trip type (home to work, work to other, and so forth).

The PEV infrastructure itineraries were generated by strategically blending the NHTS/CHTS and travel demand data sets. Respondents were drawn randomly from the NHTS/CHTS pool, and their tour was fit into the Upstate Road network in a manner consistent with the demand for trips as specified by the travel demand model.

PEV Adoption Projection

The historical adoption of HEVs is likely the best available indicator for the rate of adoption of PEVs over the next decade. We based our projection of PEV adoption for the Upstate region on a linear extrapolation of the rate of adoption of HEVs in California between 2007 and 2010, assuming that the Upstate share of statewide adoption is 0.1

percent.[5] PEV penetration in 2014 was assumed to correspond to HEV penetration in 2006, the year when HEVs reached penetration levels roughly equivalent to the current penetration of PEVs in the Upstate region.[6] Other PEV readiness projects in California have projected adoption using similar assumptions (Williams et al., 2012) and a study by Pike Research predicted penetration levels consistent with our forecast (Hurst & Gartner, 2012).

Figure 4 depicts our projection of PEV adoption for Upstate. The baseline projection follows the historical trend of HEV adoption. Two accelerated growth scenarios are also presented, representing increased rates of adoption: 10 percent and 25 percent faster than the baseline scenario. Three-time intervals are emphasized in the figure near the horizontal axis. They are the intervals over which the baseline and 25 percent growth scenarios intersect key penetration levels (0.5 percent, 1 percent, and 2 percent penetrations into the vehicle fleet). In other words, we expect that PEV penetration will reach 0.5 percent by mid-2016, but it could occur in early 2016 if adoption rates are accelerated. Likewise, we expect PEV penetration to reach 1 percent between 2017 and 2019 and 2 percent between 2020 and 2022. Note that the PEV penetration scenarios are relative to the total regional vehicle fleet, including light, medium, and heavy-duty vehicles. A 1 percent penetration into the total vehicle fleet corresponds to a 2.3 percent penetration into the light-duty fleet.

The three adoption levels from Figure 4 – 0.5 percent, 1 percent, and 2 percent – form the basis for the entire model analyses conducted for this study. To effectively support PEV drivers and encourage adoption, planners should target the deployment of EVSE infrastructure to be completed before adoption reaches these levels. Hence, the earlier end of each time interval should be interpreted as a target year for EVSE deployment. This would be 2016 for 0.5 percent, 2017 for 1 percent and 2020 for 2 percent.

Adoption of BEVs vs. PHEVs

From the perspective of deploying EVSE infrastructure, the rate of adoption of battery electric vehicles (BEVs) compared to PHEVs is vitally important. BEVs require public EVSE to complete certain types of travel, whereas public chargers are entirely optional for PHEV drivers. There is clear evidence, however, that shows that PHEV drivers utilize public EVSE frequently to maximize the all-electric miles they travel. The presence of PHEV drivers will therefore have an impact on the availability of infrastructure for use by BEV drivers who have the most compelling need for charging.

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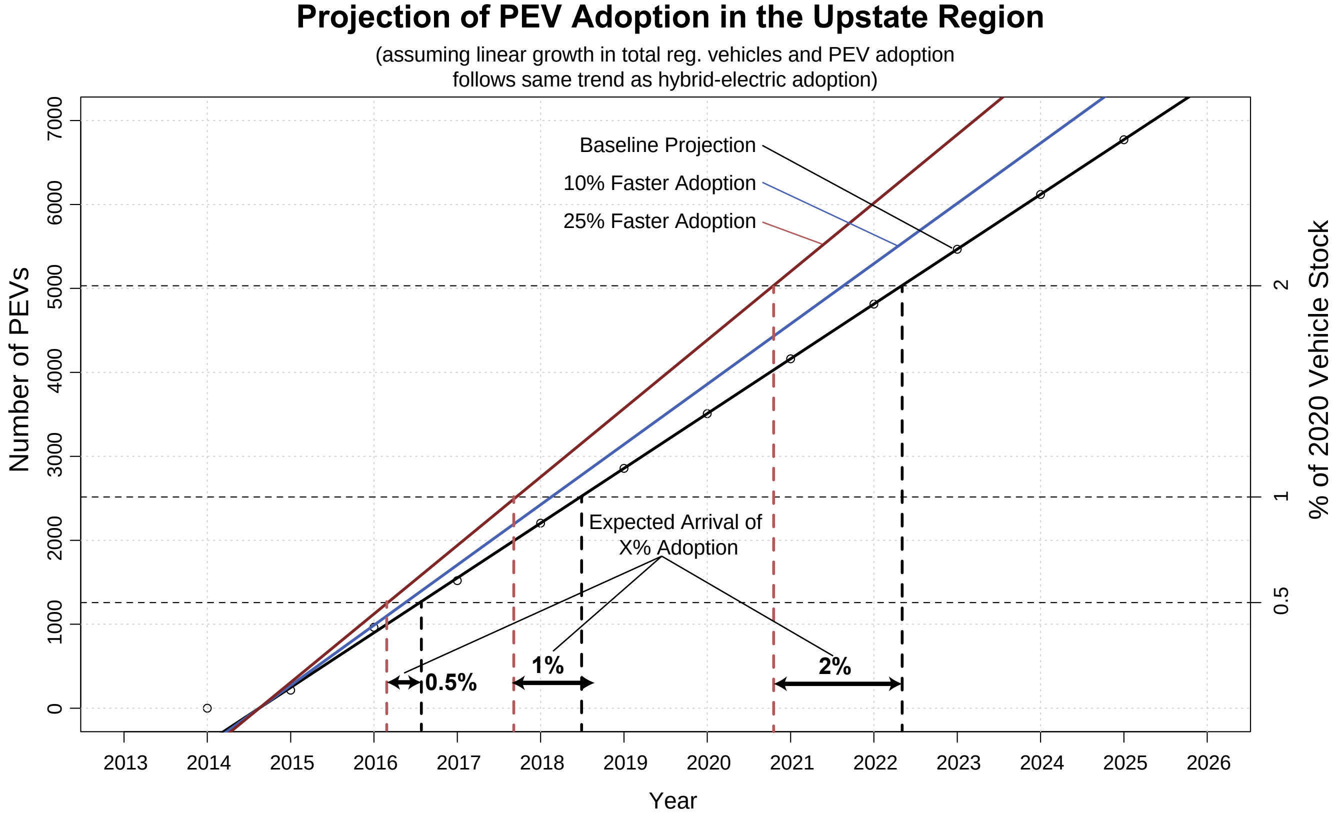
5 The share of statewide HEVs in Upstate is based on vehicle registration data summarized by Dr. Matthew Kahn of UCLA and can be found on the UCLA Institute of the Environment and Sustainability Webpage (https://www.ioes.ucla.edu/)

6 The present number of PEVs in Upstate is based on data from the Clean Vehicle Rebate Project (http://energycenter.org/clean-vehicle-rebate-project)

The market for PEVs is still in an early stage, but current trends are the best available indicator of future growth. As of September 2013, 57 percent of PEVs on the road were PHEVs. As a wider variety of BEVs and PHEVs enter the market, these market trends could continue or change dramatically. The Upstate PEV team has chosen a 50 percent/50 percent split between BEVs and PHEVs in the PEV infrastructure model for the base scenario. This represents a conservative assumption, as we can be certain that EVSE infrastructure built to support a higher fraction of BEV owners will be adequate to support a lower fraction

Figure 4: Projection of PEV Adoption in the Upstate Region



Source: SERC, 2014

Figure 4: PEV adoption projected to 2025. The time periods over which we expect to achieve benchmark penetration levels are depicted near the horizontal axis. Penetration levels represent the percent penetration of PEVs into the total regional vehicle fleet including light, medium, and heavy-duty vehicles.

Cost of Installing and Using EVSE

Determining the cost of public chargers is highly site specific. Many factors contribute to the expense, such as equipment costs, permitting fees, and installation costs. For the PEV infrastructure model it was necessary to assume an average installed cost for each level of charging. Table 1 presents our cost assumptions alongside cost estimates from several recent studies.

Table 1: Cited Price Estimates of Public Charging Stations, by Source

Study Source	Level 2	Level 3
ICF International, 2013	$6,000-23,000	$73,000-141,000
Chang et al. 2012	$1,852	$40,000
Schroeder and Traber 2012	$6,600	$118,800
Peterson and Michalek 2013	$5,000	$20,000
Gogoana 2010	N/A	$50,000
PEV infrastructure Cost Assumptions	**$15,000**	**$75,000**

Source: SERC, 2014

In practice, the cost of installing the first Level 2 charger in each location can be substantially higher (as much as four times higher) than the cost of subsequent chargers assuming that conduit and electric service upgrades are sized for future expansion. Because the PEV infrastructure model is designed to site EVSE at a macro scale, the savings from installing multiple chargers in one location are ignored and an average cost is assumed.

The PEV infrastructure model also requires the retail price of energy for charging at each type of EVSE. We conducted an economic analysis of operating a public charging station and chose pricing for the PEV infrastructure model that corresponds to the break-even price (i.e., investment and costs are paid for by station revenues on a lifecycle cost basis) for a charger that is used 10 percent of the time, or 2.4 hours per day (Table 2).

Table 2: Energy Pricing Assumed in the PEV infrastructure Model.

Level	Price ($/kWh)
2	0.45
3	0.50

Source: SERC, 2014

Macro-Siting Results

The PEV infrastructure model provides a quantitative basis for evaluating the efficacy of a given deployment of EVSE throughout the region. We use an optimization algorithm to determine the set of chargers that provide the biggest benefit to PEV drivers at the least cost. The resulting EVSE infrastructure is presented in the next section. This section provides an overview of the optimization algorithm and lists key assumptions used in the analysis.

There are multiple metrics by which we can evaluate the benefit that a given EVSE deployment would provide to PEV drivers. We chose as our primary metric the degree to which a given EVSE deployment decreases the amount of delay experienced by drivers. Using a value for drivers' time of $12.50/hour, the delay is converted into a monetary value (assuming constant conditions) projected over a 10-year time horizon. This allows us to compare the benefit of reducing driver delay with the cost of the EVSE infrastructure needed to reduce that delay.

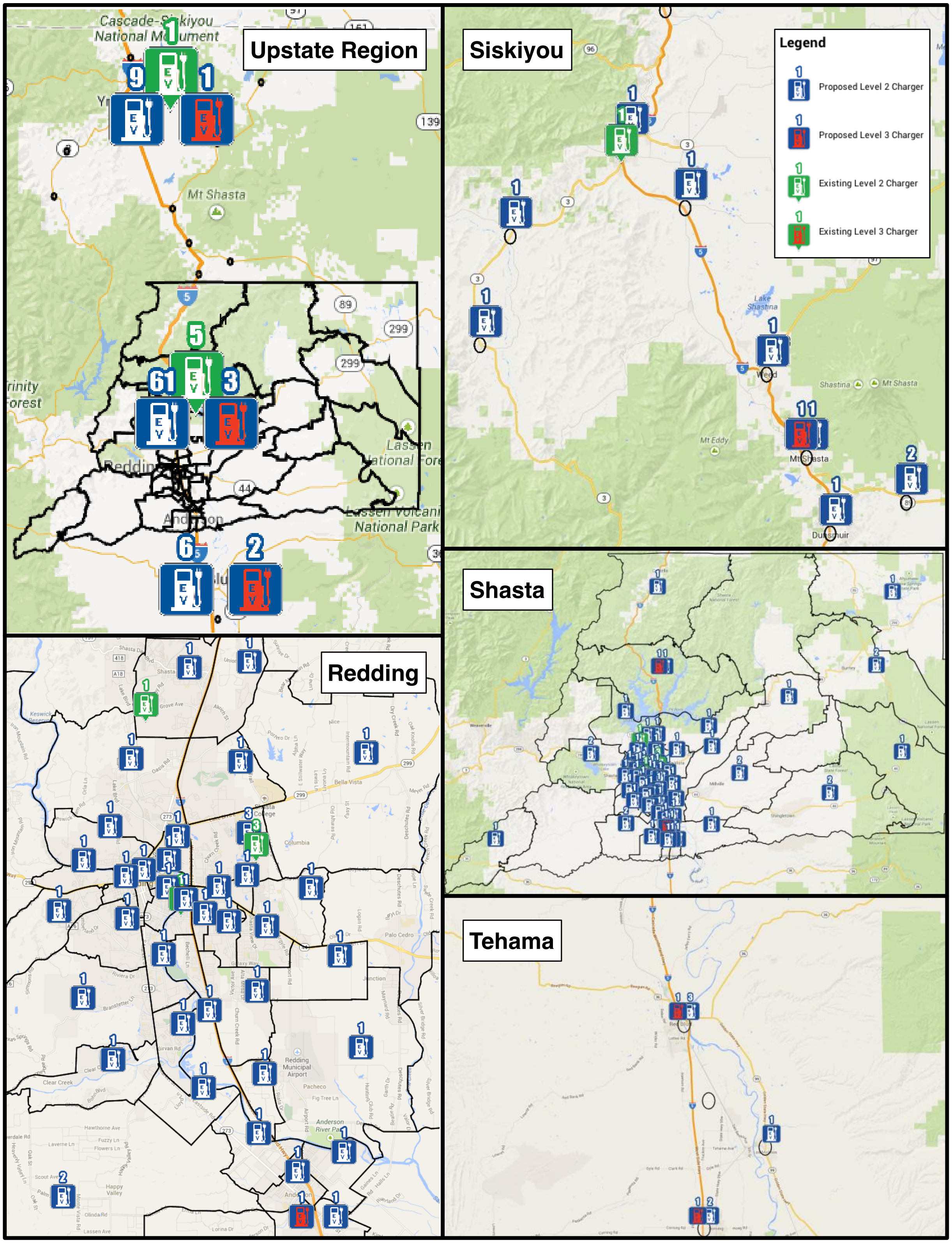
To optimize EVSE deployment for a given penetration of PEV drivers, we take the following steps:

- Step 1: Initialize the PEV infrastructure model with a PEV penetration of 0.5 percent and the present-day charging infrastructure in the Upstate Region (five chargers in and around Redding and one charger in Yreka). Call this the base scenario and run the model, storing the results.
- Step 2: For each of the 73 TAZs in the region systematically place a new Level 2 and then a Level 3 charger. Run the model each time and calculate the reduction from the base scenario in driver delay.
- Step 3: Select the TAZ and charger type that provides the maximum reduction in driver delay per dollar spent. Add this charger to the EVSE infrastructure and call this the new base scenario.
- Step 4: Repeat steps 2 and 3 until adding a new charger stops providing any significant benefit.
- Step 5: Increase the fleet penetration of PEV drivers from 0.5 percent to 1 percent (or from 1 percent to 2 percent) and repeat steps 2-4.

This algorithm is automated to produce a set of charger locations and charger levels that aims to provide the highest benefit to drivers at the least cost. In addition, the order in which chargers are added is tracked, which provides useful insight into which locations should be prioritized for EVSE deployment in the near term. Because PEV infrastructure is stochastic, the entire process is repeated several times (at least five times) and the various distributions of chargers are averaged together to form a final set of deployment guidelines.

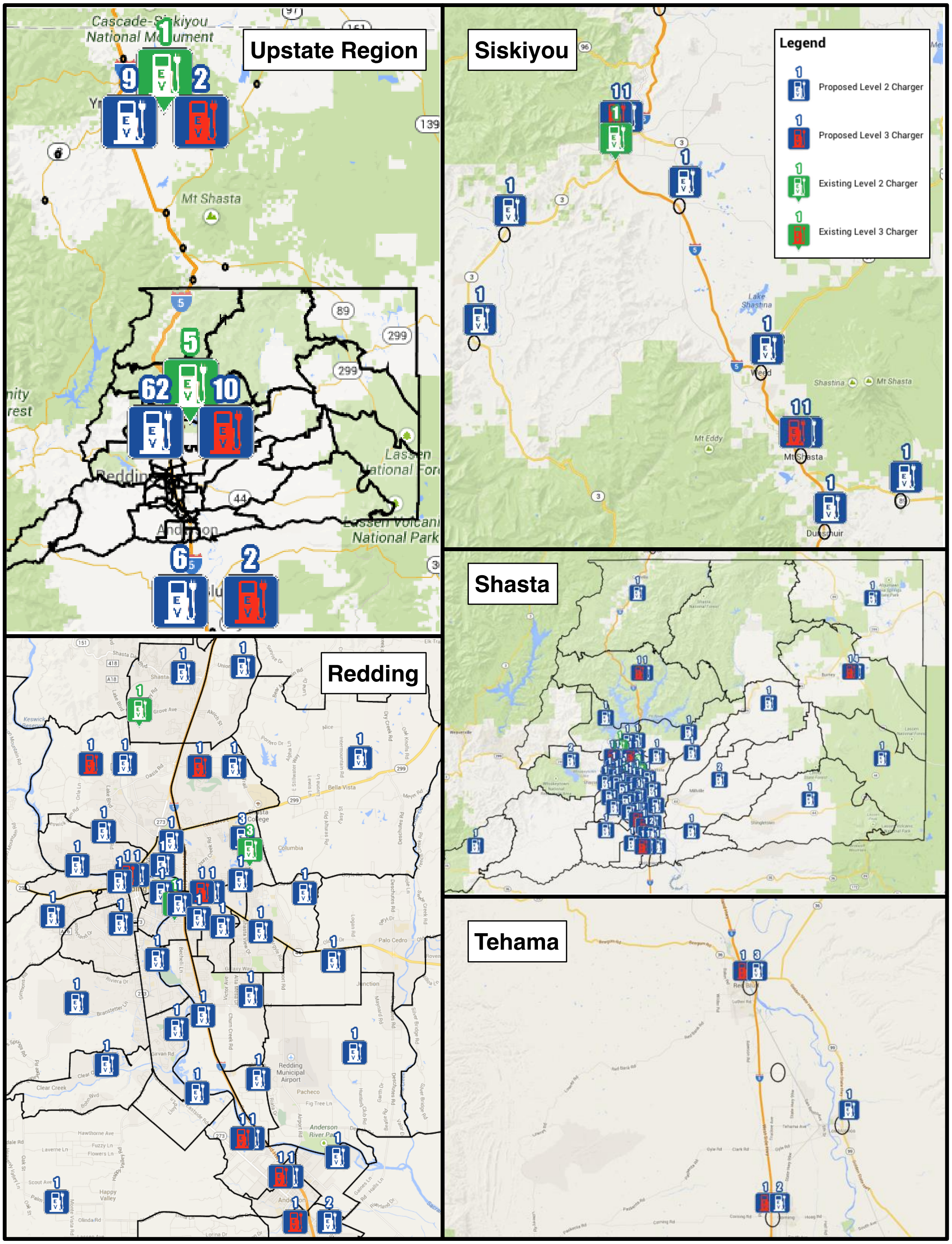
In Figures 5 through 7, we present the results of using the PEV infrastructure model to site EVSE infrastructure for the three PEV penetrations of 0.5 percent, 1 percent, and 2 percent. Each figure contains three maps: a full map of the Upstate Region, a detail of the counties of Siskiyou, Tehama, and Shasta, and a detail of the greater Redding Area. On the maps are icons labeled with the number of Level 2 (blue and white icons) and Level 3 (blue and red icons) chargers recommended for the penetration level. In addition, the green icons indicate the number of existing chargers in the region.

Figure 5: EVSE Deployment Guidelines for 0.5 Percent Penetration (Target Year: 2016)



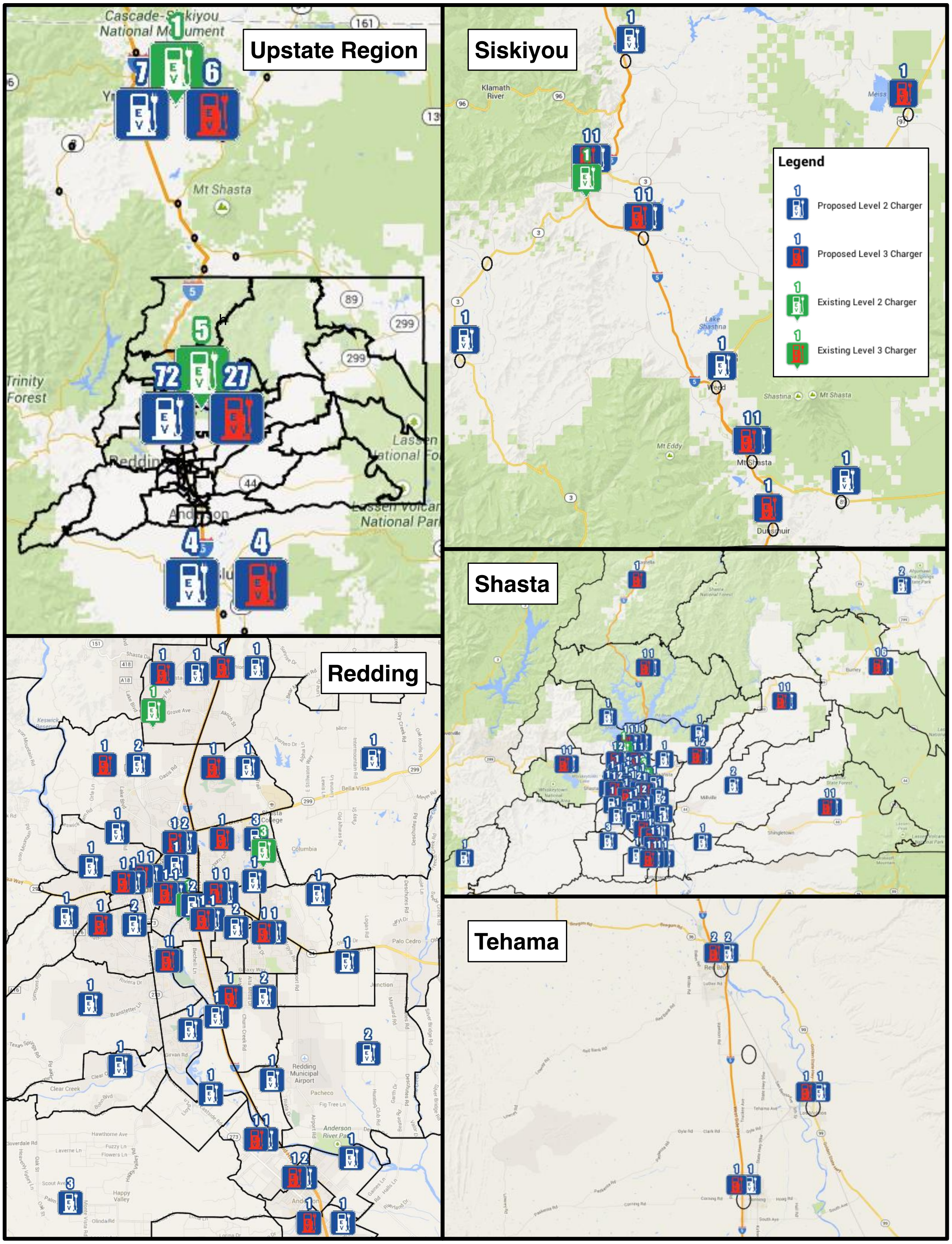
Source: SERC, adapted from Google Maps, 2014

Figure 6: EVSE Deployment Guidelines for 1 Percent Penetration (Target Year: 2017)



Source: SERC, adapted from Google Maps, 2014

Figure 7: EVSE deployment guidelines for 2 percent penetration (Target Year: 2020)



Source: SERC, adapted from Google Maps, 2014

Table 3 presents the costs associated with the recommended EVSE infrastructure summarized by county and charger level. In addition, the column titled "Mitigated Delay Value" contains an estimate of the 10-year present value of the driver delay that is reduced due to the presence of the ESVE. For the Upstate region overall, the recommendations would cost approximately $1.5M for a penetration of 0.5 percent, $2M for 1 percent, and $4.2M for 2 percent. These investments are substantially less than the value of the drivers' time that is saved by installing public EVSE. The value of the delays mitigated by the recommended infrastructure is approximately $25M for the 0.5 percent penetration, $51M for 1 percent, and $110M for 2 percent.

