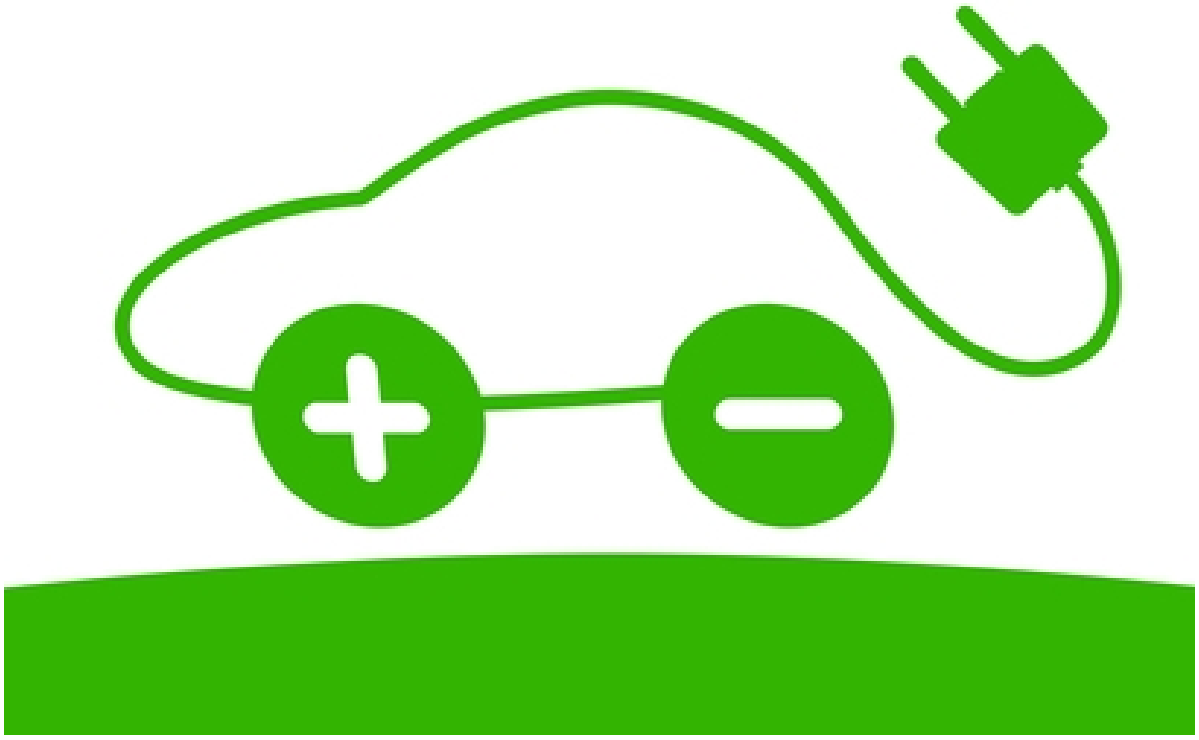
Electric Vehicle Readiness and Infrastructure Plan

Prepared for Sacramento County and the Cities Within by the

Sacramento Area PEV Collaborative



ABSTRACT

This report is the culmination of the Sacramento County Electric Vehicle Working Group (renamed Sacramento Area Plug-in Electric Vehicle Collaborative SacPEVC), which has been working together since 2015 to increase the deployment of electric vehicles and related infrastructure. The report outlines the current and forecasted demand for charging infrastructure and prioritizes their locations across Sacramento.

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Introduction

This report is an outcome of the Sacramento County led Electric Vehicle (EV) Working Group. The EV Working Group is made up of public agencies, non-profits and stakeholders with a goal of having the necessary charging infrastructure in place to meet the deployment of electric (EVs) and zero-emission (ZEVs) vehicles and anticipated increase in EV owners/drivers in the Sacramento County region. Partners in the EV Working Group include:

- County of Sacramento
- City of Sacramento
- Sacramento Municipal Utility District
- Sacramento Metropolitan Air Quality Management District
- Valley Vision
- SacEV Owner's Association
- Sacramento Clean Cities
- SACOG

The group has been actively working together since 2015 to find ways to improve EV readiness and increase accessibility to EV charging infrastructure for existing and future users. This report is a living document that should be regularly updated to reflect new data, completed projects, and in particular new policy recommendations. Members of the working group chose to formalize the group into an on-going collaborative (SacPEVC) because of the success already achieved, ability to attract funding and resources, and the potential to implement much of what is in this report. SacPEVC will be sharing this report with the other jurisdictions in the county for their use. This report provides an overview of the EV readiness for the Sacramento County area and a framework for EV related policies. The policies from this report were recommended by the EV Working Group and reflect the group's consensus on how best to increase Sacramento's readiness and the number of EVs in Sacramento and the region. The main focus of the report is on EV charging infrastructure and siting. It provides an in-depth analysis of charging demand and behavior, and proposes locations that would benefit a wide range of existing and anticipated EV users. A key goal of the working group was to be strategic in identifying the number and types of chargers and charging locations in order to meet the public's needs while avoiding an excess of chargers. **Information, including the top 100 sites for public and workplace charging from this report can be found at: http://arcg.is/1yGP9O.**

The Sacramento area is an emerging market for EVs. Recent estimates indicate that more than 3,000 rebates for electric vehicles have been issued by the California Clean Vehicle Rebate Program (CVRP) to residents in the county as of October 2016.

Increases in EV sales in Sacramento County happen for several reasons. The conditions for driving an electric vehicle in the area are ideal. Relatively flat roads, warm weather, and short commutes mean drivers can attain high mileage on a single charge[1]. At the same time, more information is available to the public on the reduced costs to operate an EV, and Sacramento County residents are taking advantage of the federal and state financial incentives to lower the cost of owning or leasing an EV. Furthermore, there is a wide variety of electric vehicle model choices with more makes and models being announced almost every quarter.
Federal and state financial incentives are part of larger policies to reduce greenhouse gas emissions (GHG) and our nation's reliance on fossil fuels and foreign oil, while also improving air quality, the

[1] Nissan conducted studies on range of their EVs under different driving conditions www.nissan.ca/vehicles/ms/leaf/en/range-fundamentals.aspx#/range-fundamentals

environment and the public's health. Both President Obama and California Governor Brown have issued orders calling for increased adoption of EVs. Governor Brown signed SB1275 "The Charge Ahead California Initiative" with the goal of placing at least 1m zero-emission vehicles in service by January 1, 2023. He also issued Executive Order B-16-2012 that among other things establishes benchmarks for 1.5 million zero-emission vehicles to be on California roads by 2025. In so doing SB1275, and other Executive Orders seek to increase EV access for disadvantaged, low-income, and moderate-income communities.

To help achieve the federal and state goals related to EVs, in 2013 SACOG created a regional EV Readiness Plan (EV Plan) called "Take Charge" to prepare the six-county Sacramento region for an increased number of EVs. The goal of the EV Plan was to create a regional approach to EV readiness, through a coordinated effort between all interested parties. The EV Plan moved the region toward the goals set by President Obama, Governor Jerry Brown and the region's own goals.

This document represents the first update to the regional EV Readiness and Infrastructure plan, and refines information to identify priority charging locations across the county. While the focus of this report is on Sacrament County, all analysis was conducted at a regional scale in order to better assess trips, travel patterns and behaviors. For purposes of this plan, the Sacramento County analysis consists of both the unincorporated county and incorporated cities. However, while the analysis is broader in scope, the plan relied on a more in-depth analysis of the County of Sacramento's codes and permit processes. This approach allowed for a more comprehensive review of County regulatory structures as a prototype, to guide recommendations that can apply more broadly to other agencies. The report is broken out into the various elements necessary for EV readiness.