Table 3: Approximate Cost of Recommended EVSE Infrastructure by Charger Type and County for Three PEV Penetration Scenarios.

	Level 2	dire Fast	Total Cost*	Mitigated Delay Value
0.5 percent Fleet Penetration				
Shasta	$849,000	$285,000	$1,134,000	
Siskiyou	$123,000	$45,000	$168,000	
Tehama	$87,000	$105,000	$192,000	
	$1,059,000	**$435,000**	**$1,494,000**	**$25,000,000**
1 percent Fleet Penetration				
Shasta	$876,000	$600,000	$1,476,000	
Siskiyou	$135,000	$120,000	$255,000	
Tehama	$93,000	$195,000	$288,000	
	$1,104,000	**$915,000**	**$2,019,000**	**$50,600,000**
2 percent Fleet Penetration				
Shasta	$1,161,000	$2,085,000	$3,246,000	
Siskiyou	$111,000	$435,000	$546,000	
Tehama	$69,000	$375,000	$444,000	
	$1,341,000	**$2,895,000**	**$4,236,000**	**$110,400,000**

*For each penetration, total regional costs are listed in bold. These costs are cumulative. For example, the infrastructure in the 0.5 percent scenario is also contained in the costs for the 1 percent and 2 percent scenarios.

Source: SERC, 2014

Conclusions about Macro Level EVSE Deployment

Based on the results of the PEV infrastructure modeling analysis, we can draw some useful conclusions about the siting of EVSE in the Upstate Region.

- Overall, relatively few chargers are needed to support many PEV drivers. Approximately 120 chargers were sufficient to support about 5,000 drivers in the 2 percent penetration scenario. The total estimated cost to install these chargers is $4.2M, which is an investment of $850 per driver, a value commensurate with incentives already in place at the state and federal levels for subsidizing vehicle purchases.

- Both Level 2 and Level 3 chargers play an important role in supporting PEV drivers. Generally, Level 2 chargers are distributed throughout the region in rough proportion to traffic intensity and Level 3 chargers are concentrated along the I5 corridor and, to a lesser extent, along other principal arterials.
- The order in which EVSE is sited is meaningful. At 0.5 percent penetration, the algorithm sited Level 2 chargers early with Level 3 chargers being added later. At higher penetrations, Level 3 chargers played a much more prominent role, reaching 30 percent of the total number of recommended chargers at the 2 percent PEV penetration level.
- Fewer PHEV drivers have Level 2 chargers but due to the smaller battery capacity in these vehicles, the difference between Level 1 and Level 2 is negligible for overnight charging. We therefore assume in the PEV infrastructure model that every PEV driver has access to a Level 2 charger at his or her residence. If fewer future BEV owners choose to install Level 2 chargers at home, the need for publicly available EVSE infrastructure will increase.
- It is recommended that EVSE infrastructure be installed in phases. While an initial level of infrastructure will be important from the outset to provide geographic coverage, reduce range anxiety, and promote PEV adoption, full EVSE deployment can be accomplished over time as the penetration of PEVs increases. In fact, it is recommended that following each phase of EVSE deployment data be collected and evaluated to assess EVSE usage rates. In addition, PEV drivers in the region can be surveyed to assess where additional charging is needed. These types of information can then be used to refine plans for future EVSE deployment.

EVSE Micro-Siting

Previously we presented a map showing the number of charging stations recommended for each Transportation Analysis Zone (TAZ) in the Redding area based on a 0.5 percent PEV penetration rate. Those "macro-siting" results were generated by the PEV infrastructure computer model developed by SERC. Each TAZ covers a large geographic area, and additional "micro-siting" work was required to identify the apparent best parking spaces within each TAZ for installing EV charging stations.

On March 24, 25, and 26, 2014 we conducted field work assessing 95 candidate sites for EV charging stations in Siskiyou, Shasta, and Tehama Counties. Forty-nine of these sites were in the City of Redding. Each site was scored using a rubric that was developed with input from the Upstate Plug-In Electric Vehicle Coordinating Council, whose membership includes Redding Electric Utility. Candidate sites were scored according to our judgment regarding a scored rubric of objectives such as: proximity to apparently suitable electrical connection, minimal trenching required through paved areas, public visibility, and proximity to basic services, among others.

Micro-Siting Rubric

Using the results of the macro-scale EVSE deployment plan, a micro-siting rubric tool was used to rank candidate Electric Vehicle Charging Station (EVCS) sites. The rubric was developed collaboratively by the project team with input from the PEVCC for the purpose of ranking candidate sites based on criteria important to the community. The candidate sites were identified through a public outreach process, local knowledge, and on-the ground site surveys.

A total of 99 candidate sites for EVCS were identified in the planning area and assessed on the ground using the rubric. The sites were assessed for Level 1, and/or Level 2, and/or Level 3 EVCS as appropriate based on-site specific characteristics and engineering judgment. After ranking the sites, owner consultations were initiated on 29 of the sites to determine which sites had interested owners who would likely provide a letter of support for a subsequent grant application for installing EVCS. As a result of these conversations a list of nine highly ranked sites with owners who committed to hosting an EVSE were selected for further evaluation, including development of preliminary site plans and cost estimates. These sites, which are shown in Table 4 below, will be shovel-ready upon completion of site-specific project permitting and final engineering work. A combination of Level 2 and Level 3 EVCS are proposed for the sites listed in Table 4 as part of the first phase of implementing the Upstate Plug-In Electric Vehicle Charging Network (Network).

To put these results into context, the macro-siting analysis indicated that for the 2 percent PEV penetration rate, approximately 120 EVCS would be sufficient to support approximately 5,000 PEV drivers in the Upstate Region.

Table 4: List of Recommended Stations for Phase 1 of Upstate Plug-In Electric Vehicle Charging Network

	County	City	Description
1	Siskiyou	Yreka	Junction Shopping Center
2		Mt. Shasta	Public Parking Lot on W. Lake St.
3		Mt. Shasta	Tri Counties Bank
4	Shasta	Redding	McConnell Arboretum
5		Redding	Sundial Bridge Parking Lot
6		Redding	City Hall
7	Tehama	Red Bluff	Tehama County Visitor Center
8		Red Bluff	River Park
9		Red Bluff	Public Parking on Pine Street Downtown

Source: GHD, 2014

In addition to the ten sites listed above, Phase 1 of the Upstate Plug-In Electric Vehicle Charging Network should include a Level 3 station along Interstate 5 between Redding and the City of Mt. Shasta. This is important so that PEVs travelling north can charge in Redding and then have an interim charging option on the route to Mt. Shasta, which involves a change in elevation of approximately 3,000 feet. The apparent best location identified during the micro-siting analysis was the Shell station at Lakehead CA. The project team was unable to make a connection with the owner of this Shell franchise by the time of this writing to gauge their interest in hosting a Level 3 station. This outreach should be conducted as an important preliminary action during the implementation of Phase 1.

Also note that an alternate location for a combined Level 2 and Level 3 in Mt. Shasta was identified in the public parking lot on Chestnut Street. This location has an existing commercial meter pedestal that is only used on July 4th for festivities, which could be used in a low-cost Level 2 EVCS installation. Pacific Power was contacted about a Level 3 EVCS in this location and indicated that there is the possibility of providing a pole mounted 480V 3 phase transformers for a Level 3 EVCS at this location.

Methodology

The macro-siting analysis provided the following results that were used to guide the process of selecting on-the-ground locations for EVCS within the planning area:

- Optimal number of Level 2 and Level 3 EVSE in each TAZ in Siskiyou, Shasta, and Tehama Counties for 0.5 percent, 1 percent, and 2 percent PEV market penetration scenarios
- The priority ranking for installing the specified number of EVCS in each TAZ

- The priority ranking was arrived at by testing which locations had the greatest potential to reduce PEV driver inconvenience on aggregate through repeated agent-based computer simulations

The results from the macro-siting analysis were used to set the target number of sites that needed to be identified for each TAZ in the Upstate Region on aggregate. A list of candidate sites was then developed for each jurisdiction in the study area.

A micro-siting rubric was developed with input from the PEVCC to rank each candidate site. Then, field work was conducted to fill in the rubric for most of the candidate sites identified. Due to the geographic size of the planning area and limitations with the scope and budget available for this study, candidate sites could not be identified in all the TAZs where EVCS were called for in the macro-siting analysis.

Micro-Siting Results

The preliminary site plans were prepared by a licensed civil engineer for the stations selected for the first phase of building out the Network. The purpose of this step was to provide a conceptual layout of the potential configuration and to assist in the development of the opinion of cost. The preliminary plans consist of two plan sheets for each site. The first plan sheet shows a vicinity map locating the station within California and a neighborhood scale site plan. The second sheet is an enlargement showing the layout of the EVCS within the parking lot, the preliminary conduit alignment between the apparent best electrical connection and the EVCS, location of signage, proposed parking lot re-striping and lettering, and other details. Note that electrical load studies were not conducted under the micro-siting analysis and the interior of existing electrical service panels were not opened. Final engineering design and permitting is required to make the sites shovel-ready.

Guidance from the California Governor's Office of Planning and Research regarding EVSE accessibility was followed during preparation of the preliminary site plans. Once the preliminary site plans were prepared to the level of detail described above, an Engineer's Opinion of Probable Cost was prepared.

Engineer's Opinion of Probable Construction Costs

The Engineer's Opinion of Probable Construction Costs were prepared by a licensed civil engineer using RS Means Site Work and Landscape Cost Data, cost data from vendors and utilities, and bid results from recent projects. The purpose of this opinion of probable cost is to provide an order of magnitude estimate of potential costs for the preliminary concepts. A cost line item was included for each major item of work identified as part of the preliminary site plans. The quantities of needed construction materials were measured from the preliminary site plans. Additional items included in the cost estimate were sales tax, General Contractor Requirements, General Contractor Overhead and Profit, a 25 percent Estimating Contingency, Cost of Bonds, and a Location Adjustment Factor to adjust nationwide cost data to the economy in the Upstate Region.

Note that the Engineer's Opinion of Probable Construction Costs should be updated with each future design iteration as the preliminary site plans are refined from their current state to final construction documents stamped by a registered professional engineer with responsible charge over the design. It should be noted that actual construction costs depend not only on the final design, but also how contractors bid the projects. Only after bidding and construction are the actual total construction costs known. Refining the opinion of probable costs throughout the process increases the confidence that the bid results will fall within the project budget but does not guarantee it.

Results and Discussion

The work products generated include:

- A completed micro-siting rubric that includes a listing of 99 candidate sites for EVSE in the planning area.
  - All the candidate sites were assessed on the ground using the rubric and site owner consultations we initiated on 29 sites.
  - A short list of nine highly ranked sites with owners who were open to discussing the concept of hosting a station were selected for further evaluation.
- A set of preliminary engineering plans were prepared for sites on the shortlist
- Engineer's Opinion of Probable Construction Costs prepared with RS Means Site Work and Landscape Cost Data, cost data from vendors and utilities, and bid results from recent projects for the sites on the shortlist including sales tax, General Contractor Requirements, General Contractor Overhead and Profit, a 25 percent Estimating Contingency, Cost of Bonds, and a Location Adjustment Factor to adjust nationwide cost data to the economy in the Upstate Region

The final micro-siting rubric spreadsheet includes a summary page for Level 1, Level 2, and Level 3 micro siting results listing all the candidate sites, their TAZ, their final ranking score, and a description of the parking space that was evaluated. Following this are rubric spreadsheets for the following areas: Anderson, Corning, Dunsmuir, Mt. Shasta, Redding, Red Bluff, Weed, Yreka, and Miscellaneous TAZs Compiled. An electronic copy of the micro-siting rubric spreadsheet has been provided to the SCEDC.

The preliminary designs for the shortlist of selected sites were compiled into a plan set under a cover page to facilitate review by the California Energy Commission, local building departments and permitting officials, and community leaders.

The intent is for the preliminary plan set to be developed into a biddable set of construction plans under a separate project. Construction specifications for the civil and electrical work will then be appended to the plan set and the project will be released for public bid under a set of general conditions that adhere to the public contract code. In this way the first EVCS in the Network can be implemented because of the work completed in this Plan.

Subsequent stations can be implemented following a similar methodology as described above by selecting sites based on the ranking from the rubric, considering geographic and political considerations, and the willingness of site hosts.

A summary of the preliminary engineer's opinions of probable construction costs for the shortlist of stations is presented in Table 5 below.

Upon review of on the micro-siting process, the following observations are noted:

- The collaborative process for developing the rubric went relatively well with quality input received from project team members and from members of the PEVCC.
- There was some redundancy in the objectives that created extra work for evaluators however this was accepted because of the consensus-based process used by the PEVCC for developing the rubric.
- The amount of time and personnel required to develop the list of candidate sites and rank them with the rubric was significant and candidate sites were not identified outside of major population centers and travel corridors in the region.
- A significant amount of public outreach and education occurred during the micro-siting process as local government officials and business owners and operators were contacted and engaged in conversations about EVCS and PEVs. These efforts generated interest in the community around the idea of a local Network and PEV transportation in general.
- The micro-siting rubric is a useful tool that could be used by other communities to derive a list of potential EVCS sites in a collaborative manner. If necessary, the post processing step using the PEV infrastructure model results could be omitted if PEV infrastructure model results are not available for the subject area.

Table 5: Summary of Preliminary Engineer's Opinion of Probable Construction Costs

#	County	City	Description	Installation Type	Preliminary Engineer's Opinion of Probable Costs
1	Siskiyou	Yreka	Junction Shopping Center	One Level 2 EVCS One Level 3 EVCS Three stub outs	$ 121,000
2	Siskiyou	Mt. Shasta	Public Parking Lot on W. Lake St.	One Level 2 EVCS Three stub outs	$ 20,000
3	Siskiyou	Mt. Shasta	Tri Counties Bank	One Level 2 EVCS One Level 3 EVCS	$ 119,000
4	Shasta	Redding	McConnell Arboretum	One Level 2 EVCS One Level 3 EVCS Three stub outs	$ 106,000
5	Shasta	Redding	Sundial Bridge Parking Lot	One Level 2 EVCS Four stub outs	$ 24,000
6	Shasta	Redding	City Hall	One Level 2 EVCS Three stub outs	$ 18,000
7	Tehama	Red Bluff	Tehama County Visitor Center	One Level 2 EVCS One Level 3 EVCS One stub out	$ 125,000
8	Tehama	Red Bluff	River Park	One Level 2 EVCS One stub out	$ 20,000
9	Tehama	Red Bluff	Public Parking on Pine Street Downtown	One Level 2 EVCS Three stub outs	$ 21,000
Total Estimated Construction Costs for Aggregated Project					**$ 574,000**
Note: Stub out refers to a conduit run to another parking space or parking spaces adjacent to proposed EVCS where the conduit system is designed to accommodate multiple EVCS circuits for future expansion. See preliminary design plans and detailed engineer's opinion of probable costs for more detail.					

Source: GHD, 2014

Note that the costs presented in Table 5 do not include the following additional project implementation costs:

- Engineering design
- Permitting
- Bid period services
- Construction management
- Project administration
- Finalization of host/owner agreements

Recommendations

As a result of the work completed, the following recommendations are offered for consideration by the SCDEC and PEVCC:

- The ranking score associated with each site is the result of field assessments guided by the objectives, weights, and criteria developed with the PEVCC
- The PEV infrastructure model prioritization is incorporated into the final ranking score for each site which brings the benefits of the data-driven macro-siting analysis into the decision of where EVCS are sited.
- The rubric should be viewed as a working tool that is being updated as new information comes in and progress is made towards developing new EVCS sites in the Network.
- Additional candidate sites can be added to the rubric for areas that were not covered under this analysis due to budget constraints and the size of the geographic region encompassed by the study.

Plan to Collect Data on Consumer Charging Behavior

The purpose of this report is to present a plan to collect consumer charging data in California's Upstate Region that is based on what is currently understood about consumer charging behaviour and what technologies and methods have the potential to collect consumer charging behaviour.

Need

In recent years, modern, mass produced plug-in electric vehicles have entered the consumer marketplace. Federal and State governments have enacted policies that incentivize the production, sale, and use of these vehicles as part of a strategy to reduce greenhouse gas emissions from the transportation sector.

Since PEV transportation and EVSE are in their nascent stages, there is some uncertainty about how best to roll-out the EVSE infrastructure to support PEV drivers, promote PEV adoption, and minimize stranded assets. Collecting consumer charge behavior data can be used to inform charging network administrators, transportation planners, and State officials about the efficacy of investments made to support publicly available EVSE.

Collecting consumer charging behavior data can also be used in the process of identifying barriers to PEV adoption and develop strategies to remove them. One barrier to widespread PEV adoption is that the driving public is accustomed to the gas station model for vehicle fueling. Under this model, drivers can obtain hundreds of miles of driving range during a brief stop at a gas station. Gas stations are ubiquitous and a driver running out of gas is a relatively rare occurrence. Drivers of PEVs experience a different paradigm.

Charging PEVs takes longer and if additional range is needed when travelling, the number of publicly available charging stations is low compared to the number of gas stations. Additionally, the distance that PEVs can travel on electric drive is typically about one-third of the range of a conventional vehicle. These generalizations speak to the paradigm shift faced by drivers who choose a PEV, yet sales are currently exceeding the rates seen for hybrid cars when they were first introduced.

PEV sales data speak to several satisfying aspects to PEV transportation such as reduced emissions, less road noise, less maintenance, lower cost per mile for fuel, the potential for renewably powered transportation, freedom from the gas station, tax credits, rebates, and the ability to fuel your car at home, to name a few. Reinforcing the current level of satisfaction experienced by PEV drivers is one way to encourage adoption.

By collecting consumer charging behavior data and using it to inform strategies for installing, operating, and maintaining publicly accessible charging infrastructure, the satisfaction that current PEV drivers feel can be maximized within the constraints of existing PEV and EVSE technologies. This satisfaction will be evident during a PEV driver's life and through social interaction the idea that PEV transportation is satisfying will grow, which will in turn encourage adoption. The opposite effect could occur if the publicly available charging infrastructure is poorly planned, operated, and maintained. In this case, PEV adoption rates could slow because public perception is that PEV transportation is associated with negative experiences.

Scope of Work

The scope of work for this report is to analyze the available technology and the effectiveness of that technology to collect consumer charging behavior data. The emphasis is on developing a consumer-friendly approach to data acquisition and to provide recommendations to stakeholders regarding the need for, value, and availability of various levels of data acquisition technology. The scope of work also includes the following activities:

- Develop a rollout plan for integrating data acquisition with the planned EVSE
- Providing recommendations for aggregating data acquisition with planned EVSE.
- Develop a consumer survey form

Uses for Consumer Charging Behavior

Consumer charging behavior data can be used to better understand the charging habits of PEV drivers to guide charging infrastructure rollout and encourage adoption. By understanding peoples charging habits, infrastructure can be placed more strategically, for example:

- Stranded assets can be reduced by learning what types of locations are unpopular for charging and then avoiding installing charging stations in those types of locations unless they are needed for safety purposes.
- PEV adoption can be encouraged by learning what types of locations are popular and installing more EVSE in those locations.

Consumer charging behavior data can show how sensitive PEV drivers are to pricing at publicly owned stations when deciding where and when to charge. Network planners and administrators, and analysts can use consumer charging behavior data to learn whether pricing at publicly accessible stations can support a for-profit charging station owner business model, or if a non-profit station owner business model or charge price subsidies are most effective in encouraging adoption. Consumer charging behavior data can be used to help funding agencies decide if available funds are best directed towards:

- Vehicle rebates to lower the cost of PEVs,
- Grants to install publicly accessible charging stations,
- Subsidies to reduce the cost of charging at publicly available charging stations,
- Or some combination of the above.

Consumer charging behavior data can also be used in the development of parking policies that promote fair use of parking and charging real estate in environment of parking scarcity.

Types of Consumer Charging Behavior Data

The following types of consumer charging behavior data are of interest for the uses described above:

- Number of charge events per day
- Energy transferred per charge event
- Duration of charge event
- Duration of transaction (can be different than charge duration)
- State of charge (SOC) upon arrival
- SOC upon departure
- Time of day each charge event occurs
- Price of electricity from the utility during the charge event
- Pricing structure of station (can vary with time and/or by user group)
- Number of events per week or month by specific vehicles
- Availability (percentage of time station is operable)
- Number of occurrences where charging station was occupied by conventional vehicle
- Number of occurrences where a driver was not able to charge because the charging station was occupied by another PEV
- Number of occurrences where a driver attempted to use a charging station, but it was unavailable due to equipment failure

Some of these data can be collected by existing technologies; others can be collected by survey. Some of the data listed above may not be able to be collected with currently available technologies and methods.