For a city or county, being prepared for an increased number of EVs on the road involves seven main steps:

1. Permit Streamlining: They must examine their processes on planning and permitting the required EV charging infrastructure, and make updates to those process as deemed necessary,
2. Demand: They need a forecast of how many EVs they can expect to have housed in their jurisdiction,
3. Infrastructure: Based on the number of EVs, they need to estimate the amount and type of charging that will be necessary to meet that demand,
4. Owners/Drivers: They need to know who will purchase EVs and where they live,
5. Behaviors: They need to know where the EV drivers, both inside and outside of their jurisdiction, will charge,
6. Policies: They need to create a plan for implementation, including policies that will address the demand for charging, and
7. Planning & Monitoring: Actionable steps will need to be planned, including a process to monitor progress of the plan and make any necessary adjustments to the plan and related policies.

1. Sacramento County Area EV Readiness

Communities throughout California are embarking on various activities to support the burgeoning electric vehicle (EV) market, and Sacramento is one of them. The county with its partners are leading an effort to update the regions' EV readiness and infrastructure plan to prepare itself and surrounding jurisdictions for increased EV adoption. This section of the report is an update to the regional EV Readiness Plan (TakeCharge) created by the Sacramento Area Council of Governments in 2013, and is intended to clarify related EV readiness actions. These actions are based on an assessment of EV readiness in the county, and are meant to highlight areas to focus future efforts. There are four elements in this section that are essential implementation steps for growing Sacramento EV population. This section also provides additional elements in its second section that are encouraged, but not considered crucial, to the implementation of this EV readiness implementation plan. The additional elements could be areas of work for future projects undertaken by the county, city, SMUD and others.

The four primary and essential elements, and likely the first steps, in an EV readiness plan are:

1. Streamlining the construction permitting and inspection process
2. Updating building codes
3. Updating parking and zoning codes
4. Implementing training and education programs

Additional elements discussed in this plan would follow the first four actions. These include: encouragement of workplace charging, work with utility companies to manage grid impacts, address charging at multi-unit dwelling (MUDs), include EVs in local government fleets, create incentives and expanded outreach, and encourage renewable energy sources in the electrical grid.

The first four elements are explained in detail and the additional elements are covered briefly in subsequent sections of this document.

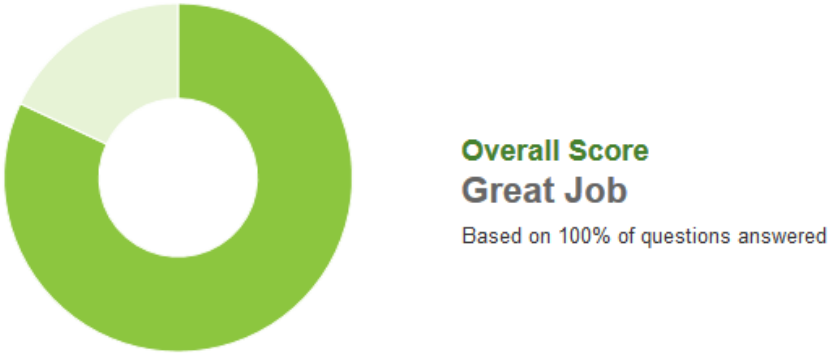
Self-Assessment

The first action of an EV readiness plan is a self-assessment and reporting on existing EV readiness. An initial assessment was completed for the County of Sacramento at the start of the project in 2016, found in Attachment A. Another assessment was completed following the completion of the project in January of 2017, and is outlined below. The County Sacramento was used as the primary test case for this assessment, to inform a more comprehensive analysis that applies more broadly across the county-wide region.

An assessment using the Department of Energy's (DOE) Plug-In Electric Vehicle Readiness Scorecard was completed for the county. Many of the elements from the assessment were completed using county-wide information; where no data from the county were present, region-wide data were used. The DOE assessment focuses on six distinct areas of readiness.

These are:

- Charging Infrastructure Planning
- Market Conditions
- Utility Involvement
- Education and Outreach
- Laws, Incentives, and Financing
- Charging Station Permitting and Inspection Process



The overall score for Sacramento County moved from "On the Right Track" to "Great Job", based on the pre and post project assessment. Much of this came from the improvements made in the county's EV permitting and installation process.

Figure 1 Sacramento County EV Readiness Score

Charging Infrastructure Planning

The county has always been involved in local and regional EV planning, this includes engagement with project partners, state agencies, utilities, and the cities within the counties boundaries. The score for this section remained at the highest level from the pre-project assessment.

Market Conditions

The market for EVs in the county has always been good, with an active and engaged utility, being a showcase as the state's capitol, and its demographics and geography being conducive to EV market penetration. Over the 12-months of the project, the number of EVs in the county has increased by between 50% and 100%, and the number of EVs available for sale has increased with manufacturers making more models available in the area. This section increased from the initial assessment.

Utility Involvement

SMUD has always been a leader in EVs, and with new and increased incentives for the purchase of EVs and the purchase and installation of EV charging infrastructure, SMUD is only increasing its commitment to EVs in the county. This score, already one of the highest in the pre-project assessment, increased due to activity from SMUD.

Education and Outreach

With the county continuing to engage project partners, and more and more tools and resources being available, the score for this section increased.

Laws, Incentives, and Financing

During this project, the County of Sacramento, SMUD, and the City of Sacramento have taken many steps to increase adoption of EVs across the county. The county has added language to the zoning and building code related to EVs and EV charging infrastructure, and SMUD has increased the incentives it offers for vehicles and charging infrastructure. The score for this section had the largest increase from the pre-project assessment.

Permit and Inspection Process

This section in the pre-project assessment received the lowest score. In the early stage of the project the county took steps to improve its permitting and inspection process. The county passed a number of EV readiness elements to align with state goal on being EV ready. This section had one of the biggest increases in scores, and helped move the overall EV readiness score for the county.

The Figure 2 below highlights how the scores before and after the project for each of the areas improved.