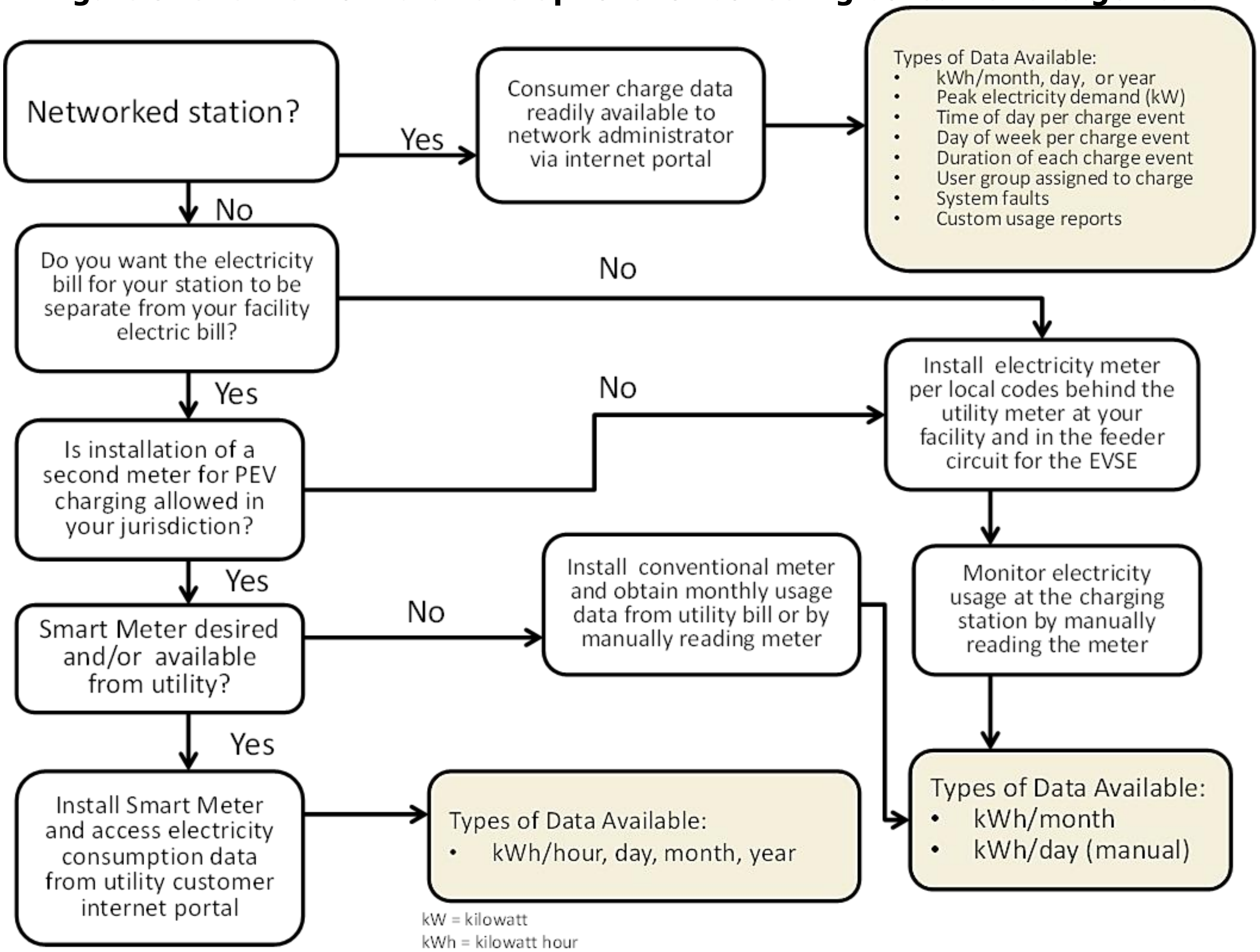
Review of Available Data Collection Technology

Technology for collecting consumer charge behavior is built in too many masses produced EVSE. A wide range of manufacturers offer networked systems that can transmit and receiving data to and from the internet via cell phone signal. This enables EV drivers to pay for charging and station administrators to manage the charger over the internet to set charging cost, monitor usage, download custom reports, and detect system faults.

Networked Versus Non-Networked Systems

Non-networked EVSE are also available with the most basic type being a smart relay box, a cord, and a plug configured to charge vehicles for free following safety and communication protocols contained in the Society of Automotive Engineers Standard J1772. To monitor usage from this type of station additional metering hardware would need to be installed. Figure 8 below provides an overview of consumer charge data collection options from modern EVSE.

Figure 8: Overview of Hardware Options for Collecting Consumer Charge Data



Source: GHD, 2014

As can be seen in the figure above, the most convenient method to collect consumer charging data is by choosing networked EVSE. Networked EVSE also provide the highest level of detail about consumer charge behavior because these systems are designed for the purpose of monitoring and administering networks of charging stations.

A utility smart meter that is installed as a dedicated meter for a single EVSE can provide kilowatt hour usage for the station by the hour, day, month, and year through an online web portal. The data can be downloaded in spreadsheet format for reporting and analysis. A utility smart meter installed for a bank of charging stations can provide usage data for the bank of chargers but will not be able to provide information about individual EVSE usage within the bank.

Pacific Gas and Electric allows a dedicated meter to be installed for PEV charging and has a specific rate set up for EV charging. Jurisdictions in the Upstate planning area generally allow separate meters to be installed for electric vehicle chargers with one known exception being Humboldt County. Humboldt County does not allow a separate meter to be installed for PEV charging in residential applications; however, separate meters for non-residential applications are allowed.

If a separate conventional electricity meter is installed for the EVSE then data, in units of kilowatt hours (kWh) per month will be provided by PG&E on the monthly bill. To obtain data in terms of kWh per day, the meter would have to be read manually daily.

If a conventional meter was installed in the charging station circuit behind the facility's main meter, the data in units of kWh per month could be read manually over a time interval of choice.

Customized electricity metering and data logging hardware is available to allow more comprehensive and convenient metering of non-network charging stations. These types of systems would be most applicable for remote stations that are out of range of cellular network signals. In this scenario, the same parameters that are monitored by networked stations could be monitored and the data would be collected manually by swapping a data logging module or connecting a laptop computer and downloading the data on a regular basis.

Networked EVSE and Open Charge Point Protocol

Open Charge Point Protocol (OCPP) is a standard that applies to data transfer and communications for EVSE. The OCPP was implemented to address the challenge of interoperability of PEV charging across the diverse landscape of EVSE. EVSE that are OCPP compliant can be accessed by any PEV driver regardless of what charging networks they may or may not belong to and what network the EVSE is associated with. The OCPP also allows EVSE owners and administrators to reconfigure the software on the EVSE to support their business/operations model. Currently, EVSE that are installed using funding from the State of California are required to be OCPP compliant.

Available Data Acquisition Technology

There is a wide range of EVSE available on the commercial market and the technology is rapidly evolving. This section presents a summary of the most common types of EVSE available at the time of this writing.

Level 1, Level 2, and Level 3 EVSE

EVSE are available with different power ratings. Level 1 EVSE utilize a 120-volt, 20-amp, single-phase branch circuit. Level 2 EVSE utilize a 240 volt, up to 80-amp, single phase circuit. Level 3 EVSE utilize either a 208 volt or 480 volt three-phase circuit with a current rating up to 400 amps. Level 3 EVSE are also referred to as DC fast charge stations because there is a rectifier in the EVSE that converts alternating current to direct current, which is then supplied directly to the Battery.

Networked Level 2 EVSE

As described above, networked EVSE provide the most convenient means of collecting consumer charging behavior. EVSE wired to a network can be managed, monitored, and its usage can be tracked and reported on. Furthermore, as electric utility rates change, the EVSE owner can adjust the price of consumer charging. Networked EVSE facilitates versatility of use for both the owners and the consumers. Networked EVSE allows PEV drivers to readily access charging stations via a service plan, credit card, or a smart phone. Additionally, networked EVSE facilitates data collection and reporting of consumer charge behavior. This section highlights the most common networked EVSE available at the time of this writing. Since the technology is rapidly evolving, the reader will find that there are networked EVSE available in the commercial marketplace that are not summarized here.

To collect consumer charging behavior data, the EVSE must be supported by a management network. Many manufacturers pair their EVSE with a web-based network for management, monitoring, and control of their charging stations. Charging stations that currently use, or have the option to use, a web-based management network includes AeroVironment, Blink, ChargePoint, ChargePro, ClipperCreek, and Eaton. The network associated each charging station is listed in Table 6.

Table 6: Charging Station and Associated Management Network.

EVSE	Management Network/Software
AeroVironment	AeroVironment, Liberty PlugIns
Blink	Blink
ChargePoint	ChargePoint
ChargePro	SemaCharge
Clipper Creek	PowerDash, Liberty PlugIns
Eaton	Sky Network (Greenlots), Liberty PlugIns,
General Electric WattStation	WattStation Connect

Source: GHD, 2014

Networked EVSE allows the owner, host, or even in some cases the local utility company to manage their charging stations. The network is primarily accessible via internet access, but some networks also include smart phone access. On most EVSE networks, access to the web-based network allows an operator to set pricing, manage EV driver accounts of subscription plans, monitor the station, notify drivers of charge status, troubleshoot problems remotely, produce environmental reports (for example, greenhouse gas (GHG) reduction, fossil fuel displacement, and so forth), track usage, and export data as available. When a utility company has access to the network, additional management may include assigning shedding groups, demand response, and blackout response.

EVSE Charge Ratings

The most common Level 2 EVSE charge rating is only slightly larger than the capacity of the on-board charges in most PEVs. If not carefully considered, EVSE could fall behind the charging capabilities of electric vehicles. The charge ratings for current EVSE ranges between 5.8 kW and 18 kW, as noted in comparison in Table 7. It is important to note that the leading EVSE manufacturers only offer 7.2 kW Level 2 chargers, while a many of the electric vehicles on the market are capable of charging at 6.6 kW. Furthermore, the Toyota RAV4 and Tesla Model S are capable of charging at 10 kW. Thus, if more PEV manufacturers follow the trend and move towards the capability of charging at 10 kW or greater, the EVSE that offer charging at or below 7.2 kW will limit their ability to minimize PEV driver charging time and therefore decrease driver satisfaction, which may discourage PEV adoption. Consequently, any EVSE infrastructure rated to 7.2 kW may need to be upgraded. Alternatively, if EVSE with a rating of at least 10 kW were selected initially, along with its supporting electrical infrastructure, increases in PEV charge ratings will be better supported. Stations that can charge at 19.2 kW would ensure that future increases in the capacity of on-board chargers would be support up to the limit of the allowable Level 2 charging current under the Society of Automotive Engineers Standard J1772 standard.

Table 7: Comparison of EVSE Models and Their Charging Rates

EVSE Brand	Level 2 EVSE Model	Charge Ratings
Blink	Single Pedestal	7.2 kW
ChargePoint	CT4011-GW Single Pedestal	7.2 kW
ChargePro	Single Pedestal	7.2 kW
Clipper Creek	CS-Series Single Pedestal	5.8, 7.2, 9.6, 11.5, 13.4, 15.4, 17.3, or 18.0 kW
Eaton	Single Pedestal	7.2, 9.6, or 16.8 kW

Source: GHD, 2014

EVSE Data Access

For independent agencies to obtain consumer charging data from EVSE owners, it is recommended that the owners sign a Disclosure Agreement with the entity seeking to collect the data. The agreement would permit the entity to periodically access the networked EVSE from a web-terminal and export consumer charging data that does not violate consumer privacy rights. The simplest approach to obtaining approval from the owner would be by presenting the agreement to the owner when he or she applies for an EVSE installation permit, for tax incentives, or during other application EVSE processes.

Other Sources of Relevant Data

Consumer Outreach

Data exported from charging stations represents only a subset of data available for use in analyzing consumer charging behavior. Charging station data indicates how an existing set of charging stations were utilized. However, it does not indicate consumer preference and/or response to the existing infrastructure. Another subset of behavior data could come from consumer outreach. Consumer outreach in the form of a survey could complement the data exported from charging stations and could explain what cannot be interpreted from raw data. For example, a survey might indicate that most consumers want a charging station at a nearby recreation area. This information wouldn’t be gleaned from charge data alone. Furthermore, a survey could indicate whether a DC Fast Charger should be implemented instead of additional Level 2 chargers at a particular location.

To obtain consumer data via a survey, the survey could be presented through the vehicle registration renewal process, at a charging station, at the dealership, or in via a public outreach project. Ideally, the target demographic for consumer outreach would be drivers who have had time to get comfortable with their EV driving habits. Ideally, they have also had time to consider how and where the EVSE infrastructure might be improved. Vehicle registration renewal is typically performed via the USPS mail, and since it occurs after one year of EV ownership it would be an ideal avenue for obtaining information via a consumer survey. For those EV drivers within each county, the DMV could enclose a simple flyer within the renewal letter requesting consumer responses via a web-survey. Another avenue for outreach could be through an advertisement on the charging stations themselves. A station owner could offer, for a limited time, a discounted charging cost for those drivers who participate in a web-survey. For the latter approach to be effective, private EVSE owners may have to receive subsidies from the State or another agency accounting for the difference in lost charging revenue so that they are willing to offer this discount without incurring any losses.

The Electric Vehicle Driver Survey that was prepared seeks driver experience and feedback on the existing EVSE infrastructure in the region. The survey asks EV drivers to respond to questions such as where they charge, are there enough publicly accessible EVSE, how much they are willing to pay for a charge event, and their general opinion and satisfaction about their EV charging experience. The goal of this survey is to determine how the utilization might be affected by location, pricing, and equipment, which cannot be obtained from the charge data alone.

Vehicle Telemetry

Additional charging behaviour can be obtained through vehicle telemetry. Useful telemetry data from a vehicle may include:

- GPS route information including start and stop times and locations
- Number of trips per day
- Battery state of charge (SOC) at the beginning and end of trip

The data is useful because, for example, it may indicate where numerous drivers have depleted their batteries in attempts to make trips but have been limited by insufficient public EVSE infrastructure. Hence, indicating where consumers need additional public EVSE. Additionally, inferences could be made from SOC at trip start and stop, which could be used to infer consumer confidence in their regional EVSE infrastructure. A major hindrance in obtaining telemetry from consumers is that it requires a PEV driver to allow the installation of a telemetry module in his or her electric vehicle and to allow the release of the driver’s behaviour to a third-party. Drivers may be sensitive to third parties having knowledge of their whereabouts. Thus, drivers would need an incentive to be willing to release their potentially private driving information. The module may need to be subsidized by the State or other agency, and a Disclosure Agreement would be required so that the agency would be permitted to periodically export the driver’s vehicle behaviour data.

Some electric vehicle manufacturers have already set up telemetry web-interface systems as optional purchasing features. The telemetry systems allow drivers to monitor their energy usage, check SOC, remotely start and stop vehicle charging, track greenhouse gas (GHG) reductions, and produce usage reports.

One example is that Nissan offers an optional telematics service through CARWINGS for vehicles that are equipped with navigational equipment. To use the service, an additional module is installed on the PEV, and vehicle data is exported to a server. The data can be accessed via a web-terminal or smart phone. The data was logged by the telematics system and includes (CARWINGS, 2013):

- Daily trip number
- Total electricity used
- Electricity used from consumption
- Electricity used from regeneration
- Distance travelled
- Energy economy in mi/kWh
- CO2 tailpipe emission reduction

Currently, drivers of the Chevrolet Volt and the Honda Fit PEV have access to remote charge management via a web terminal or smart phone, but do not have the capability to log and export vehicle usage data.

The types of data that can be obtained from networked EVSE do not vary significantly between manufacturers. Thus, to obtain the largest set of consumer charge data from EVSE, the most cost effective EVSE should be considered. Table 8 lists the costs of 7.2 kW Level 2 that were available at the time of this report. As a result of the capital lower costs, more business owners and stakeholders may be willing to invest their capital into adopting the new technology. Additionally, the costs to the PEV driver should also be considered because they could impact the revenue associated with the EVSE ownership model. This section addresses the costs associated with investment of EVSE.

Table 8: Equipment Costs for Networked 7.2 kW EVSE Including One Year of Service Fees

EVSE	EVSE Model (Level 2)	Cost
Blink	Blink Pedestal Single	$ 4,755
ChargePoint	CT4011-GW Single Pedestal	$ 5,666
ChargePro	ChargePro Charging Station	$ 4,895
Clipper Creek	CS-40 (Pole mount)	$ 5,730

Source: GHD, 2014

Plan for Data Acquisition

The information presented above was used to develop a recommended rollout plan for collection consumer charge behavior data. The plan is consisting of the following elements:

- Select OCPP compliant, networked EVSE
- Distribute a PEV Driver Feedback Survey
- Create Database
- Update Database on a quarterly basis
- Report out to the stakeholders on an annual basis

Selecting OCPP compliant, networked EVSE will enable the collection of the following data:

- Number of charge events per day
- Energy transferred per charge event
- Duration of charge
- Duration of transaction
- Time of day each charge event occurs
- Cost to EV driver to charge
- Availability (percentage of installed time that station is operational)

These data will allow the network administrator to determine:

- Station Utilization
    - This will help determine what types of locations are popular and when it is time to install another station at a popular location
- Frequency of PEVs remaining plugged in after their battery has been completely charged
    - This will help determine when it may be advantageous to implement a charging policy that requires PEVs drivers to move their vehicles within a certain period after their battery has been fully charged, which will free up the EVSE for another PEV to charge.
- Frequency of overnight charging
    - This will help administrators understand demand for overnight charging opportunities for residents that do not have access to a dedicate parking space such as urban apartment and multifamily housing development dwellers
- The relationship between charging price and station utilization
    - This will help administrators understand how effective their marketing campaign is in explaining the actual costs of operating and maintaining the network and the justification for the pricing structure
    - This will also help administrators balance pricing and utilization by providing a feedback mechanism from PEV drivers
- The reliability of various types of EVSE

    - If availability of a particular brand of EVSE is low and externalities such as vandalism have not occurred, then the administrator will be able to avoid that brand of EVSE for subsequent charging station installations
- The prevalence of vandalism in particular locations
    - From recent experience in the Upstate region, certain locations are more prone to vandalism than others. Vandalism can affect the availability of stations and it will be useful for the administrator to know which areas are more prone to vandalism.
    - If utilization of stations in vandalism prone areas is low, then the administrator may elect to remove the EVSE to avoid incurring repeated expenses associated with repairs.
    - If the location is highly utilized or important for safety reasons then the administrator can either harden the existing EVSE or install a new vandal resistant EVSE, if one becomes commercially available

Distributing a PEV Driver Feedback Survey and managing the data received will provide the network administrator with data that cannot be obtained from EVSE directly. The survey form was created using Google Forms, a free online tool that allows users to create surveys, create links to the survey for use on websites and in documents, and analyze survey results. The survey can be distributed by embedding a link on the websites of stakeholder organizations, by including the web address of the survey on printed promotional materials associated with the Upstate PEV Readiness Plan and the Upstate Plug-In Electric Vehicle Charging Network. Partnering with local auto dealers to provide handouts or business cards with each purchase of a PEV would make PEV drivers aware of the survey and the local charging station network, which could result in valuable feedback. The types of data that can be collected with the survey include the following:

- Frequency of use for each station in the network by individual drivers
- Additional locations where drivers would like to see EVSE
- Frequency of occurrences where a driver was not able to charge because the charging station was occupied by another PEV
- Frequency of occurrences where a driver attempted to use a charging station, but it was unavailable due to equipment failure
- Frequency of occurrences where charging station was occupied by conventional vehicle

Once the type of EVSE to be purchase has been selected and the consumer survey has been finalized, the network administrator can design a database to store the data to be collected in a way that will facilitate analysis and reporting. A Microsoft Excel template can be created for monthly or quarterly data download/input from the EVSE and survey result tracking spreadsheet. The template can include graphs and tables to be used in reporting out to stakeholders the results of the consumer charge behavior data acquisition program. The results can be used for public outreach and to guide procurement and management decisions by the network administrator to maximize quality, value, and convenience to the PEV driver within the constraints of a non-profit cost recovery business model.

EVSE Recommendations

Networked EVSE that are OCPP compliant and capable of payment by credit card should be selected for deployment. In areas where vandalism is a concern, EVSE that are hardened with features such as a locking cord retraction system should be considered, if and when such units become commercially available.

For Level 2 EVSE, units with the highest power rating should be selected where practical to prevent the need for future upgrades as onboard PEV battery charger capacities increase over time towards the 1819.2 kW limit as per the Society of Automotive Engineers Standard J1772 standard. However, the highest charge rate is not necessarily the most feasible option for all situations because this choice may trigger service upgrades that could make the project economically infeasible. SCEDC should consider installing the largest capacity Level 2 EVSE possible in each location without triggering service upgrades. If a service upgrade is unavoidable, consider upgrading the service to support a high-power Level 2 EVSE to support growth in vehicle on-board chargers in the coming years.

ClipperCreek Level 2 EVSE with the Liberty PlugIns add on seems to provide the most flexibility for installing high power, networked, OCPP compliant charging stations across a wide variety of electrical service sizes. This configuration also lends itself to development of hardened EVSE through the addition of a cord retraction system or automated locker/kiosk arrangement that could be triggered by the Liberty PlugIns system.

For Level 3 EVSE, units with both CHAdeMO and J1772 Combo plugs should be deployed on each unit to accommodate all PEVs with DC fast charge capability, except for Tesla, which has its own DC Fast Charge network specific to its cars. The additional cost to include both cords will likely be small compared to the overall project cost to install the EVSE. The voltage of the closest three-phase power connection should be considered when selecting the EVSE. Installation costs can be reduced if the EVSE input voltage and the voltage of the nearest three-phase power connection are matched. Additionally, care should be taken to deploy EVSE designed for the altitude and temperatures at the site.

Greenhouse Gas Reduction Estimates

The Upstate PEV research team conducted an analysis of the GHG reductions that are achievable in the Upstate region through adoption of PEVs and deployment of public EVSE infrastructure.