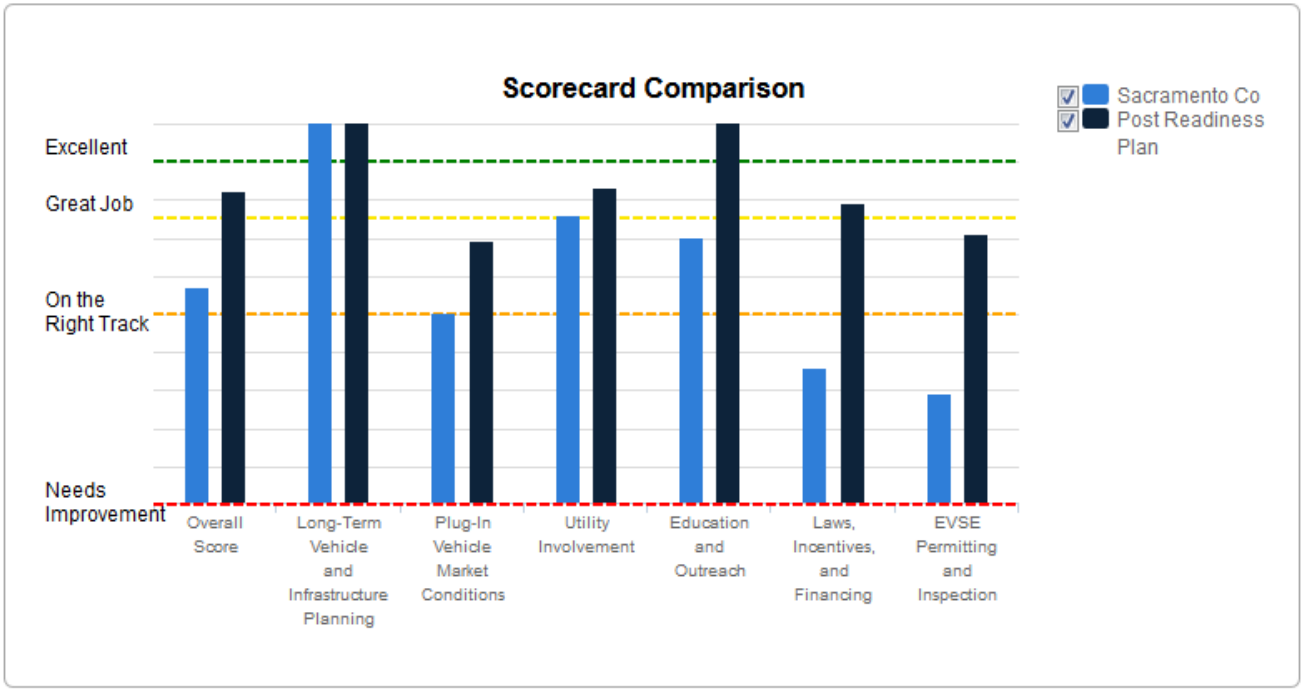


Figure 2 Sacramento County EV Readiness Score Comparisons

2. Forecasting EV Ownership in Sacramento County

Residents of Sacramento County, and its incorporated cities, are increasingly turning to EVs for traveling to work, to run errands, and to visit family and friends. A vast majority of these trips, including residents' daily driving, can easily be made with the range afforded by electric vehicles today and in the future (SACOG 2016). As Sacramento County plans for infrastructure to charge the increasing fleet of electric vehicles, it will need to consider several factors:

1. How many EVs do its residents own today?
2. How many EVs will be driven in the future?
3. Who is currently driving an EV?
4. Where will the EV be driven?
5. How will they be charged?

This forecast is the first part of the Sacramento County EV Infrastructure Plan. It looks at the first three factors to plan for electric vehicle infrastructure: how many EVs are driven in Sacramento County today, who is driving them, and how many will be driven in the future. Two main analytical approaches were used to find a range of future EV ownership: EV purchase data projected into the future, and calculating Sacramento County's share of 1.5 million EVs in California by 2025, called for by California Executive Order B-16-2012.

These approaches are very different. One projects past car purchase data into future years to forecast future EV ownership; the other uses the Executive Order's targets for EVs driven in California by certain years. They provide a very large range of EV ownership, and both of these approaches should be used more as basis for scenarios to plan EV infrastructure rather than as a firm forecast or target. These two approaches provide a range of results that allow the County to implement this plan with sensitivity to fluctuations in EV markets, EV technology advancement, incentive programs, available public charging infrastructure, and fuel prices, all of which affect EV adoption rates.

EV adoption rates were forecasted in SACOG's 2012 regional EV plan, TakeCharge II: Infrastructure Roadmap. With four more years of EV purchase data available and a focus on Sacramento County, this report updates those forecasts and increases the resolution of analysis on Sacramento County, independent of the other five counties in the SACOG region. The following section of this plan will forecast where those EVs will drive.

Methods

Three methods were used to forecast Sacramento County's future EV population. The first two used California Vehicle Rebate Program (CVRP) data, which track rebates submitted for the purchase of new electric vehicles and tracked to the place of residence zip code. These data span five years of electric vehicle rebates, starting in January 2011 and collected for this analysis in March 2016. As of October 2016, there were 3,000 EV rebates in Sacramento County. Some sources have EV sales as high as 5,000 in Sacramento County, but SACOG was unable to obtain these data for this research. The five years of EV rebates were the best publicly available data to estimate EVs sales in California. These data, however, do not capture vehicles purchased where a rebate was not or cannot be used, resale vehicles, or those vehicles purchased and registered outside of the county and then brought into the

county at a later time. CVRP data include many variables, summarized in Table 1 below. They were paired with additional data such as gas price trends, number of unique EV models available on the market, number of publicly available chargers, and trends in the population (or "stock") of EVs on the road. "Regression analysis" – a statistical method to estimate the relationship between variables – was used with these data. Weekly EV sales were regressed against the additional parameters using all-subsets model selection. Regressions were performed in R (R Core Team 2015), and Excel. Regression 1 modeled gas prices, unique EV models, and EV stock. Regression 2 modeled gas prices, available chargers, and EV stock.

These models indicate that weekly EV sales are positively correlated with the price of gas, so a rise or fall in gas prices is associated with the increase and decrease in EV sales, respectively. This relationship is also true for the number of EVs available for sale, the number of EVs on the roads, and available charging infrastructure. In other words, as these variables increase, so do sales of EVs. The sub-models – EVs on the market and EV stock – are positively correlated with time; there are increasingly more EVs both on the market and on the roads. It must be noted that these models illustrate EV ownership patterns under the consumer environment over the past five years (incentives, policies, et cetera). Thus, they are useful to predict what the future EV market may be should that environment remain relatively constant. As incentives, policies and technologies change, these forecasts must be updated.

TABLE 1: CVRP Data
Date of rebate submission
Owner Characteristics (Business, Individual, Local Government Entity, Non-Profit, State Government Entity)
Amount of Rebate ($0 - $5000)
Vehicle Category (Battery Electric Vehicle, Plug-in Hybrid Electric Vehicle, Fuel Cell Electric Vehicle, Other)
Vehicle Make (BMW, Chevrolet, Ford, Nissan, Tesla, Toyota, et cetera)
County of Submitter
Air District of Submitter
ZIP Code of Submitter
Census Tract of Submitter

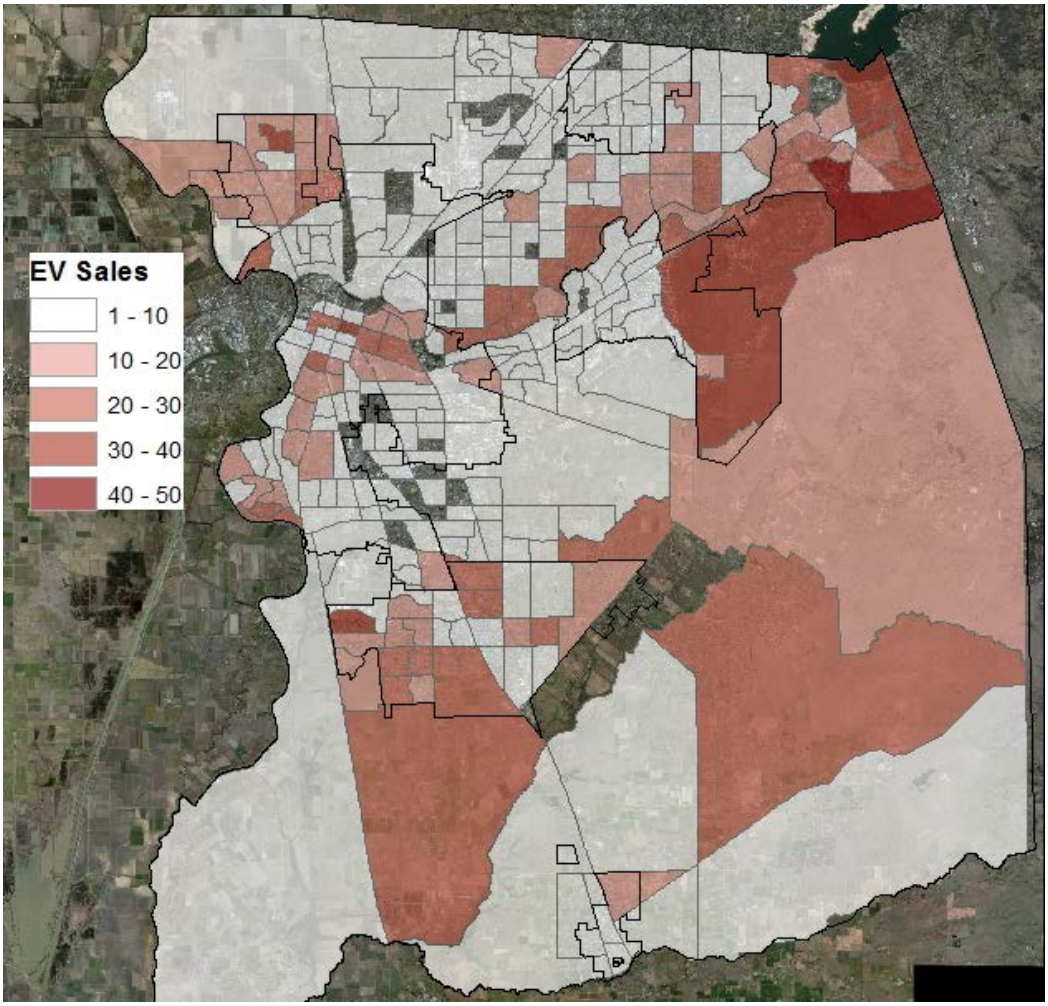


Figure 3 EV Sales by Census Tract

Based on CVRP data, there is an upward trend in EV sales in Sacramento County from 2010 through 2016. This trend follows the SACOG region as a whole. As of October 2016, there were just under 6,000 EVs in the six-county SACOG region and 3,000 EVs in Sacramento County. This ratio is likely explained by Sacramento County's share of the region's high-income households, defined here as households with annual incomes above $100,000. Sacramento County is home to 55% of the region's high-income households (2014 American Community Survey). High household income is strongly correlated with EV purchase and ownership[2].

This ratio was used in this analysis to identify Sacramento County's share of EVs in future target years. Additionally, Sacramento County's share of total households in the SACOG region – 61% – was used to find EV ownership levels that would reflect lower purchase prices of EVs in the future and/or potential incentive programs. Used in tandem, these ratios were used to calculate a range of EV ownership levels in Sacramento County based on the 1.5 million EVs called for statewide by 2025 in Executive Order B-16-2012. This range outlines EV ownership scenarios for which Sacramento County can plan.