Greenhouse Gas Reduction Estimates - Methodology

The Upstate PEV leveraged several sources of data to estimate the impact of PEV adoption on region wide GHG emission in the year 2020. The first was modeled output from the PEV infrastructure simulation model (see Chapter 2’s Model Development), which provides an estimate of the number of electric vehicle miles traveled given three hypothetical penetration levels into the vehicle fleet of the Upstate region. The second data was from the California Air Resources Board EMFAC 2011 model,[7] which was used to quantify the reduction in GHG

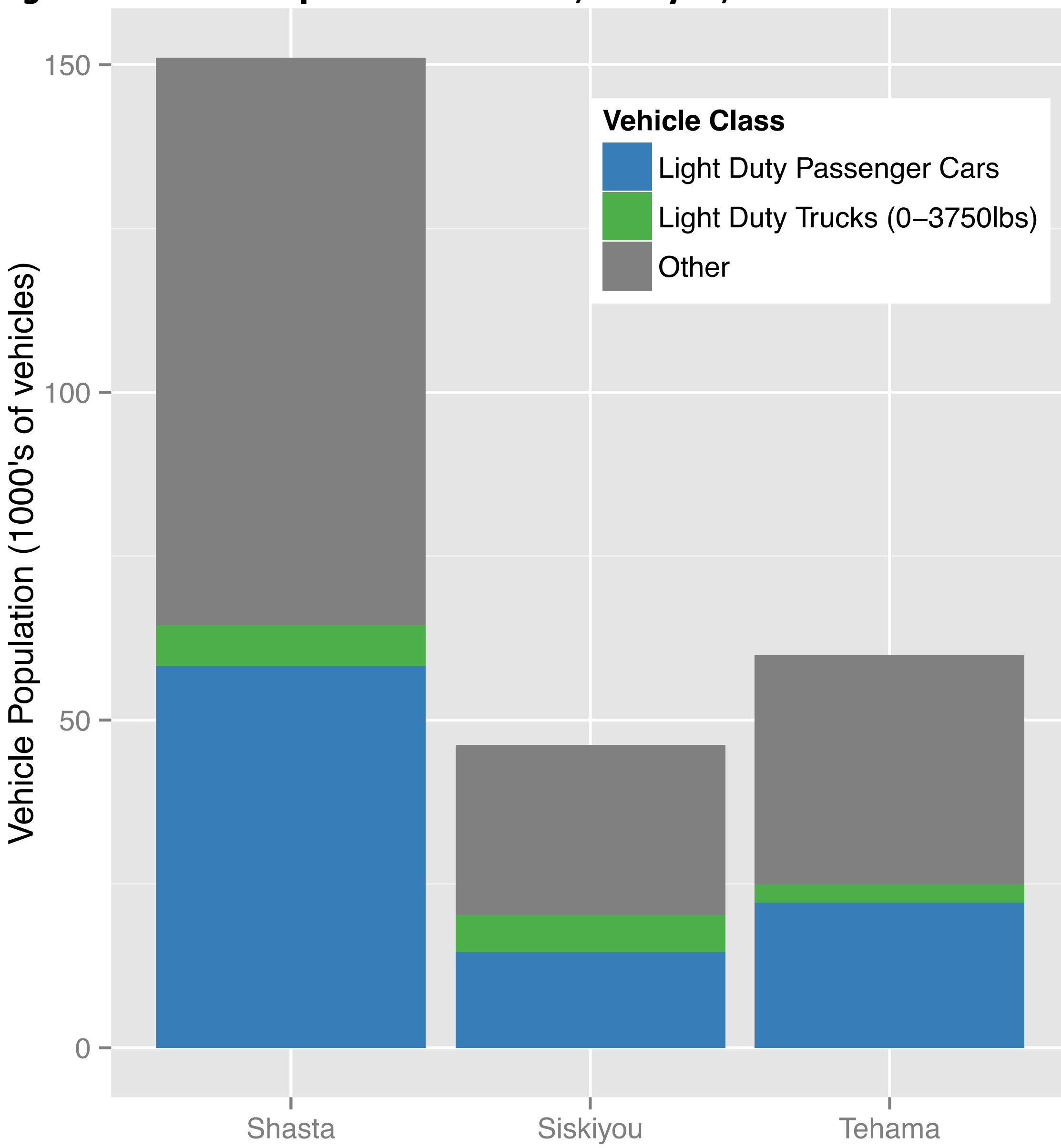
[7] Information of the California Air Resources Board EMFAC 2011 model can be found on the California Air Resources Board EMFAC Webpage (https://arb.ca.gov/emfac/)

emissions associated with the displacement of conventional vehicle miles traveled with electric vehicle miles. The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) emissions model by Argonne National Labs was used to quantify upstream emissions associated with conventional vehicles and PHEVs. Finally, the GHG emissions associated with the electricity needed to charge PEVs were based upon data gathered from the three electric utilities in the Upstate region (Pacific Gas & Electric, Redding Electric Utility, and Pacific Power).

Regional Fleet Composition

The EMFAC 2011 model output used in this analysis includes an estimate of vehicle population, vehicle miles traveled, and GHG emissions rates in the year 2020. These values are disaggregated by county, vehicle class, fuel type, and model year. A summary of the light duty fleet composition is provided in Figure 9. Note that the fleet penetration scenarios throughout this report were developed relative to the full vehicle fleet in each county. A 1 percent fleet penetration corresponds to a 2.3 percent penetration into the light-duty vehicle fleet.

Figure 9: Vehicle Population in Shasta, Siskiyou, and Tehama Counties



Source: SERC, 2014

PEV Fleet Composition

Three fleet penetration levels were simulated in the PEV infrastructure simulation model: 0.5 percent, 1 percent, and 2 percent. These levels represent the percentage of total vehicles that were replaced by with plug-in electric vehicles. PEVs are assumed to be 50 percent battery electric and 50 percent plug-in hybrid electric. PEVs are also assumed to be 99 percent light duty passenger cars and 1 percent light duty trucks. The conventional vehicles replaced by the PEVs are assumed to the same class of vehicle (that is, 99 percent/1 percent light-duty cars/trucks). Vehicle adoption is assumed to be spatially distributed throughout the Upstate Region in proportion to present day population.

Estimating Emissions
The PEV infrastructure model was used to simulate a workday of travel and charging behavior in the region for the three penetration levels and two scenarios. The first scenario included no new public electric vehicle supply infrastructure, and the second included the EVSE infrastructure recommended in this report (Chapter 2's Conclusions about Macro Level EVSE Deployment). These scenarios allow one to distinguish between benefits associated with PEV adoption alone and adoption coupled with public EVSE.

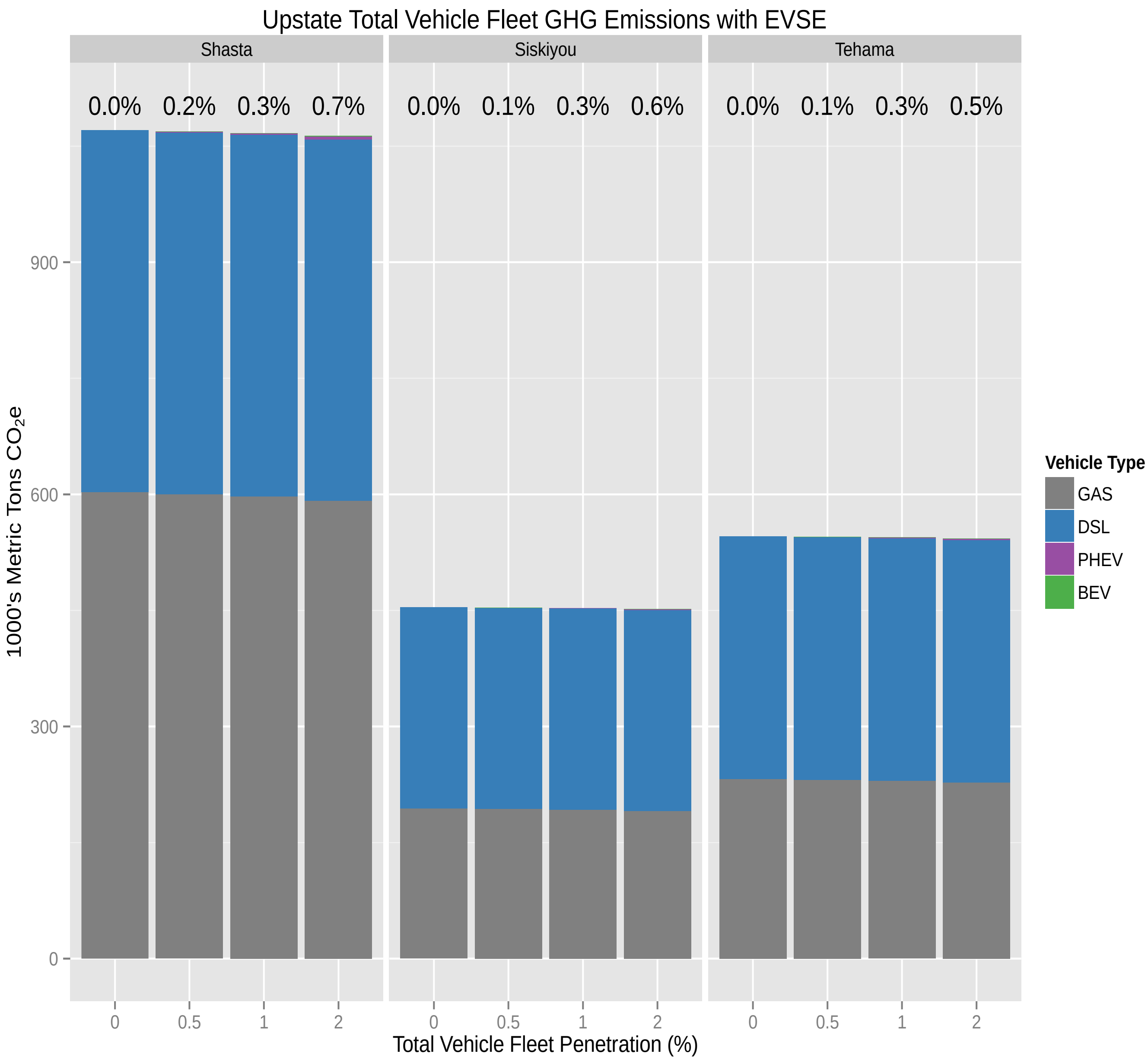
PEV infrastructure produces estimates of the total number of electric miles and gas miles traveled on a typical weekday. These were totaled and used to adjust vehicle miles traveled from the EMFAC model for vehicles of class light duty auto and light duty truck 1 that use gasoline. Then two new "fuels" were added to the analysis, "BEV" and "PHEV", to account for emissions associated with these two kinds of PEVs. The vehicle miles traveled for BEV and PHEV were distributed based on the distribution of electric and gas miles traveled from the PEV infrastructure model with all the gasoline miles traveled going to PHEV and all the electric miles traveled going to BEV (in reality, PHEV's have a mixture of both but for GHG accounting it is simpler to separate). The emissions rate for operating a PHEV on a per mile basis is based on the emissions rate of a gasoline vehicle but scaled in proportion to the ratio of fuel economy between a typical PHEV (50 mpg) and a conventional light duty vehicle from the EMFAC model (18-23 mpg).

Upstream emissions for gasoline and diesel were based on the Argonne GREET model (1.31 kg CO2/gal of gasoline and 0.784 kg CO2gal of diesel) and for electricity were based on a population-weighted average of the three primary electric utilities in the upstate region (0.20 tons CO2/MWh electricity). Finally, the EMFAC 2011 emissions estimates are representative of a typical weekday, so we used a factor of 347.5, which is based on the conversion factors used by EMFAC, to convert weekday emissions to annual emissions.

Greenhouse Gas Reduction Estimates - Results
Figure 10 shows the impact of PEV penetration into the total vehicle fleet on total fleet emissions. The labels near the top of each plot annotate the percent reduction in GHG emissions associated with each scenario. For all three counties, a 1 percent penetration into the total vehicle fleet results in a 0.3 percent reduction in total fleet GHG emissions. Figure 11 presents the same result, but the emissions quantities are restricted to just light duty vehicles. So, a 1 percent penetration into the total vehicle fleet (which is a 2.3 percent penetration into the light duty fleet) results in a 1.5 percent reduction in light duty vehicle emissions.

The impact of public EVSE on emissions is relatively small, for all counties the emissions reduction achieved by installing public charging infrastructure is approximately 3 percent greater than what is achieved from PEV adoption alone. Despite this modest benefit in terms of emissions, there is a substantial benefit to BEV drivers from having public EVSE installed in their region. As Figure 12 demonstrates, hundreds of drivers simulated in the PEV infrastructure model avoid becoming stranded when they have access to public EVSE. The public chargers make a substantial amount of travel possible that wouldn't otherwise be feasible in a BEV with approximately 70 miles of range. For this reason, it is reasonable to conclude that installing public EVSE is an essential component to the uptake of PEVs and the emissions benefits from adoption alone can be partially credited to the development of a public charging network.

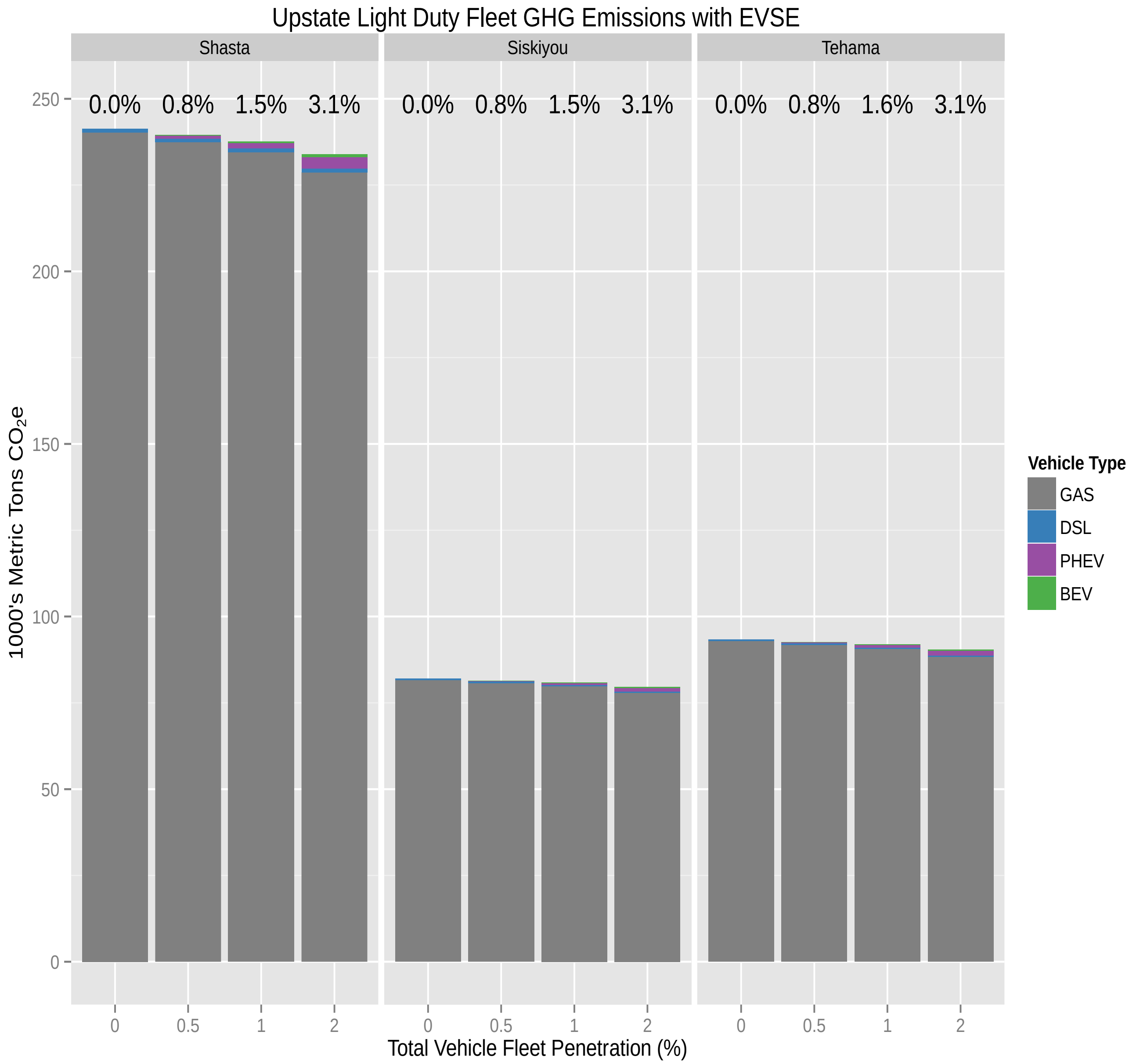
Figure 10: Impact of PEV Adoption in the Upstate Region on Total Vehicle Fleet GHG Emissions by Vehicle Type



Source: SERC, 2014

*The black percentage labels indicate the percent reduction in emissions for each scenario

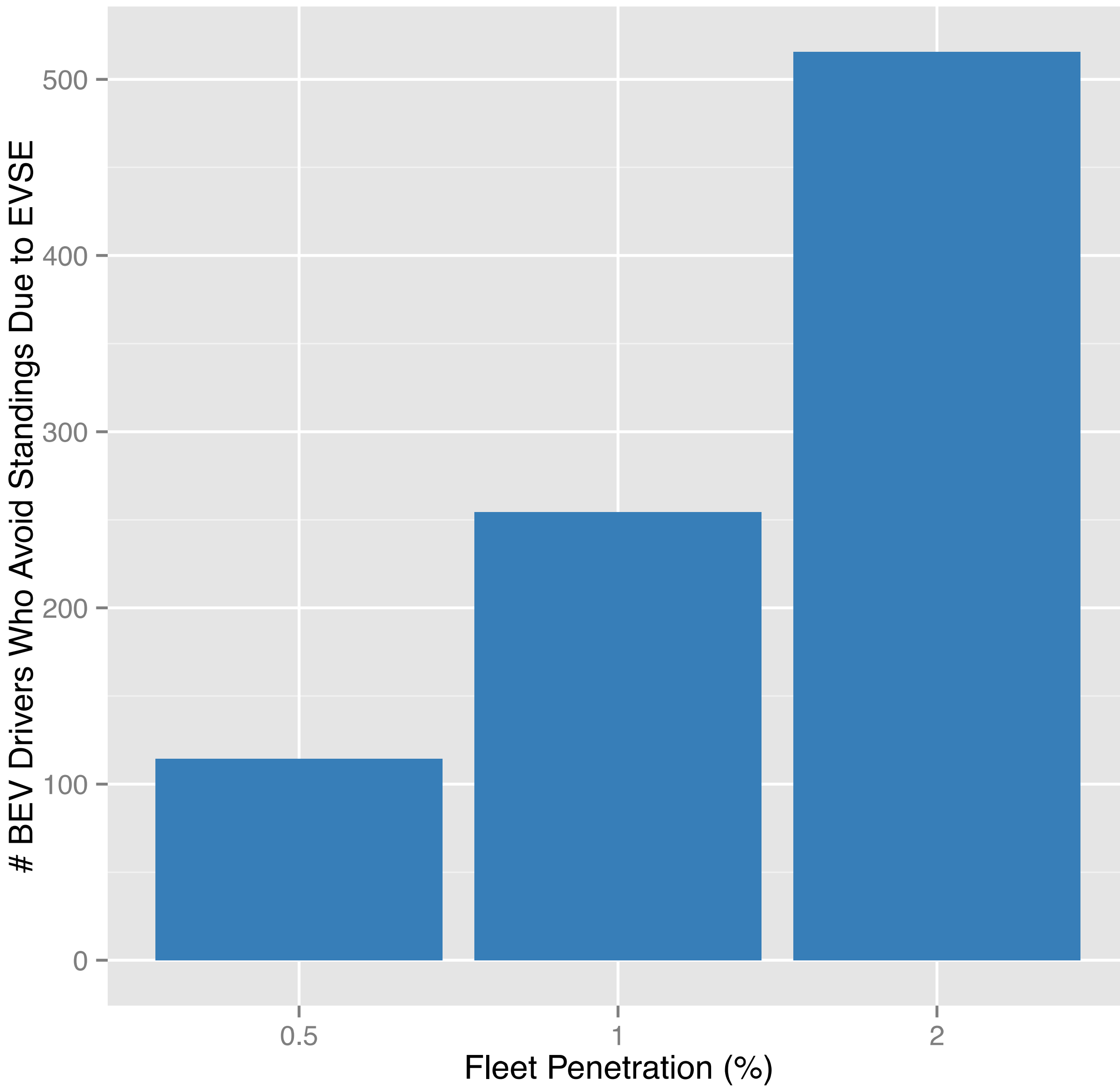
Figure 11: Impact of PEV Adoption in the Upstate Region on Light Duty Fleet GHG Emissions by Vehicle Type



Source: SERC, 2014

*The black percentage labels indicate the percent reduction in emissions for each scenario

Figure 12: The Number of BEV drivers Who Avoid Strandings Due to Public EVSE Siting Recommendations from the Upstate PEV Readiness Plan.



Source: SERC, 2014

Plan to Mitigate On-Peak PEV Charging

The Upstate Plug-in Electric Vehicle team assessed impacts and identified mitigation measures for on-peak PEV charging. The analysis found that even at a 2 percent penetration of PEVs into the light duty vehicle fleet, the increase in peak demand – while not negligible – is nevertheless within the range of natural load growth that utilities already account for the course of normal system planning and upgrading activities. This explains why PEV charging is not a cause of significant concern for utility service planners now. Mitigation measures for on-peak charging consist of a combination of economic and technical measures. Economic measures include peak period pricing structures that can discourage on-peak charging. Technical measures include load-shedding algorithms available in some EVSE and onsite renewable energy generation and battery storage systems integrated with EVSE.