[2] EV Collaborative 2012; Tal, Nicholas, Woodjack, Scrivano 2013

TABLE 2: Households by Income Level - (2014 and 2036)				
	HHs 2014	> $100K 2014	HHs 2036	> $100K 2036
Sacramento	519,460	123,112	735,690	174.358
SACOG Region	848,179	222,659	1,188,347	311,958
% of Region	61%	55%	62%	56%

2014 ACS. Columns may not sum due to rounding.
PopGen, SACOG 2016. Columns may not sum due to rounding. 2036 numbers are in 2014 dollars.

Results

The different forecasting approaches produce a wide range of EV ownership. Executive Order B-16-2012 is ambitious compared to the forecast based on EV purchases thus far. Interpreted differently, historical EV purchases may not yet indicate the rapid adoption of EVs that Executive Order B-16-2012 is expecting. Regardless, EV adoption will likely fall somewhere in the middle of these scenarios and this range provides a basis for scenarios of investment and infrastructure prioritization. Table 3 illustrates a range of future EV ownership scenarios by key target years, as well as the percent of households that would own EVs assuming one EV per household.

These are forecasts using past data, so these scenarios will require update as more data become available and trends are observed. There are several factors that also affect EV adoption that are not captured in the CVRP. Incentive programs for buyers – like the CVRP – spur EV sales, as do updates to EV technology, policies and consumer attitudes. Resale of used EV's is also not captured in the CVRP. Used EV's will create a secondary market that has the potential to increase affordability for a broader income group (those with incomes less than $100,000). Additionally, the State has created a Financing Assistance Pilot Project to help lower income communities access EV's. For the purpose of this report, it is assumed vehicles purchased in the region either stay in the region through long term ownership, or resale, or are replaced with used EVs purchased by other owners. These result in a zero net migration of vehicles in or out of the region, with only the addition of new EVs being made when purchased.