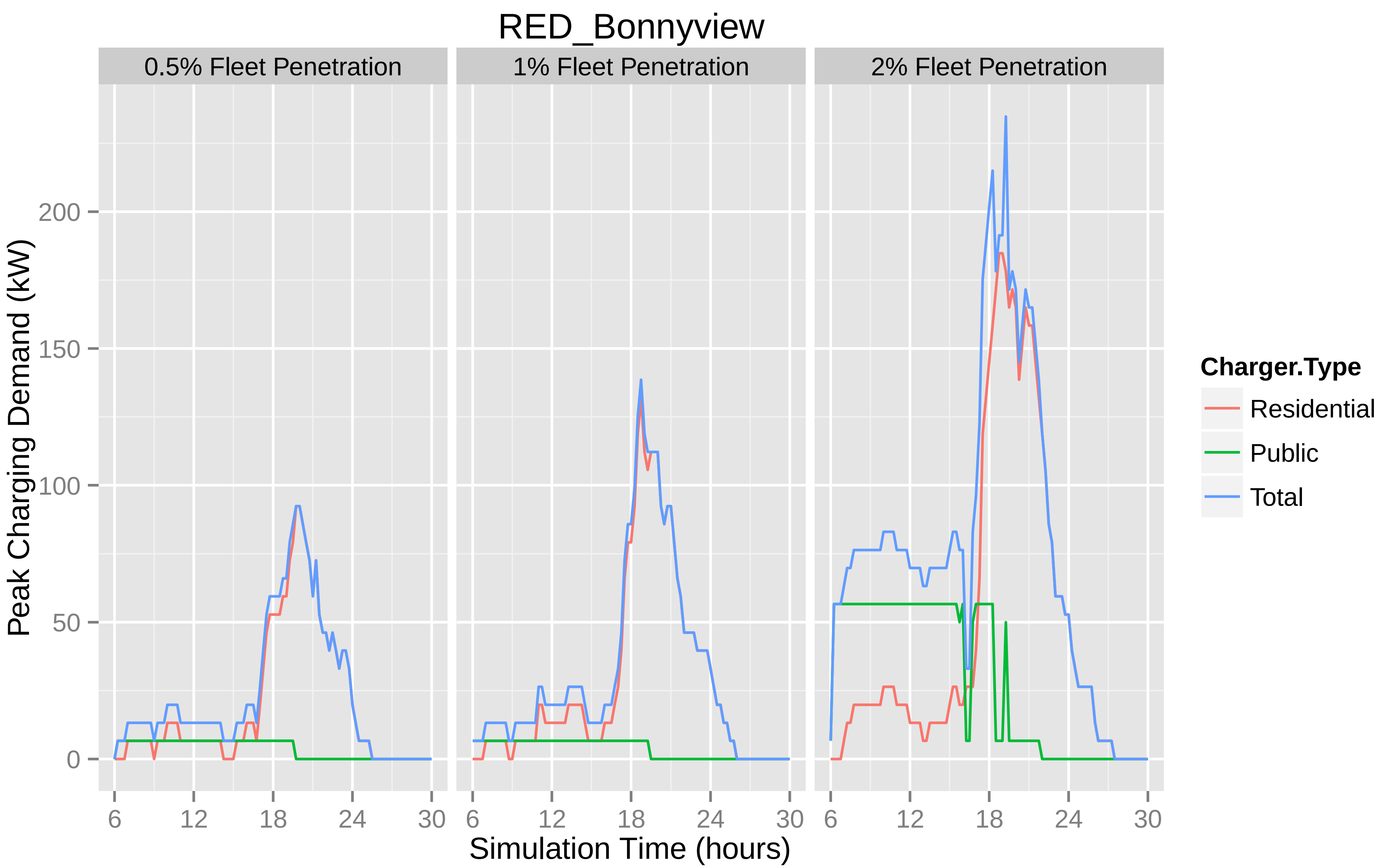
Distribution Level Peak Demand Analysis

The Upstate PEV team obtained distribution grid infrastructure data from Pacific Gas & Electric for 23 circuits in Shasta County (which do not cover Redding Electric or Pacific Power service territories) and 13 circuits in Tehama County. The infrastructure data were used to compare the spatial extent of each distribution circuit to the size of the TAZs used in the PEV infrastructure. It was determined that the sizes of the TAZs are approximately the same as the size of a single distribution circuit in both rural and urban regions of Shasta and Tehama Counties. Based on this result, the peak demand impact analysis was conducted at the spatial resolution of the TAZ.

Unfortunately, the Upstate PEV team was unable to procure load data from PG&E or the other utilities at the distribution circuit level. So, the analysis of peak demand consists of conducting five replicate simulations with the PEV infrastructure model for each penetration scenario and summarizing the PEV charging demand by TAZ. The results of these simulations were then presented to regional utility managers at Redding Electric Utility and Pacific Power.

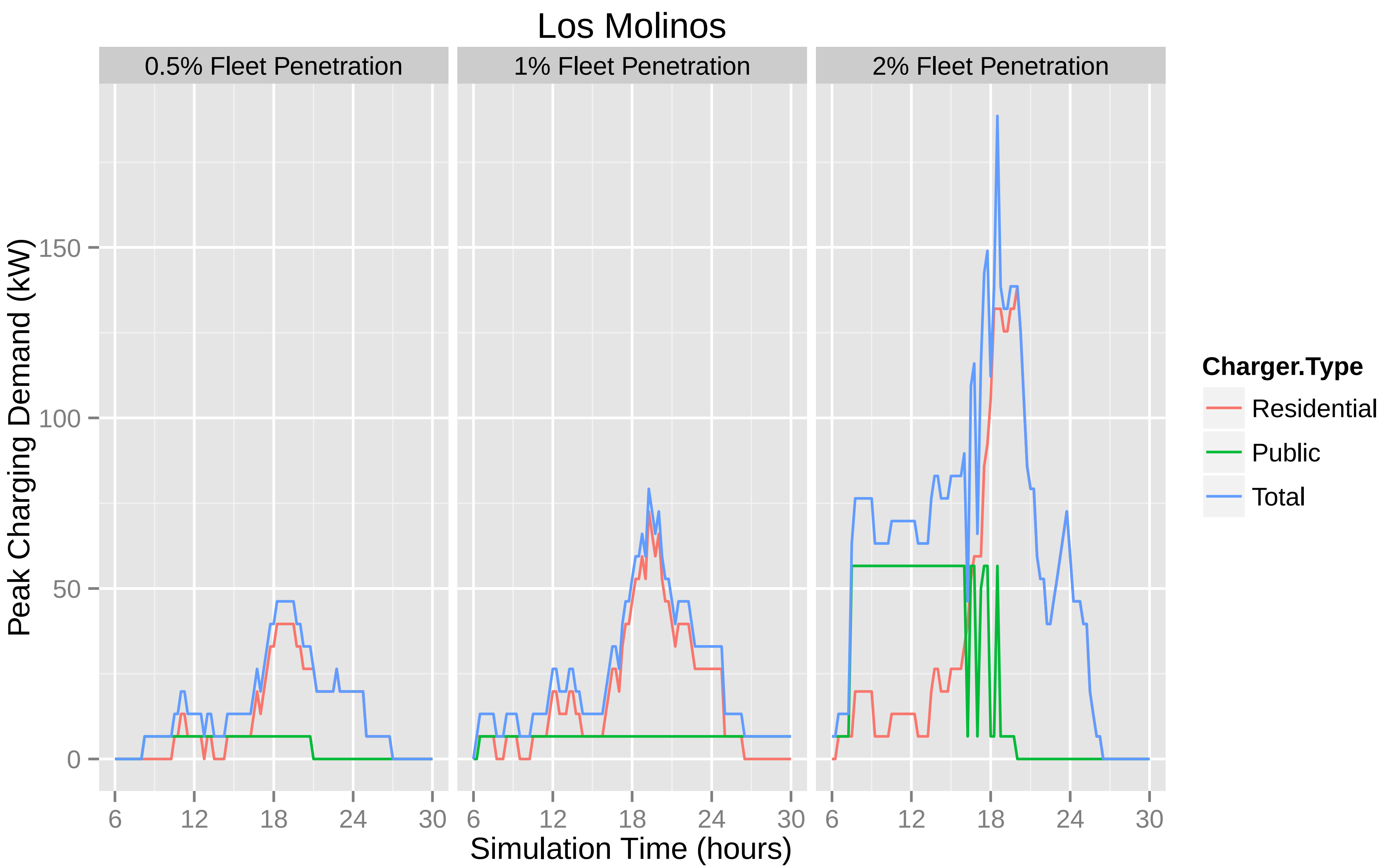
Figures 13, 14, and 15 present the simulated peak demand for power due to PEV charging in a TAZ in Redding, Los Molinos, and Etna to show, respectively, demand curves for urban, semi-urban, and rural areas of the Upstate Region. Model runs started at 6 AM and went through 6 AM the following day (hour 30 on the plot). Figure 16 presents a summary over all TAZs in the region categorized into urban, semi-urban, and rural groupings. Five curves are plotted showing the 0, 25, 50, 75, and 100 percentile peak demand that occurred over all the TAZs in that category and over all five replicate simulations performed with the PEV infrastructure model.

Figure 13: Peak Demand Projections for the Bonnyview TAZ in Redding, an Example of an Urban TAZ.



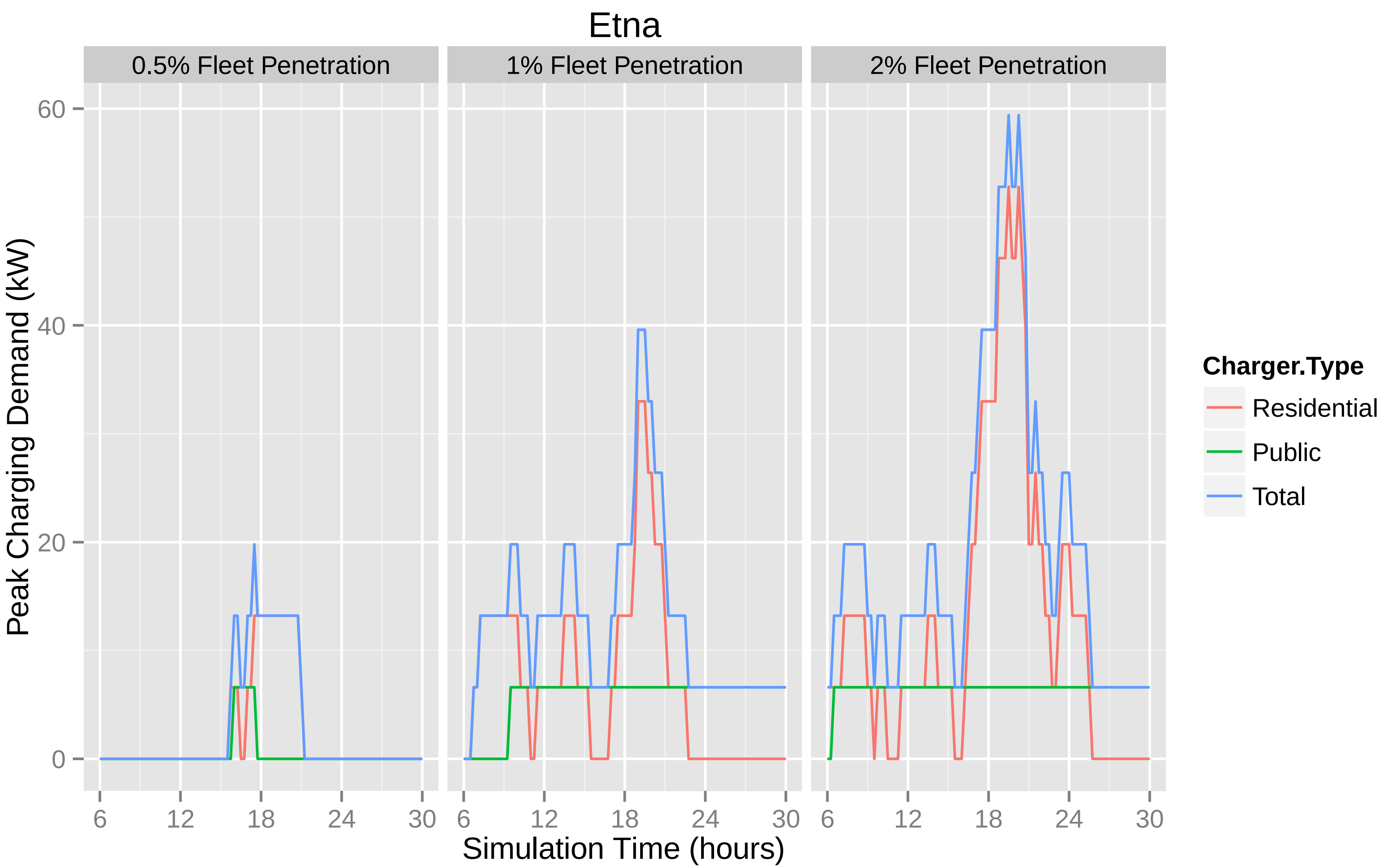
Source: SERC, 2014

Figure 14: Peak Demand Projections for the Los Molinos TAZ in Tehama, an Example of a Semi-Urban TAZ



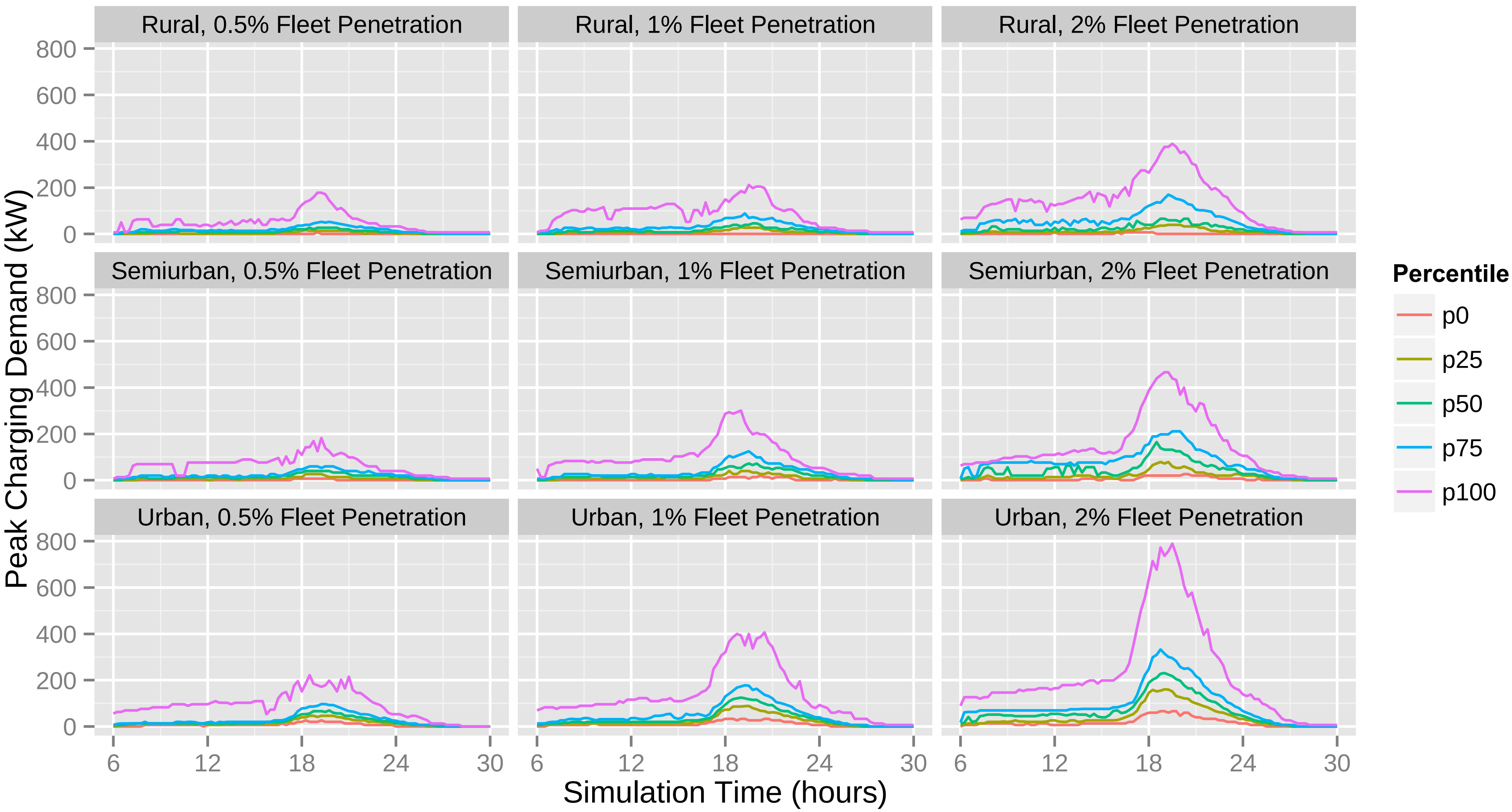
Source: SERC, 2014

Figure 15: Peak Demand Projections for the Etna TAZ in Siskiyou, an Example of a Rural TAZ



Source: SERC, 2014

Figure 16: Peak PEV Charging Demand Percentile Projections Over All TAZs by Category (Urban, Semi-urban, Rural) and PEV Fleet Penetration.



Source: SERC, 2014

For all penetrations and locations, the peak demand for charging occurs in the early to mid-evening (6-9 pm), driven primarily by the arrival of PEV drivers to their home at the end of the day. Generally, the peak summertime loads driven by air conditioning demand occur before 6:00 PM. Therefore, the PEV peak is unlikely to directly exacerbate feeder-level peak load; however, the ramp down period from air conditioning loads may overlap to some degree with the ramp up period from PEV. This could potentially prolong the duration of the afternoon peak event and may eventually require mitigation measures.

The worst-case peak demand occurred at 2 percent penetration in an urban TAZ and had a magnitude of about 800kW. For a feeder with an existing peak of 5 MVA, the additional peak load from PEV charging over a 10-year time horizon represents an annual growth rate of about 1.5 percent. This rate is commensurate with "natural" load growth due to population and other demographic drivers. This implies that the worst impacts from PEV charging – while not negligible – will occur on a time horizon that allows the utilities to anticipate and mitigate through their regular process of system planning and upgrading. The more typical impacts from charging will fall substantially below the worst-case scenario. Over 75 percent of peak demand in the 2 percent penetration and urban scenario was below 350kW.

Finally, through direct conversations with utility planners from Redding Electric and Pacific Power, the Upstate PEV team was reassured that the load growth projections from PEV charging fall well within typical rates of growth already accounted for by their regular processes.

Site Level Peak Demand Analysis

In cases where the electrical service for an existing facility must be expanded to accommodate installation of an EVSE, the utility will typically cover the cost of the service upgrade upstream of the customer's meter and the customer will cover the costs of upgrades downstream of the meter. For cases where a new service is required for the EVSE installation, a cost share arrangement is typical between the customer and the utility for the new service drop from the nearest transformer with appropriate voltage. The specifics of the cost share arrangement depend on the estimated revenue that can be expected from the new service and is evaluated on a case-by-case basis. In general, the cost share requirements in these cases will tend to comprise a significant portion of the overall cost of the EVSE installation.

All three utilities in the Upstate region impose monthly demand charges. If PEV charging occurs coincident with a facility's existing peak electric load, then it will directly add to that facility's monthly demand charge. The severity of this impact is largely dependent on the demand charge level imposed by the utility and can vary substantially between the three utilities that serve the region. Table 9 shows typical demand charges levied by each of the utilities, as well as an estimate of the monthly bill impacts that would be experienced during the summer period if electric vehicle charging took place coincident with the host facility's existing peak demand period.

Table 9: Electric Bill Demand Charge Impacts for Summer Peak Coincident Charging Events

Utility	Rate Schedule	Summer Demand Charge ($/kW/mo)	Cost with coincident 6.6 kW Level 2 charge event ($/mo)	Cost with coincident 50 kW DC fast charge event ($/mo)
Pacific Gas & Electric	A-10*	$18.37	$121	$918
	E-19*	$14.28	$94	$714
Pacific Power	A-32	$3.26	$22	$163
	A-36	$7.28	$48	$364
	AT-48	$5.28	$35	$264
Redding Electric	E7, E8	Up to $29.65	$196	$1,483

Source: SERC, 2014

* Assumes secondary voltage electric service.

These potential demand charges could be a serious deterrent to a potential site host who might be considering installing an EV charging station or to a fleet operator who is considering adding PEVs to their fleet. One potential mitigation measure is to place the EVSE on an electric service that is not subjected to demand charges (for example, a service on a small commercial rate). If such a service is not available, it may be possible to request a new small commercial service just to serve the EVSE, but this would need to be worked out with the local utility. Other potential mitigation measures include charging higher rates for PEV charging during a facility's peak demand period to discourage charging during that time and to help recoup demand charges and installing technical solutions such as those mentioned above (for example, smart EVSE that can shed load during peak demand events, battery storage, and solar electric systems). This issue of demand charges should be discussed with the utility prior to installing EVSE.

Methods for Mitigating or Deterring On-Peak Charging

As mentioned previously, on-peak charging generally does not appear to be an issue in the Upstate Region. However, there are several methods that could be used to deter on-peak charging if there were a desire to do so.

Mitigation measures for on-peak charging consist of a combination of economic and technical measures. Economic measures include peak period pricing structures that will discourage on-peak charging. PG&E rate schedules include peak period energy pricing and demand charges that make electricity consumption during peak periods more costly. These measures can act to discourage on-peak charging when real-time electricity costs are passed through to the PEV drivers. Redding Electric Utility and Pacific Power and Light do not currently have timedifferentiated pricing structures. However, both utilities do impose demand charges that could impact the cost of providing electricity for EV charging purposes.

For these pricing mechanisms to work, the EVSE network administrator must set up a pricing schedule that corresponds to the peak energy and demand charge schedules that pertain to the site. Modern networked EVSE allow pricing to vary according to a schedule; however, the amount of effort to set up a varied pricing schedule is not insignificant. In addition, demand charges pose unique challenges. Determining whether demand charges will be triggered for a PEV charging event depends on what other loads are present at the host facility at the time of the charging event, and on the customer's overall load profile. Demand charges are difficult to pass through to PEV drivers in real-time because these charges are not determined nor incurred until the end of an electric utility's monthly billing period.

Technical measures include load shedding algorithms available in some EVSE and onsite renewable energy generation and battery storage systems integrated with EVSE. Certain EVSE, such as the Liberty Plug-In System, provide a means for the charging load to be shed if the utility sends out a curtailment signal. In this case, the PEV driver will not notice that a curtailment event has occurred unless they are denied a consequential amount of energy during the event. Using this technology and specific signaling, the utility can limit the extent to which PEV charging occurs during extreme peak periods. It may be possible to configure this type of system to shed the PEV charging load if the facility load is nearing the point where demand charges will be incurred.

Another technical solution is offered by a company called EV For Oregon; they offer a high power EVSE that is integrated into a photovoltaic system with a 30-kilowatt-hour battery pack. This type of system helps mitigate peak demand because the energy for charging is provided through the battery pack which allows for a reduced demand from the electricity grid. The photovoltaic system is beneficial in providing renewable energy to recharge the battery pack, which again reduces the load experienced by the electricity grid for PEV charging. Similar systems without the photovoltaic system are available from specialty manufacturers allowing peak demands to be mitigated using a battery pack and inverter coupled to the EVSE.

Plan for Mitigating or Deterring On-Peak Charging

Discussions with PG&E, Redding Electric Utility, and Pacific Power staff regarding peak impacts from EV charging at a 1-2 percent penetration of PEVs indicate there will be no significant issues on their respective distribution systems. For this reason, mitigation of on-peak charging impacts in the Upstate Region may be considered a low priority. However, there could be site level issues associated with demand charges. This could be a deterrent to the installation of EVSE and the adoption of PEVs and will likely need to be addressed.

PEV and EVSE technologies are still in their early stages, and new features and capabilities will certainly make their way into the marketplace. As the market evolves it will be important for PEV stakeholders to keep themselves informed about the following topics:

- Stay informed about utility electric rate options and how they relate to peak charging (time-of-use rates, peak demand charges, rules on second meters, and so forth). Advocate for fair and effective policies for PEV drivers and EVSE site hosts.

- Stay informed about EVSE features regarding pricing schedules and demand response features. Examine how the true costs of PEV charging can be passed through to the consumers who are charging their PEVs?
- Examine methods for dealing with demand charges. What impact does PEV charging have on EVSE host site demand charges? How can demand charges be tracked and then passed through to consumers? What sort of pricing structures can be used in place of demand charges for accounts that serve EVSE loads? Can EVSE be placed on an electric service that will not be subjected to demand charges?
- Stay informed about EVSE systems that incorporate battery storage, renewable energy generation, and/or demand response features to mitigate peak charging impacts.

Plan for Streamlining EVSE Permitting, Installation and Inspection

Plug-in electric vehicles and the associated infrastructure require attention from planning and building departments in every city and at a county level. Currently, some of the biggest barriers in quick PEV and EVSE adoption are found in the permitting process, as PEVs and EVSE are relatively new to the market and planning and building department staff are often unfamiliar with the technology. The challenges associated with PEVs include the process of issuing permits for PEV charging units and managing the demand on the electricity grid, particularly at the local level.

This plan summarizes the EVCS permitting process, describes the roles of the various authorities involved in the approval process, describes the current practices in the Upstate Region, summarizes best practices from the experiences of other communities, and provides recommendations for streamlining EVCS permitting processes.

Purpose

The purpose of this report is to present a plan to streamline EVCS permitting, installation and inspection in the Upstate Region that is based on an assessment of current practices in the region and lessons learned from other communities.

Need

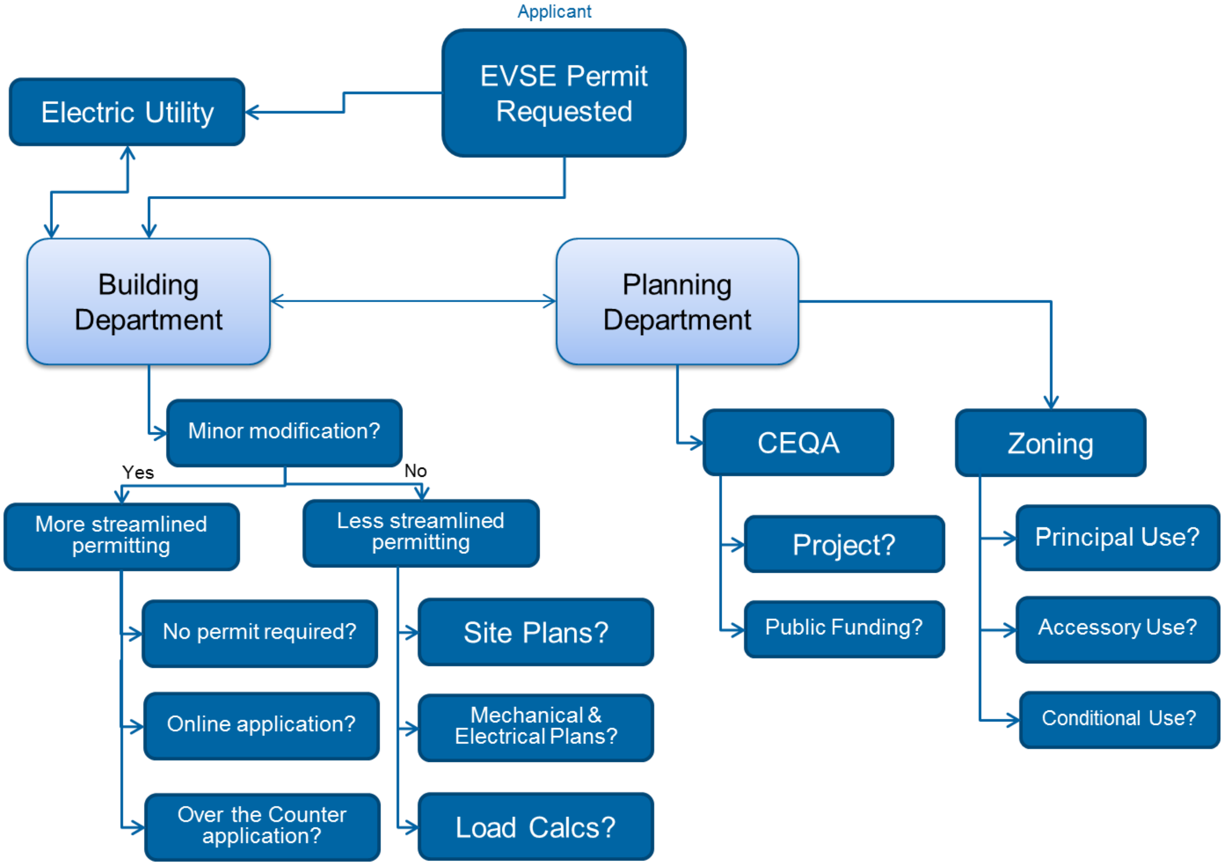
In recent years, modern, mass produced plug-in electric vehicles have entered the consumer marketplace. Federal and State governments have enacted policies that incentivize the production, sale, and use of these vehicles as part of a strategy to reduce greenhouse gas emissions from the transportation sector. Since PEV transportation and EVCS are relatively new to the mass market, local planning and building department staff are often unfamiliar with the technology, which can lead to delays and increased costs for permitting EVCS. These delays and increased costs can constitute a barrier to PEV adoption as potential PEV and EVCS owners could become discouraged by unnecessarily difficult permitting and installation processes and elect to stay with the internal combustion vehicle and fueling paradigm. To help meet Federal and State PEV adoption targets, it is important to streamline the ECVS installation process and reduce disincentives to consumers as much as is practical.

Scope of Work

The scope of work for this report is to review the status of EVCS permitting in the major jurisdictions within the Upstate Region, provide a summary of model EVCS permitting practices from communities outside the region, and develop a plan to streamline EVCS permitting in the

Upstate Region. The general process of EVCS permitting involves numerous steps illustrated in the flowchart Figure 17.

Figure 17 Flow Chart for EVSE Permitting and Planning Approval



Source: GHD, 2014

Description of General EVSE Permitting Process

As shown in Figure 17, the permitting process starts with the applicant notifying the building department and the electric utility (EU). Notifying the EU may be overlooked by the applicant because the building department will involve the EU as appropriate for the type of EVCS installation under consideration. The building department will guide the applicant through the process and determine to what extent the planning department needs to be involved in the process. Ideally, for simple installations, the permit may be issued over the counter without involvement of other entities. In practice, building department staff may have difficulty guiding consumers through the process because they are unfamiliar with the technology. The roles of the entities shown in Figure 17 are described in further detail below.

Electric Utility

The EU will become involved in the permitting process anytime there are modifications required upstream of a given customer's meter to support the EVCS and the EU needs to be informed when a customer's load changes significantly. This can occur when the addition of EVCS at a given facility triggers a need for a service upgrade to accommodate the increased load, or when a new service is requested at a specific location to support the installation of EVCS. In the former case, the EU may upgrade their electrical infrastructure as needed to support the expanded service requirements at no cost to the customer or cost share participation may be required. In the latter case, the EU will typically evaluate the request and estimate the potential revenue from the new load. If the potential revenue to the EU is high, the cost to the owner of the new load is low. If the potential revenue to the EU is low, the cost to the owner is higher. If the EU is involved in each EVCS installation, the building department will not close the permit until all the checks and inspections required by the EU have been completed.

Building Department

The building department is responsible for issuing a permit for the EVCS installation after verification that all applicable requirements have been met. For private commercial and residential installation of Level 1 and Level 2 EVCS, the character of the work is analogous to installing an additional electrical outlet. The primary purpose of the permitting process in this case to verify that the existing electrical service has the capacity to safely support additional load from the EVCS as per the National Electric Code and any local codes that are applicable.

For publicly accessible Level 2 EVCS additional considerations can arise such as land use zoning, environmental impacts of construction, encroachment on required dimensions for sidewalks and parking stalls, accessibility guidelines, and illumination requirements among others. For Level 3 EVCS, the EU is typically involved throughout the permitting process due to the intensity and character of the new electrical load.

As shown in Figure 17, the key differentiator is whether the EVCS can be considered a "minor modification" by the building department. If this is the case, then it becomes relatively easy to streamline the permitting process for the applicant. Examples of permitting processes in other communities where installation of EVCS is considered minor work are provided in a subsequent section below.

If a given EVCS installation involves an electrical service upgrade or significant site work, for example, then the building department may not consider the installation to be "minor work" and a more complex and costly permitting process could result. Site plans, electrical plans, load calculations and zoning reviews could be required to allow the building department to fully evaluate a permit application for certain installation. For residential load calculations, Article 220 of the California Electric Code is used to determine if the addition of the EVCS installation will result in an increase in service capacity for the host facility.

A summary of the electrical codes applicable to EVCS installations are shown in Table 10 below.

Table 10: Summary of Electrical Codes Applicable to EVCS Installations

CEC Section #	Summary of Requirements
625.13	Cords and plugs may not have exposed parts
625.24	Cords and plugs must be grounded
625.9	EV connectors shall not be interchangeable with other receptacles and shall have a grounding pole that connects first and disconnects last
625.15	EVSE[1] shall be marked "For use with Electric Vehicles"
625.23	If the EVSE is 60 A or larger and greater than 150 V to ground, then a disconnect must be installed within site of the EVSE and be capable of being locked in the open position.
625.30	EVSE connector shall be mounted at least 2 feet but not more than 4 feet above ground
625.17	EVSE cable shall not be longer than 25 feet unless equipped with a cable management system that is part of the listed EVSE

Source: GHD, 2014

A building department may request a mechanical plan as part of the permit application. Such a request would reflect a historic need to provide mechanical venting for interior spaces used for PEV charging when battery chemistries allowed venting of explosive gases during charging. Due to advances in battery technology, venting is very rarely required for interior spaces used for charging commercially available PEVs. In general, building department staff are aware that requiring mechanical venting plans is not applicable to modern EVCS installations.

Planning Department

The planning department will become involved in the EVCS permitting process upon request of the building department. This typically occurs when the proposed installation may cause environmental impacts or conflict with zoning ordinances.

CHTS

In California, the environmental review is conducted under the California Environmental Quality Act (CEQA) framework, and the first step is to determine whether the proposed installation is a "project." Jurisdictions often consider typical EVCS installations to be minor modifications and therefore not "projects" under CEQA, in which case no further environmental analysis is required. However, if public funding is being used for the installation, then the CEQA process must be followed regardless of whether the installation is considered a project.

The next step in the process is to determine whether the installation is exempt from further analysis under CEQA. A reviewer may consider a given installation a "project" under CEQA and then determine that it qualifies for one of several possible exemptions such as: The project is ministerial in nature, there is no possible significant effect from the project, or the project qualifies for either a statutory or categorical exemption. Commonly filed exemptions for EVCS are:

- 15301 (Class 1) for Existing Facilities
- 15303 (Class 3) for Small Structures
- 15304 (Class 4) for Minor Alterations to Land

If a given installation is considered a non-exempt project, then there is the potential for a significant environmental impact and a CEQA document is required. An initial study would be prepared to determine whether a mitigated negative declaration or an environmental impact report would be required.

Zoning

Zoning ordinances describe what types of uses are permissible on a given real property based on the community's general plan document. Zoning ordinances will list principal uses for each type of land use zone in the community. If the proposed use is not listed as a principal use, then, it may be considered an accessory use to a listed principally permitted use, or a conditional use permit would typically be required to allow the proposed use. As an alternative to the conditional use permit, the project proponent can request that the zoning type for the property in question be changed to a zoning type that includes the intended use among its principally permitted uses. Obtaining a conditional use permit is significantly less involved than re-zoning a property; however, both processes are lengthy and costly in most cases.

Since PEV transportation and EVCS are new to the mass market, electric vehicle charging is rarely listed as a principally permitted use in zoning ordinances. Common best practice is for EVCS to be considered an accessory or similar use to a variety of principally permitted uses, whenever possible. This is reasonable because any use that involves vehicle traffic through the site is supported by EVCS when vehicular traffic is comprised of both conventional vehicles and PEVs. EVCS support the principally permitted use by enabling PEV drivers to use the site. PEVs generally require longer "fueling" times at destination locations as opposed to the current gasoline station model for conventional vehicles. EVCS can be considered an accessory to the principally permitted use of the destination.

In the event where the sole purpose of a given property becomes PEV charging, for example a niche commercial facility catering specifically to charging needs of PEV drivers, a conditional use permit would likely be required since PEV charging is too new to be listed as a principally permitted use under any zoning classification.

General Plan Considerations

A community's general plan can play an important role in streamlining EVCS permitting processes. If the general plan includes policies to promote the adoption of PEVs then it is more likely that PEV charging will be listed as a principally permitted use across a wide range of zoning types. Also, the building and planning departments have a stronger foundation for making the permitting process as fast and inexpensive as possible.

Incidence of Language Supporting PEV Transportation in Local General Plans

A review of the general plans for the jurisdictions in the Upstate Region was conducted and the results are presented below.

Table 11: Electric Vehicle Inclusion in Local General Planning Documents

Jurisdiction	EVs or alternative fueled vehicles mentioned in General Plan?
Siskiyou County	Yes
Shasta County	Yes
Tehama County	Yes
City of Yreka	No
City of Weed	No
City of Mt. Shasta	No
City of Dunsmuir	No
City of Redding	Yes
City of Red Bluff	No
City of Corning	No

Source: GHD, 2014

As can be seen in Table 11, the general plans for four jurisdictions in in the Upstate Region contain mention of PEVs or alternative fueled vehicles. Table 12 through Table 15 provide summaries for these instances.

Table 12: Summary of Language Supporting PEVs from Siskiyou County Community Planning Documents

Section	Summary
Energy Element, pp 66	Efficiency Potentials, Transportation. Opportunity identified for increasing the efficiency of transportation fuel use and shifting to cost-effective alternative fuels.

Source: GHD, 2014

Table 13: Summary of Language Supporting PEVs from Shasta County Community Planning Documents

Section	Summary
Climate Action Plan	Reference to State Low Carbon Fuel Standard
Energy Section of General Plan	Role of Government: As a large consumer of energy, Government can use its own actions as models for energy conservation and planning. Through its actions local government may elect to act as a provider of incentives that encourage energy conservation. For example, conversion of an agency's vehicle fleet to alternative fuels could stimulate other firms to do the same.
Policy 6.4.4, E-j	The County should continue to implement plans to convert more of its vehicle fleet to hybrid or alternative fuels that meet or exceed air quality standards.

Source: GHD, 2014

Table 14: Summary of Language Supporting PEVs from Tehama County Community Planning Documents

Section	Summary
Air Quality Impact Mitigations	Promote Transportation Alternatives, Support Green Fuels, and Reduce GHG emissions from transportation. Consider model clean vehicle requirements.
Implementation Measure OS-2.6g	Support vehicle improvements and the use of clean vehicles that reduce emissions and improve air quality.
Implementation Measure OS-2.6h	Replace the County's fleet vehicles with new vehicles that utilize the lowest emission technology available, whenever economically feasible.

Source: GHD, 2014

Table 15: Summary of Language supporting PEVs from City of Redding Community Planning Documents

Section	Summary
Air Quality Element	While the electrical car has the greatest potential for addressing air quality issues, its omnipresence on the roads and public acceptance parallel to that of the combustion vehicle is probably many years away.
Policy 13	New Transportation Technology, Implementation Strategy: The city will monitor advancements in new technology regarding electric vehicles and cleaner burning combustion vehicles to ensure that future land-use and transportation systems can easily interface with technology when it is available and where reasonable. The city will pursue the development of Joint Venture projects involved in new technology.
Policy 15	The City should adopt a schedule to replace or convert conventional fuel vehicles with alternative fuel vehicles as rapidly as feasible based on available funds.
Section F. Level B measures, Item 4:	Convert fleet vehicles to clean-burning fuel as appropriate

Source: GHD, 2014

*This supporting language in local community planning documents is valuable for use in encourage policy development to streamline the EVCS permitting processes in these communities.

Current Practices for EVSE Permitting in the Upstate Region

Current EVCS permitting practices for jurisdictions in the Upstate Region were reviewed and the results are summarized in this section. None of the jurisdictions in the region have permitting processes specific to EVCS installations.

Siskiyou County, Yreka, Weed, Mt. Shasta, and Dunsmuir

Richard Kinsman, the Planning Director, was contacted to discuss EVCS permitting in Siskiyou County. Mr. Kinsman indicated that he was making a list of code revisions and that revisions for EVCS permitting could be included such as including them as a conditionally permitted use for some commercial zoning classifications. Currently EVCS would be allowed by right in the highway commercial zoning classification.

Mr. Kinsman also spoke with building official Mike Crawford, who related that he hadn’t had any applications for electrical service upgrades to accommodate in-home EV charging, though he also acknowledged that these types of minor service upgrades don’t typically result in permit requests. Mr. Crawford indicated that he hasn’t had any inquiries regarding commercial charging stations yet.

Mr. Crawford subsequently called the City of Yreka’s building official and a contract building official for the cities of Mount Shasta, Dunsmuir, and Weed and they reported that the only

EV-related permits they've issued were for the one Level 2 Tesla charging station in Yreka at the Comfort Inn and the four Tesla charging stations at the Tree House Inn in Mount Shasta. The contract building official also reported that there have been no permit requests for residential EV charging stations in Yreka, Mt. Shasta, Dunsmuir, and Weed.

Shasta County

Building Division Manager Dale Fletcher was contacted to discuss EVCS permitting in Shasta County. Mr. Fletcher indicated that no commercial permits have crossed his desk yet and he has completed "a couple of residential permits." Mr. Fletcher related that for typical EVCS installation the process would be "over the counter" with a plan review and the permit fee would be on the order of $200. The process would include a quick zone review where the parcel would be reviewed. Shasta county has a policy that requires a property to be brought up to code if are any code violations are noted during the permitting and inspection processes. Mr. Fletcher did not see any additional permitting requirements for Level 3 installations but noted that each permit application would be reviewed on a case-by-case basis.

Tehama County

Bob Halpin of the Tehama County Planning Department and John Stover, the Building Official for Tehama County were consulted regarding EVCS permitting processes in Tehama County. Neither Mr. Halpin nor Mr. Stover has had an EVCS permit application come to their attention.

City of Redding

Development Services Supervisor, Erich Mayne, was contacted regarding EVCS permitting in the City of Redding. Mr. Mayne indicated that to his knowledge his department had not processed any permit applications for EVCS. Mr. Mayne indicated that permitting a typical residential EVCS installation should be a routine over the counter process and that permit fees would depend on the cost of the project and would follow the department's fee schedule. Since the City of Redding has its own electric utility, Redding Electric Utility, there is some streamlining for EVCS built into the process. The EU will, by default, be involved in the permitting process and their input on a given permit application will under one jurisdiction rather than two. As for new measures to streamline the permitting process, some experience processing permits for EVCS within the department would be helpful in identifying potential opportunities.

City of Red Bluff

The City of Red Bluff Building Department was contacted, and staff recommended talking to Eduardo Griego (surname not provided), the counter technician. Mr. Griego related that the department had not had any commercial or residential EVCS permit applications to date. After a discussion regarding the technology, Mr. Griego related that it sounded like the permitting process for Level 2 EVCS would be routine. For Level 3 EVCS it may be more involved due the higher operating voltage. For both Level 2 and Level 3 EVCS Mr. Griego indicated that they would likely need to process a few permits before opportunities for streamlining could be discussed.

The City of Red Bluff Planning Department Director, Scot Timboe was contacted to discuss EVCS permitting from a planning perspective. Mr. Timboe indicated that he would likely handle the zoning review using a "similar use" finding unless the subject project involved exclusive use of a property for EV charging. Mr. Timboe indicated that the Community Development Director can make the decision to issue a similar use finding or, if an application is controversial, then they could put it on the Planning Commission's agenda, in which case the City Manager would also be consulted. Mr. Timboe stated that he did not see a reason to create a new regulation adding to the complexity of the process because, based on his understanding, EVCS are not radically different than other technology currently being permitted, and it would be more efficient to use the existing regulatory framework.

City of Corning

Efforts were made to contact Terry Hooford and John Stoufer of the City of Corning to discuss EVCS permitting from both planning and building department perspectives however no contact had been made at the time of this writing.

Best Practice Examples from Other Communities

There are several communities throughout the United States that have taken steps to streamline their EVCS permitting processes. This section presents several examples of such efforts beginning with examples where the installation of EVCS is considered minor work.

Minor Work Designation

The following two examples demonstrate cases where EVCS permitting was streamlined by categorizing certain installations as "minor work."

- In the state of New Jersey, the installation of residential EVCS is considered "minor work." The applicant is required to provide verbal notification to the code enforcement agency prior to commencing installation. Then a permit application must be filed within five days of the notification.
- The state of Oregon has expanded its "minor label" program to include EVCS installations. Licensed electricians can purchase a booklet of 10 minor installation labels for EVCS.
    - Certain design restrictions apply.
    - The cost is approximately 10 percent of the cost for a standard permit.
    - One tenth of the minor installations get inspected.

Online Permitting

Allowing permits for EVCS installations to be issued through an online process is a recent development that speeds up the process and reduces costs. The following examples demonstrate online permitting process being used in other communities.

- The city of Houston Texas offers online express permitting for EVCS installations. Online permits are issued automatically and instantaneously for standard EVCS installations and inspection typically occurs on the day of installation.
- The city of Los Angeles California offers online permitting for EVCS installations. Owners are allowed to start using their EVCS immediately upon installation and inspection typically occurs within 24 hours after installation.
- In San Francisco California, electricians that are registered with the building department can obtain permits for EVCS installation instantly online.
- In Charlotte North Carolina, there are two options for online EVCS permits: one for homeowners and one for contractors. The introduction of these processes has reduced the turnaround time for permits to between one and two days.

Over the Counter Permitting

Providing over-the-counter permits for EVCS installations is common practice in many communities across the United States. In this process, the applicant is typically walked through the permitting process by building department staff and the permit can be issued in about one hour. Inspections are then scheduled to coincide with the installation. The following examples demonstrate over the counter EVCS permitting processes used in other communities.

- Raleigh North Carolina applied its existing "stand alone" permitting process to EVCS permitting. The applicant is walked through the process at the counter and the process typically takes approximately one hour. Inspection can occur as early as the following day.
- The San Francisco building department issues same-day over the counter permits for residential EVCS
- The City of Irvine has developed an over-the-counter permit worksheet. The worksheet provides a streamlined permitting process for residential EVCS installations where the sub panel servicing the installation is rate at 100 A or more. The worksheet requires that the applicant have basic knowledge of the size of the electrical service panel, the nameplate rating of the EVCS they wish to install, the square footage of their home, and the number and type of lighting circuits and major appliances in their home.

Plan Check

In the case where some aspect of the EVCS installation causes the need for a more thorough review of the proposed work, a more involved process involving a plan check is typically required. This process will typically include the following requirements:

- Building permit application
- Site Plan
- Electrical Plan
- Load Calculations
- Inspection

The building permit application itself is like what would be filled out under the online and over the counter permitting scenarios however it will be less specific to EVCS installations. The site plan will show the property boundary, outlines of structures, locations of existing utilities, dimensions, and location of proposed EVCS and feeder circuit. The electrical plan will include a single line diagram, a panel schedule, load calculations, and a plan showing the circuit layout, conduit and wire size and type, and any details relevant to the installation. Depending on the requirements of a given building department, it may be required to have an appropriately licensed professional prepare the electrical plan for the EVCS installation

Examples of specific permitting processes for EVCS installations that have been specified by other jurisdictions are summarized below.

City of Sebastopol

The City of Sebastopol provides some guidance to the permitting process for installation of EVCS. The steps they suggest are:

- Determine level of service required (Level 1 or level 2 charging station)
- Evaluate existing electrical service, include load, and circuit size, and determine if upgrade is required

- Produce wiring plan
- Determine if second meter will be required
- Determine installation location
- Obtain Permit
- Perform installation
- Inspect installation
    - A copy of the manufacturer's installation guide is required on site for inspector.

City of Sacramento

The City of Sacramento has a guide to EVCS permitting. The following steps are provided by the streamline guide:

- Determine level of charging required
- Have an electrical contractor evaluate the load of the place of installation.
- Determine if a new meter or sub-meter will be required
    - Time-of-Use rates apply in the city based on Sacramento Municipal Utility District "Residential Time-of-Use Electric Vehicle rates. To receive these rates a separate meter or a sub-meter must be installed which requires a building permit
- Submit application, fees and required documents to the City Permit Center
    - Required documents include load check/evaluation, electrical plans (wiring), specifications of EVCS to be installed, and mechanical plans (if required for ventilation)
- Obtain building permit
- Complete installation
- Schedule and complete installation inspection
- Connect to existing utility

City of San Diego

The City of San Diego issued an Information Bulletin providing guidance to how to obtain proper permitting for EVCS. The city also provides a general idea of the cost of the permitting and inspection process in the bulletin. The process they suggest is:

- Complete general application
- Gather necessary documents and plans
    - Site plan, floor plan, electrical plan and load calculations are required
    - If in publicly accessible area, disabled accessibility plans are required
- Obtain electrical/building permit(s)
- Install EVCS
- Complete inspection

Atlanta Permitting Process

The City of Atlanta has a permitting process in place for installation of EVCS. The city does not require a permit for the standard Level 1 charging station, as the standard 120-volt outlet will not require modifications to the electrical system. Level 2 charging stations that require wiring to the electrical system require a permit for installation, and the following steps have been outlined to streamline the permitting process.

- Select licensed electrical contractor to make installation
- The party fills out "Atlanta's Electrical Permit Form" along with the contractor
- Contractor submits the completed from and fees to the Office of Buildings
- Applications will then be reviewed, and permits issued
- Electrical contractor can then perform the installation
- Installation is inspected by the Office of Buildings
    - Failed inspections can be re-inspected at a fee of $50, for up to three times.

Recommendations for Streamlining EVSE Permitting in the Upstate Region

The follow actions are recommended to streamline the EVCS Permitting process in the Upstate Region:

- Include policies to encourage PEV transportation in community planning documents as part of document update cycles
- List PEV charging as a permitted use across a broad range of zoning classifications
- If a zoning review is triggered, consider the EVCS as an accessory or similar use to another permitted use whenever possible
- Develop a standard EVCS permitting process that can be used across the Upstate Region for typical residential installations that meet the following criteria:
    - EVCS is not accessible to the public
    - EVCS is located within 25 feet of main electrical panel
    - Results of load calculation worksheet indicates that the existing main electrical panel for the building is adequate
    - Advertise the standardized process for residential permits at car dealerships, building department counters and websites
    - Allow the standardized process to be completed using an over-the-counter permitting approach
- Establish a permit fee structure specifically for EVCS installations making fees as low as possible for each jurisdiction
- Allow second meters for EVCS to enable PEV driver access to lower rates for PEV charging provided by utilities

Note that implementing an online permitting process for EVCS installations does not appear to be a practical goal in the Upstate Region because online permitting is not currently used in the region and establishing such a system solely for EVCS permitting is not warranted.

Recommended EVCS Permitting and Installation Guide

The following brief guide summarizes the recommended steps for installing EVCS in residential, multifamily, and publicly accessible commercial settings.

Residential Installations

- Determine specifics of vehicle charging requirements from manufacturer of your specific vehicle
- Check with Electric Utility regarding rate schedules, metering, and electrical service requirements
- Check with your building department to:
    - Determine what the permitting requirements for your EVCS installation
    - Determine whether a second electricity meter is allowed for your vehicle
- Decide where you want to place your EVCS at your residence
    - If you decide on an outdoor location, make sure that you select an EVCS that is rated for outdoor service
- Determine whether your home's existing electrical service is adequate to supply the selected EVCS
    - EVCS are considered continuous duty loads so circuit breaker must be rated for 125 percent of nameplate rating on EVCS
- Select an electrical contractor if required or desired
    - Check to make sure their license for electrical work is current
- Develop installation plans if required by building department for your installation
    - Site plan, electrical plan with single line diagram and panel schedule, and specification sheet for your EVCS are typically required
- Apply for building permit
- Order EVCS and any additional required materials
- Install EVCS
- Notify building department that you are ready for an inspection
    - Make any required changes because of the inspection
    - Building department will notify electric utility when the installation has passed inspection

Multifamily Residential Installations

There are additional considerations for EVCS installations at multifamily unit (MFU) dwellings. If the owner of the MFU decides to install the EVCS as part of the infrastructure offered to tenants, then the process above can be followed. While the property owner will not know the specifics of the types of vehicles that will be use the EVCS, the connections between today's commercially available PEVs and EVCS are standardized to allow interoperability.

If a tenant living in the MFU wishes to install EVCS to support a PEV they have purchased or intend to purchase, then they must obtain permission of the owner of the facility. If the owner will not finance the installation and the tenant obtains approval and proceeds with the installation, then the tenant will need to accept that when they move away from the MFU, the electrical circuit installed to support the EVCS will remain the property of the owner. Level 1 chargers are most applicable in this situation since they are inexpensive to install and can be used for other purposes besides PEV charging.

Publicly Accessible Installations

Commercial businesses, municipalities, and institutions may desire to install publicly accessible charging stations to increase patronage or as a public service. These types of installations follow a similar process as described above for residential EVCS. However, the following additional considerations are likely to apply:

- Determine whether you want to the PEV drivers using the station to pay for use or not.
  - If yes, then select EVCS that has pay by credit card capability
  - If no, then any EVCS can be used
- Determine whether to install Level 2 or Level 3 chargers
- Determine where in parking lot to install the EVCS accounting for accessibility guidelines as published by the OPR
  - The first of 25 publicly accessible EVCS installed in each parking lot should be designed for accessibility, including a parking space and access aisle with specific dimensions
- Develop site plan with civil engineer, contractor, or other appropriately licensed entity
  - Include way finding signage at ingress to parking lot
- Develop electrical plan with electrical engineer, electrical contractor, or other appropriately licensed entity
  - EVCS are considered continuous duty loads so circuit breaker must be rated for 125 percent of nameplate rating on EVCS.
- Apply for permit
- Make any changes to plans required upon review of permit application by building department
- Obtain permit
- Construct project

Plan for PEV Adoption in Fleets and Other Incentives

PEV Adoption in Fleets

In today's alternative energy market, there are several opportunities available to the fleet decision maker to reduce carbon and energy consumption. These include technologies such as biofuel, gaseous fuels, liquefied fuels, improvements to internal combustion engines and hybridization, as well as more fundamental improvements to fleet processes. Specifically, the adoption of plug-in electric vehicles by fleets is one opportunity that will not only offer organizations many benefits under the right circumstances but will also prove to be a critical catalyst in reaching Governor Brown's goal of having 1.5 million electric vehicles on the road by 2025.

Revenue growth, reduced energy spends, increased market share and improved corporate reputation are all benefits that can be brought about by putting in place strategies to minimize energy consumption and carbon emissions.

In the right circumstances electric vehicles can offer multiple benefits for an organization. These range from financial, operational, and environmental benefits, and include:

- Whole life cost savings
- Reduction in air pollution and carbon emissions
- A smoother, quieter, and more pleasant driving experience

Through detailed analysis, it is possible to identify the benefits that electric vehicles can bring to a vehicle fleet. The scale of these opportunities will increase as the number and variety of car and commercial vehicle models escalate over time.

With the intention of increasing awareness of EV opportunities, options, and benefits among fleet decision makers as well as helping guide them through fleet specific considerations (such as whole life cost modeling) that are necessary to successfully introduce EV's in their fleets, the project team executed the following activities:

- Identified fleets in the Upstate region
- Compiled resources for fleet decision makers
- Developed a methodology and spreadsheet tool for evaluating EV fleet opportunities
- Contacted local fleet decision makers
- Conducted fleet evaluations for the City of Mt. Shasta and the City of Redding
- Prepared a plan to accelerate EV adoption in fleets

The project team worked closely with fleet managers to assess PEV opportunities within their fleets, taking into consideration fleet vehicle types, duty cycles, procurement schedules, life-cycle operational costs, and local-government environmental targets, such as climate action plans, that can be addressed through PEV adoption. The project team coordinated with vehicle and EVSE manufacturers and vendors to provide fleet decision makers with detailed information on the range of equipment options available to meet stakeholders' specific fleet needs. Using this information, the project team assisted fleet managers in developing and implementing individualized procurement strategies and timelines to acquire and integrate PEVs and install supporting EVSE.

Fleets in the Region

A list of public and private fleet operators in the region was compiled. Below are the fleet categories that were identified.

- Local Government
- Siskiyou County
- Shasta County
- Tehama County
- Anderson
- Corning
- Dorris
- Dunsmuir
- Etna
- Fort Jones
- Montague

- Mount Shasta
- Red Bluff
- Redding
- Shasta Lake
- Tulelake
- Weed
- Yreka

State Agencies

- California Department of Fish and Wildlife
- California Highway Patrol
- California Department of Social Services
- California Department of Rehabilitation
- California Department of Motor Vehicles
- Department of Water Resources
- State Water Resources Control Board

Federal Agencies

- The U.S. Forest Service
- Bureau of Land Management
- U.S. Fish and Wildlife Service
- U.S. Department of Agriculture - Natural Resources Conservation Service
- U.S. Postal Service
- The U.S. Social Security Administration
- National Park Service (Lassen National Park and Whiskeytown National Recreation Area)

Upstate Tribes

- Karuk Tribe
- Pit River Tribe
- Quartz Valley Indian Reservation
- Redding Rancheria

Schools/Colleges

- College of the Siskiyou's
- Institute of Technology
- Lake College
- National University
- Shasta Bible College
- Shasta College
- Simpson College

- University of California Cooperative Extension

Private Fleets

- Delivery services (Federal Express, United Parcel Service)
- Building contractors (general, electrical, HVAC, plumbing, security systems)
- Professional services (engineering, land surveyors, home health care)
- Rental car companies (Avis, Budget, Dollar, Enterprise, Hertz)
- Retail delivery/distribution (florists, bakeries, catering, auto parts)
- Retail repair services (appliance repair, office equipment repair)
- Taxicabs (ABC Cab Company)
- Telecommunications (Charter Communications, Sisqtel)

Resources for Fleet Managers

Below is a listing of resources and tools that offer important information to fleet operators who are considering adopting PEVs for their fleets. Information provided includes general information sources, listings of available PEVs, cost and environmental footprint calculators, EV charging station maps/locators, information on incentives (for example, tax credits and rebates), and resources for developing green fleet policies.

General Information Sources to Support PEV Adoption in Fleets

- Plug-in Electric Vehicle Handbook for Fleet Managers, USDOE/Clean Cities
- Alternative Fuels Data Center, USDOE (http://www.afdc.energy.gov/)
- Plug-In Electric Vehicle Resource Center, California Air Resources Board (http://www.driveclean.ca.gov/pev)
- California Governor's Office of Planning and Research, Zero-Emission Vehicles web page (https://opr.ca.gov/planning/transportation/zev.html)
- Institute for Local Government Greening Agency Fleets Resource Center (https://www.ca-ilg.org/overview/greening-agency-fleets-resource-center)
- Listings and Information for Currently Available PEVs
- Clean Cities 2014 Buyer's Guide (http://www.afdc.energy.gov/uploads/publication/60448.pdf)
- Clean Cities Guide to Alternative Fuel and Advanced Medium- and Heavy-Duty Vehicles (http://www.afdc.energy.gov/uploads/publication/medium_heavy_duty_guide.pdf)
- Light-Duty and Heavy-Duty Alternative Fuel Vehicle Search (http://www.afdc.energy.gov/vehicles/search/)
- Find and Compare Cars on U.S.EPA Webpage (http://fueleconomy.gov/feg/findacar.shtml)
- DriveClean Buying Guide for Clean and Efficient Vehicles, California Air Resources Board (http://www.driveclean.ca.gov/)
- California Air Resources Board Clean Vehicle Rebate Project (https://energycenter.org/clean-vehicle-rebate-project)
- Plug-in Cars Map on Plug Share Webpage (http://www.plugincars.com/cars)

- Fleet Cost and Environmental Footprint Calculators
- Vehicle Cost Calculator (http://www.afdc.energy.gov/calc/)
- Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Fleet Footprint Calculator (https://greet.es.anl.gov/tools)
- Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool (https://greet.es.anl.gov/afleet)
- Petroleum Reduction Planning Tool (http://www.afdc.energy.gov/prep/)

EV Charging Station Maps/Locators

- Alternative Fueling Station Locator, USDOE (http://www.afdc.energy.gov/locator/stations/)
- PlugShare (http://www.plugshare.com/)
- Charge Point Stations (https://na.chargepoint.com/charge_point)

PEV Incentives (rebates, tax credits, grants)

Federal Tax Credits for PEVs

Federal tax credits of up to $7,500 per vehicle, depending on battery capacity, have been available for the last few years for eligible PEVs (see Internal Revenue Service Form 8936). The credit must be used in the year it is claimed and cannot be carried over to subsequent tax years. The credits will be phased out as sales increase. Specifically, credits will be phased out as each manufacture reaches 200,000 in eligible PEV sales. Through 2012 the largest cumulative PEV sales in the US is for the Chevrolet Volt, totaling about 31,000 vehicles in 2011-2012. For further information see Tax Incentives on the Fuel Economy Webpage (https://www.fueleconomy.gov/feg/taxcenter.shtml).

State PEV Rebates

The Clean Vehicle Rebate Project offers vehicle rebates ranging from $1500 to $2500, depending on the all-electric range of the PEV. Funding for this program is expected to last through 2015, though rebate levels may drop with time. Over the last two years nearly 17,000 rebates have been awarded totaling about $39 million. For more information see California Clean Vehicle Rebate Project Webpage (http://energycenter.org/clean-vehicle-rebate-project).

Another state program, the Hybrid and Zero Emission Truck and Bus Voucher Incentive Project, offers vouchers ranging from about $8,000 to $45,000 per eligible vehicle. These vouchers are geared toward fleet vehicle operators and amounts vary depending on the type of truck (hybrid versus zero emission) and the gross weight of the vehicle (heavier vehicles getting larger vouchers). Recent funding levels have been $18 to $19 million annually, and funds are expected to continue through 2015 or 2016. For more information see California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (http://www.californiahvip.org).

State Grants for Electric Vehicle Charging Stations

The California Energy Commission, under their Alternative and Renewable Fuel and Vehicle Technology Program, is offering grants to support the installation of electric vehicle charging stations. Each year an investment plan is adopted, and over the last three years approximately $7 million per year (out of $90 to $100 million total) has been allocated for this purpose. Note that this program funded the Upstate Plug-In Electric Vehicle Project. Funding for this program is expected to continue through 2016. For more information see California Energy Commission Webpage (http://www.energy.ca.gov).

Department of General Services Master Vehicle Contracts

The California Department of General Services maintains master contracts for vehicles that local agencies can use to purchase fuel efficient and alternative fuel vehicles at lower prices than may be available otherwise. The California Department of General Services awards master vehicle contracts to individual dealerships for specific models of vehicles within a general class of vehicles, such as hybrid sedans. Local agencies can order vehicles directly from selected dealerships under the California Department of General Services master vehicle contracts. The California Department of General Services website contains all the information necessary for local agencies to find vehicles and dealerships that are included in the contracts. Information about using the California Department of General Services website to purchase vehicles can be found at the link below. California Department of General Services Informational Document (https://www.ca-ilg.org/sites/main/files/file-attachments/resources__Using_DGS_Master_Vehicle_Contracts_FINAL_0.pdf).

Resources for Developing Green Fleet Policies

- Model ordinance for local governments regarding the adoption of zero emission vehicles and the greening of municipal fleets, California Governor's Office of Planning and Research can be found in the Zero- Emission Vehicles in California Community Readiness Guidebook (https://www.opr.ca.gov/docs/ZEV_Guidebook.pdf)
- Green Fleet Case Studies for California Local Government Fleets (http://www.ca-ilg.org/post/greening-agency-fleets-community-stories-and-snapshots)
- Information for Evaluating Green Fleet Options for California Local Government (http://www.ca-ilg.org/post/information-help-evaluate-green-fleet-options)

Fleet Evaluation Tool

A fleet vehicle assessment requires identification of vehicles that might be suitable for replacement with a PEV. For those vehicles that are deemed potentially suitable, an economic analysis can be performed to evaluate the cost-effectiveness of switching to a PEV. In addition, the GHG emission impacts can also be assessed. PEV adoption will typically result in reduced GHG emissions and can thereby help a municipality or other organization meet its GHG reduction goals.

Fleet electrification will also require the installation of electric vehicle charging equipment, also known as EVSE. The capabilities and capacities of various EVSE units should be researched and considered. Level 2 chargers will typically be suitable for charging vehicles overnight, whereas Level 3 fast chargers can be used for quick charging (for example, 20 minutes), though at a much greater cost. Also, some EVSE units can charge multiple vehicles at one time. Based on the number of electric vehicles and their charging needs, an assessment of required EVSE must be made.

To conduct a PEV fleet vehicle assessment a set of information must be compiled to characterize the existing fleet vehicles as well as the potential PEV replacements. Information required for the existing, conventional fleet vehicles is listed below.

- Average and maximum miles traveled per day

- Average annual mileage
- Percent city driving
- Annual maintenance costs
- Characteristics of the likely conventional replacement vehicle (purchase cost, fuel economy)
- Cost of fuel

For potential PEV replacement vehicles, the following information is necessary:

- PEV characteristics (range in miles per full charge, efficiency in miles per kWh)
- PEV purchase cost and expected PEV maintenance costs
- PEV incentives (applicable rebates, tax credits, and so forth)
- Estimated installed cost of electric vehicle charging equipment
- Cost of electricity (including time of use aspects and demand charges)

To facilitate the evaluation of PEV adoptions for fleet applications the Plug-In Electric Vehicle Fleet Evaluation Tool (FleET) was developed. An Excel spreadsheet-based tool, PEV FleET is intended to be used by fleet operators or others who desire to perform fleet evaluations. Users are prompted to input necessary data and then choose the vehicles they want to evaluate. Outputs from the tool include:

- Incremental initial cost
- Simple payback
- Discounted payback
- Internal rate of return
- Net present value (over a 10-year life cycle)
- Avoided downstream tons of CO2 per year

This tool can be used to calculate the costs and benefits in a vehicle fleet when replacing conventional ICE vehicles with plug-in electric vehicles (PEVs). PEVs can include both BEVs and/or PHEVs. Note that the PEV FleET model assumes vehicles are being replaced at the end of their useful lives. Therefore, comparisons are between a new conventional ICE replacement vehicle and a new PEV. Costs and specifications (like fuel economy) are based on the new vehicles. Annual mileage figures, however, should typically be based on the usage characteristics of the old vehicle being replaced.

Features of the PEV FleET model are:

- Includes compiled information on currently available PEVs, including cost, range, fuel economy, tax credits and California state rebates
- Includes compiled information on a sampling of available EVSE, including cost, input power, and associated annual fees
- Includes compiled information on typical EVSE installation costs
- Includes compiled information on utility electric rates for commercial customers, including Pacific Gas and Electric, Redding Electric and Pacific Power and Light
- Allows individual and aggregate PEV assessment for fleet applications

- Allows evaluation of individual vehicles or a fleet of vehicles
- Allows inclusion or exclusion of the cost of electric vehicle charging infrastructure
- Allows use of State-negotiated fleet vehicle rates where applicable

Fleet Assessments

Outreach to fleet managers included communications with local municipalities. Two municipalities, the Cities of Mount Shasta and Redding, expressed interest in participating in fleet evaluations. The project team worked with city staff from these two jurisdictions to conduct an evaluation of their fleets and assess opportunities for PEV deployment (see below). Information about PEVs and access to the PEV FleET tool was also available to other local municipalities upon request.

Important Criteria for Fleet Evaluations

The PEV market is in its early stages of development. Currently there are only about 25 light-duty PEVs available, and they are primarily passenger sedans, coupes, and hatchbacks. There is one small sport utility battery electric vehicle, the Toyota RAV4. There is also one manufacturer who is offering a PHEV range-extender in a full-size truck, van, or sport utility vehicle format. These vehicles are supposed to be available in the 2014/2015 timeframe.

Because of this limited menu of offerings and because battery all-electric vehicles have limited range, it is important to make sure that available PEVs can meet the requirements of the application being considered. In addition, the initial cost of PEVs is often greater than comparable conventional counterparts, but they can pay for themselves over time because they operating costs are substantially lower. Key pre-screening criteria that should be considered before conducting a full economic analysis include:

- The required vehicle range (miles driven per trip) is compatible with PEV characteristics. Battery all-electric vehicles typically have a 60-100 mile range on a full charge. Plug-in hybrid electric vehicles typically have a 10-40 mile all-electric range, but can be driven longer distances (for example, >300 miles) using the gasoline-powered drive train.
- PEVs can meet the needs of the application. Currently PEVs are primarily available as light duty passenger vehicles. Passenger and cargo capacities should be evaluated to make sure they are appropriate. Hatchback models with fold-down rear seats can offer added utility and cargo hauling opportunities.
- The vehicle being considered is to be replaced in the next couple of years.
- The vehicle being considered has relatively high annual miles driven. Annual miles driven have a big effect on economic payback. In general, more miles that are driven results in a quicker payback.

Evaluation of PEV Opportunities in Local Fleets

The PEV FleET was used to evaluate opportunities for PEV adoption in two municipal fleets in the cities of Mount Shasta and Redding. In both cases, the project team worked with city staff to identify vehicle applications that were most likely to be suitable for PEV adoption. City staff provided required input data for the model. PEV adoption opportunities were first evaluated for specific vehicles on a one-for-one replacement basis without the inclusion of EVSE costs. Numerous PEVs were evaluated for each application and simple paybacks were evaluated. A combined fleet analysis was then performed where multiple PEV adoptions were considered along with the purchase and installation of EVSE infrastructure. Finally, a sensitivity analysis was conducted to assess the impact to the model results caused by changes in various input parameters.

In both cases model results showed there were multiple cost-effective opportunities for adoption of PEVs.

Lessons Learned

The following are some key lessons learned while working to promote the adoption of PEVs in Upstate region municipal vehicle fleets.

- There is a mixed level of interest from fleet managers. Some may be very interested in PEV opportunities, while others may have little to no interest.
- Fleet managers have limited time available to assess fleet opportunities for PEVs. They must see value in the effort, such as the potential to reduce fleet operating costs. They may be averse to taking risks with new technologies that are not fully proven and that may not meet their needs.
- While we attempted to develop a user-friendly spreadsheet tool for evaluating PEVs in a vehicle fleet, the likelihood that a fleet operator will have the time and resources required to utilize the PEV FleET tool is probably rather low. It is more likely they would need the assistance of an outside analyst to help them utilize the tool.
- There are limited options in terms of PEV range and size, and very limited PEV options for heavy-duty vehicles like trucks and vans. These limitations limit adoption opportunities.
- There is a need for light duty plug-in electric trucks and vans.
- Fleets that have already adopted fuel-efficient vehicles may find it more difficult to identify cost-effective opportunities for PEVs.
- Fleet operators may have a desire to consider all alternative fuel vehicle fleet options, not just PEVs.
- Some municipal fleet vehicles have low annual miles driven – this lengthens payback times for PEVs and can make it hard to meet cost effectiveness criteria.
- The higher initial cost of PEVs and the high cost of EVSE can be barriers.
- Parking enforcement can be a good niche application for a PEV, though there are limited offerings regarding plug-in electric parking enforcement vehicles.
- It is important to pre-screen fleet vehicles to make sure that available PEVs can meet the requirements of the application being considered. There is no point spending time and resources evaluating PEVs for an unsuitable application.
- To conduct a reliable evaluation, it is important to have access to accurate vehicle travel data, such as maximum trip length, average trip length, annual mileage, and annual maintenance costs. This information may not always be readily available.
- For PHEVs, it is important to be able to estimate how many miles will be driven in all-electric mode for a given application. This can be difficult to accurately estimate and may significantly impact the economic analysis. The possibility of collecting travel data for fleet vehicles using cell phone data, GPS data, or other tracking devices can be very valuable in enabling an accurate fleet assessment.

- There is minimal information available on the likely maintenance costs associated with PEVs. One source estimate that PEV maintenance costs will be only half as much as their conventional ICE vehicle counterparts. This annual maintenance cost savings can have a very significant impact on the cost effectiveness of PEV adoption. More reliable information is needed on this topic.
- Electricity demand charges can have a negative impact on the cost-effective adoption of PEVs into fleets, especially where demand charges are high. This issue should be discussed with the local electric utility and strategies should be explored for mitigating excessive demand charges. One option may be to place the EVSE on a separate, non-demand metered electric account.

Plan to Accelerate PEV Adoption in Fleets

The Siskiyou County Economic Development Council has administered the Upstate Plug-in Electric Vehicle Readiness Project, and many other governmental and non-governmental entities in the region have participated in the project, either through participation on the Upstate PEVCC or by attending project meetings. Below is a list of actions that these entities can take to help promote PEV adoption in fleets in the Upstate region:

- Make presentations to elected officials and city staff
- Provide the "Upstate Plan to Accelerate PEV Adoption in Fleets" to fleet operators
- Share the wealth of information and resources that have been assembled as a part of the Upstate Plug-in Electric Vehicle Readiness Project
- Make the PEV FleET tool available to fleet operators
- Offer guidance and assistance to fleet operators in evaluating green fleet options
- Encourage municipalities to adopt green fleet policies
- Encourage municipalities to include green fleet activities in their climate action plans
- Encourage local businesses to adopt green fleet policies
- Publicize and promote local green fleet activities
- Document and share successful local case studies where PEVs have been introduced into local vehicle fleets

Municipal Activities and Incentives to Promote PEVs

The project assessed potential policies to encourage and incentivize broader community-wide adoption of PEVs. The economic, convenience, and status-based incentives include preferential or reduced-cost parking in pay parking areas, extended on-street parking time limits, free work-place charging, and special PEV utility rates available using second meters.

PEV Education and Outreach Activities

Media-Based Outreach

The Upstate team worked to keep partners, stakeholders, and interested community members engaged and involved in the progress of the PEV readiness project by utilizing outreach methods including social media, printed collateral, document sharing, and website.

Website: The SCEDC created a page on their website that provides information on PEV's in California and information on the Upstate PEV readiness, information about the PEVCC (including meeting minutes), a list of information resources related to PEVs, and links to charging station locators. Also included on the page are links to project reports and outcomes, as well as updates about current project related events (presentations, PEV ride and drive event, and so forth). The webpage can be accessed at: Plug-In Electric Vehicles Program on Siskiyou Economic Development Webpage (https://www.siskiyoucounty.org/plugin-electric-vehicles-program?rq=pev)

Document and Presentation Share: The Upstate team regularly made video presentations available to view for interested parties who were not able to view a presentation in person. These links were provided through email communications and on our website. Upstate Plug-in Electric Vehicle Coordinating Council meeting summary http://vimeo.com/86343047

Social Media: Facebook and Twitter – the SCEDC regularly updates these two social media outlets with brief points of interest on projects, including PEV's. Throughout the life of the project, these outlets were updated with PEV information as needed. Siskiyou EDC Facebook Page https://www.facebook.com/SiskiyouEDC and Siskiyou EDC Twitter Account https://twitter.com/siskiyouedc

Outreach Events

Outreach events were a key component to the Upstate Outreach and Education Plan. Throughout the life of the project, the Upstate team conducted numerous outreach events including presentations to local community groups, tabling at community events, participation in PEV conferences, and the coordination of one informational event, including the showcasing of seven different PEVs and Hybrid PEVs from a local car dealership, Redding Crown Motors.

- Yreka Rest-stop on the Mexico to Canada, BC2BC by EV rally on July 2, 2013 – Yreka, CA
- EV 101: The Future is Now! Planning the Electric Vehicle Charging Network in Northern California – Redding, CA
- Zero Emission Vehicle conference – Sacramento, CA
- Electric Vehicle Road Map 7 conference – Portland, OR

Education and Outreach Plan

The goal of this plan is to provide information on Plug in Electric Vehicles to various sectors of Siskiyou, Shasta, and Tehama Counties through a diverse approach to education and outreach. A summary of the education and outreach plan is outlined below. The audience for a multi-media outreach approach includes:

- Emergency and First Responders
- Community Leadership and Local Government
  - County Boards of Supervisors, City Councils, and other elected and appointed bodies.
- Community Services
  - Formalized groups which include Rotary, Elks, Kiwanis, and so forth.
- Public Fleet Operators

- Private Fleet Operators
- Consumers
  - Buyers/Potential Buyers
  - All others

Many of the communities within the Upstate planning region are actively involved with their local governments. This plan will utilize that activism to try reaching several of the identified groups initially through this forum.

The Outreach Methods

- Direct Presentations
  - PowerPoint when available and in speech format when unavailable.
- Radio Ads
  - Short ads describing the planning process and notifying of ways to engage
- Print Material
  - Flyers for distribution at meetings and other community events
- Web-Based
  - Website with routinely updated project information and method to receive additional information.

The Plan

- Create Materials
  - Create Website
  - Create Print Material
  - Write and Record Radio Ads
  - Create Presentation
- Develop List of All Community Leadership Groups
- Develop List of All Community Service Groups
- Develop List of All Public Fleets
- Develop List of All Private Fleets
- Develop a List of All Emergency Responders
- Develop List of All Local Media Outlets
- Scheduling
  - Schedule Meetings for all Leadership and Service groups
  - Schedule meetings with public and private entities

Sharing Project Results

The following is a list of locations and organizations with which the project results and progress were shared:

- EV101 Workshop – Redding, California

- Zero Emission Vehicle Conference– Sacramento, California
- North State Super Region Partnership, meeting presentation – April 30, 2014 - Weaverville, California
- Electric Vehicle Road Map 7 Conference – Portland, Oregon
- Local Transportation Commission – Yreka, Siskiyou County, California
- Board of Supervisors – Red Bluff, Tehama County, California
- Transportation Department and Air Pollution Control – Red Bluff, Tehama County, California
- Shasta Regional Transportation Agency – Shasta Lake, Shasta County, California
- Distributed Video Presentation of Upstate PEV Plan
- Weed Rotary Meeting – Weed, California
- Yreka Rotary, meeting presentation – Yreka, California
- Mt. Shasta Rotary, meeting presentation – Mt. Shasta, California

CHAPTER 3: Conclusions and Recommendations

Assessment of Project Success

The Upstate Plug-in Vehicle Readiness Project team, including the PEVCC, is very excited by the positive outcome of our project goals. Efforts to promote PEV adoption and develop an infrastructure plan have been successful. This project demonstrated that three counties and a coalition of private and public organizations in the Upstate region can work collaboratively to meet large goals, adopt a plan, and coordinate across disciplines. Further, with the completion of the PEV Readiness Plan, the Upstate region is now prepared to engage future funding support for implementation and infrastructure deployment.

- To evaluate the success of the Upstate PEV Readiness Project we have used the project's metrics section from Chapter 1 as a prompt for discussion of the results in the bullets below:
- The Upstate PEVCC was successful in gaining adequate representation and participation of stakeholders in the three different counties, Tehama, Shasta, and Siskiyou, that formed the Upstate region. Further, the Upstate PEVCC also had adequate representation from impacted sectors including electricity producers, local elected officials, non-profits, air quality management boards, and transportation boards. Progress of the PEVCC contributions were successfully recorded through meeting minutes, feedback from workgroups, and communication updates.
- The Infrastructure Deployment Plan accomplished much more than was intended. The objective methodology of the plan helped unify the PEVCC and promoted engagement in our goals of outreach and education. The Infrastructure Deployment Plan was comprised of two elements, namely macro-siting, and micro-siting. The macro-siting approach employed an agent-based model to assess the need for EV charging stations throughout the region. The model utilized existing travel demand and travel survey data to simulate PEV driver behavior. The micro-siting process utilized a decision matrix to evaluate candidate EV parking spaces with a scoring rubric. More specifically, candidate EV charging locations were scored by weighting objectives of the California Energy Commission, the PEVCC, the outreach experience from the North Coast PEV readiness project, and the engineering contracting firm GHD. Scoring objectives primarily included aspects like public access, infrastructure cost, and ownership options that met requirements for future California Energy Commission Infrastructure funding opportunities.
- Permitting requirements for installing EVSE were assessed with the help of local building and planning officials in Upstate region communities. In addition, a workshop was put on in Redding, California during March 2014 to help educate local building and planning officials on example application, inspection, and permitting methods that have been successful in other areas. A plan was developed to streamline those requirements and follow the feedback from the assessment and outreach events that should improve future EVSE installation processes in the Upstate region.

- The municipal vehicle fleets in the cities of Redding and Mt. Shasta were successfully evaluated for plug-in electric vehicle adoption feasibility. Based on these evaluations, a plan to accelerate plug-in electric vehicle adoption was created for regional vehicle fleets. Several public and private vehicle fleets were contacted and given plug-in electric vehicle adoption information and the feedback from fleet managers was positive.
- An educational outreach plan to improve plug-in electric vehicle adoption in Upstate communities was achieved and a campaign was developed. A wide variety of stakeholders received information on the Governor's ZEV commitments and the benefits of PEVs in Upstate California through a spectrum of media outlets including digital, print, and in-person speaking engagements. Examples of these stakeholders ranged from high level Local Transportation Commissions and County Supervisors to interested Rotary members and the public at events.

Conclusions and Lessons Learned

The Upstate Plug-in Vehicle Readiness Project was a tremendous learning experience for stakeholders in our region and generally resulted in a positive project outcome. The original goals and aims of the project were achieved, and the planning documents that were produced will be a tremendous asset to future PEV infrastructure deployment and utilization. The communities representing the Upstate region have been open to PEV planning and most stakeholders that participated in this PEV readiness effort have been very supportive.

The following is a list of the primary lessons that were learned from this exercise in PEV readiness planning:

- Outreach and engagement of key stakeholders is critical to overall program success for the region.
- Overall, relatively few chargers are needed to support many PEV drivers in the region. Approximately 120 chargers were sufficient to support around 5,000 drivers in the 2 percent penetration scenario. The total estimated cost to install these chargers is $4.2M, which is an investment of $850 per driver, a value commensurate with incentives already in place at the state and federal levels for subsidizing vehicle purchases.
- Both Level 2 and Level 3 chargers play an important role in supporting PEV drivers. Generally, Level 2 chargers are distributed throughout the region in rough proportion to traffic intensity and Level 3 chargers are concentrated along the I5 corridor and, to a lesser extent, along other principal arterials.
- Concerns have been raised regarding the impact of EVSE charging on site host's peak demand charges. PEV charging stations, especially DC fast-charge stations, can significantly impact peak demand charges if PEV charging is coincident with existing facility peak demand.
- The peak demand impacts of EVSE charging on electrical distribution circuits is expected to be modest at this point and well within the range of natural load growth that utilities already account for during normal system planning and upgrading activities.

- The benefits of PEV adoption were very apparent to stakeholders and the public. PEVs can reduce air emissions (both criteria pollutants and greenhouse gases), can lower operating costs for drivers, and can be used to promote tourism and economic development.
- Municipal fleets offer good opportunities to deploy PEVs and demonstrate their benefits. PEVs can save local governments money and help them green their fleets. In addition, it allows them to lead by example and can help influence the purchase decisions of businesses and residents in the community. However, there is a need for larger, heavier duty PEV models because some areas of the Upstate Region depend more on trucks and SUVs than light-duty passenger vehicles. For example, the City of Mt. Shasta receives large amounts of snow in the winter, requiring the use of larger vehicles with four-wheel drive and high ground clearance.
- Transportation planning boards and jurisdictional leaders (including planning and building officials) were receptive to PEV introduction, adoption, and charging infrastructure. Transportation planning boards and air pollution control districts were very receptive to the idea of using PEVs to address their commitments to improve air quality and lower transportation related pollution.
- There is a need to develop a viable EVSE ownership model(s) for the region. Prospective EVSE site hosts were generally receptive to the idea of developing a cooperative cost-sharing network. This cooperative network, inspired by the North Coast PEV Readiness Plan ownership model, would allow a consistent consumer experience, better data gathering, reduced cost of installation, and easier EVSE maintenance. It could also allow lightly used EV charging stations that are in more remote locations and are critical to interconnectivity and safety to be partially subsidized by heavily used stations located in more urban areas.
- Building departments in the region are generally receptive to the installation of EVSE and don't see a problem with permitting these facilities. Nonetheless, some standardization and streamlining could help create a more convenient process. In addition, zoning regulations for EVSE should be better defined so that building departments know how best to classify and handle EVSE permits.
- Continued education, outreach and incentives are critical to establishing a strong PEV market. There is a need to educate drivers regarding their expectations for PEV range, access to and need for public charging infrastructure, and total cost of ownership for PEVs compared to comparable petroleum fueled vehicles.

Recommendations

In reflection of what the Upstate Plug-in Electric Vehicle Readiness Project has accomplished, the following recommendations are listed below:

- Stakeholders and the public are receptive to the benefits of PEVs in Upstate California and promotion of PEV benefits should continue.
- Efforts should be made to maintain the Upstate PEVCC.
- The response has been positive to the current charging infrastructure in Shasta County and the Tesla charging stations in Siskiyou and Tehama County. Implementation and

EVSE infrastructure deployment efforts should continue in the Upstate region as it is a critical link on Interstate-5 connecting the West Coast Electric Highway. These deployment efforts should be based on the Upstate Plug-in Electric Vehicle Readiness Plan and data should be collected to assess the results of such efforts. Data collection is critical to refining current models and planning future infrastructure deployment.

- Continue collaborative efforts in the region across various organizations, including transportation planning boards, air pollution control districts, economic development groups, municipal government, and others. Work to deploy publicly accessible EVSE and to establish a publicly owned EVSE network with an aim to transition it to a private ownership model where appropriate and desirable.
- Identify a lead organization and other key partners and prepare to pursue grant funding for EVSE infrastructure deployment that follows the deployment guidelines developed in this project.
- It is recommended that EVSE infrastructure be installed in phases. While an initial level of infrastructure will be important from the outset to provide geographic coverage, reduce range anxiety, and promote PEV adoption, full EVSE deployment can be accomplished over time as the penetration of PEVs increases. In fact, it is recommended that following each phase of EVSE deployment data be collected and evaluated to assess EVSE usage rates. In addition, PEV drivers in the region can be surveyed to assess where additional charging is needed. These types of information can then be used to refine plans for future EVSE deployment.
- A statewide policy to reduce peak demand charges associated with utility metering of publicly accessible EVSE, once all reasonable peak-demand mitigation measures have been met, would greatly benefit, and incentivize future infrastructure deployment.

Continue efforts to support other low or zero emission alternative fuel vehicles (for example, hydrogen). Siskiyou County, part of the Upstate region, has joined the Northwest California Alternative Fuels Readiness project funded by PON-13-603 under the California Energy Commission

GLOSSARY

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

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

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

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

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)—Enacted in 1970 and amended through 1983, established state policy to maintain a high-quality environment in California and set up regulations to inhibit degradation of the environment.

CALIFORNIA HOUSEHOLD TRAVEL SURVEY (CHTS)— The California Department of Transportation (Caltrans) conducts the California Household Travel Survey (CHTS) every ten years to obtain detailed information about the socioeconomic characteristics and travel behavior of households statewide.[8]

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

Electric utility (EU)—An electric utility is a company in the electric power industry (often a public utility) that engages in electricity generation and distribution of electricity for sale

[8] California Household Travel Survey on Caltrans Webpage (https://dot.ca.gov/programs/transportation-planning/division-of-transportation-planning/data-analytics-services/transportation-economics/ca-household-travel-survey#:~:text=The%20California%20Department%20of%20Transportation%20%28Caltrans%29%20conducts%20the,socioeconomic%20characteristics%20and%20travel%20behavior%20of%20households%20statewide.)

generally in a regulated market. The electrical utility industry is a major provider of energy in most countries.[9]

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

GREENHOUSE GASES, REGULATED EMISSIONS, AND ENERGY USE IN TRANSPORTATION (GREET®)—A full lifecycle model sponsored by the Argonne National Laboratory (U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy). GREET® fully evaluates energy and emission impacts of advanced and new transportation fuels, the fuel cycle from well to wheel, and the vehicle cycle through material recovery and vehicle disposal. It allows researchers and analysts to evaluate various vehicle and fuel combinations on a full fuel-cycle/vehicle-cycle basis.

ELECTRIC VEHICLE CHARGING STATION (EVCS)— An electric vehicle charging station, also called EV charging station, electric recharging point, charging point, charge point, electronic charging station (ECS), and electric vehicle supply equipment (EVSE), is an element in an infrastructure that supplies electric energy for the recharging of plug-in electric vehicles—including electric cars, neighborhood electric vehicles and plug-in hybrids.

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

HYBRID ELECTRIC VEHICLE (HEV)—A vehicle that combines an internal combustion engine with a battery and electric motor. This combination offers the range and refueling capabilities of a conventional vehicle, while providing improved fuel economy and lower emissions.

NATIONAL HOUSEHOLD TRAVEL SURVEY (NHTS)— Conducted by the Federal Highway Administration, the NHTS is the authoritative source on the travel behavior of the American public. It is the only source of national data that allows one to analyze trends in personal and household travel. It includes daily non-commercial travel by all modes, including characteristics of the people traveling, their household, and their vehicles.[10]

OPEN CHARGE POINT PROTOCOL (OCPP)—The goal for Open Charge Point Protocol (OCPP) is to offer a uniform solution for the method of communication between charge point and central system. With this protocol it is possible to connect any central system with any charge point, regardless of the vendor. A uniform standard prevents all kinds of coordination problems and is therefore an advantage for the whole electric vehicle market.[11]

PG&E - PACIFIC GAS AND ELECTRIC COMPANY

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[9] Electric Utility Wikipedia Definition (https://en.wikipedia.org/wiki/Electric_utility#:~:text=An%20electric%20utility%20is%20a%20company%20in%20the,a%20major%20provider%20of%20energy%20in%20most%20countries.)

[10] National Household Travel Survey from the Federal Highway Administration Webpage (https://nhts.ornl.gov/)

[11] Open Charge Alliance Protocol Webpage (https://www.openchargealliance.org/protocols/)

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

PEVCC - PLUG-IN ELECTRIC VEHICLE COORDINATING COUNCIL

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

SCHATZ ENERGY RESEARCH CENTER (SERC)—was founded in 1989 with a mission to promote the use of clean and renewable energy.[12]

SISKIYOU COUNTY ECONOMIC DEVELOPMENT COUNCIL (SCEDC)—is a private non-profit organization which has developed strategies that result in the constructive, balanced economic growth of the region. Their mission is to facilitate business growth, retention, and attraction to promote community prosperity.[13]

STATE OF CHARGE (SOC)—Available capacity expressed as a percentage of its rated capacity.

TRAVEL ANALYSIS ZONES (TAZ)— (which stands for travel, transportation, or traffic analysis zones) may have several uses, depending on how a travel model is structured, including: storing information about the people and places in each zone, serving as origins and destinations of trips, and calculating travel times between (and within) zones.[14]

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[12] The Schatz Energy Research Center About Page (https://schatzcenter.org/about/)

[13] The Siskiyou Economic Development Council About Page (https://www.siskiyoucounty.org/mission)

[14] Travel Forecasting Resource About Webpage (https://tfresource.org/topics/Traffic_Analysis_Zone.html)