In planning for EVs, these ownership forecasts are useful to anticipate the magnitude of the EV fleet in Sacramento County. They provide several alternatives or scenarios that will alter the amount of EV infrastructure needed throughout the county.

The following section of this plan provides not just the future magnitude of the EV fleet, but also the directions that EVs will be traveling throughout the county. SACOG's travel model is used to find trips made by likely EV drivers, including the trips' origin and destination.

Comprehensively, this provides a snapshot of both how much, what level (speed) of charging and where EV infrastructure will be needed throughout Sacramento County. These forecasts account for total EV demand countywide, and are inclusive of both the unincorporated county and incorporated cities.

TABLE 3: Forecasted EV Stock in Sacramento County							
		Forecasted EVs			Percent of HHs		
		2020	2025	2036	2020	2025	2036
High	Executive Order, by HH Share	55,752	83,628	144,955	11%	14%	21%
	Executive Order, by High Income HH Share	44,403	66,604	115,447	9%	11%	16%
Medium	Regression (2), by HH Share	21,731	35,625	118,117	2%	4%	9%
	Regression (2), by High Income HH Share	19,593	25,314	106,499	2%	3%	9%
Low	Regression (1), by HH Share	10,356	22,587	65,915	2%	4%	9%
	Regression (1), by High Income HH Share	9,366	20,428	59,615	2%	3%	9%

3. How Many and What Level of Chargers?

There are many factors that influence how much charging infrastructure is needed to meet the demand of existing and future EVs, including: the number of EVs on the road, the range of the EVs, the amount of driving, the general use of the charger host location (residential, workplace, or public), and the level (speed) of charging desired.

The first factor in determining the number of chargers needed to meet demand is the number of EVs on the road. The EV forecast outlined in Table 3 above can be broken into high (Executive Order), medium (regression 2), and low (regression 1) scenarios. These forecasts were used to help determine charging needs for Sacramento County.

The next factor is the use of the EV, including the distance driven, the range, and how many EVs a charger will charge on a typical day – or the throughput of each charger.

Currently there is a wide range of fully electric miles that are possible from light-duty EVs, typically ranging from 60 to 120 miles[3]. Some vehicles, like the Chevy Bolt and Tesla Model X, get over 200 miles. With cheaper batteries and longer range on more vehicles, the average range of EVs will continue to increase over time[4]. For this analysis, an average range of 160 miles was used for the year 2035, which was assuming an average of 200 miles on a full charge and charging when the vehicles was at 20% of capacity.

Another factor used in estimating the amount of charging needed is the amount of driving. How far the typical car travels in a day will help determine how much charging is needed. For this analysis, an average of 24.2 miles per day per person was used, based on estimates from the 2016 MTP/SCS[5].

The last factor considered is the general location, also known as: residential, workplace, or public charging. The location of the charging for these various categories dictates how long the car will be parked, for example 12+ hours at home, 8 hours at work, 20 minutes at the store, etc. The length of parking time can help to determine the level of charging that is needed, level 1, level 2 or DC Fast Charge. For example, in residential uses, the car is typically parked for a longer duration requiring a lower level of charging, whereas public charging (grocery stores, coffee shops, etc.) the duration is typically shorter requiring a higher level of charging. Using information derived from travel modeling

[3] https://www.fueleconomy.gov/feg/evtech.shtml
[4] https://www.nrdc.org/experts/roland-hwang/future-electric-vehicles-bright
[5] http://www.sacog.org/general-information/2016-mtpscs

done for the 2016 MTP/SCS, the amount of charging instances by residential, workplace, and public categories was determined, and shown in Figure 4 below.

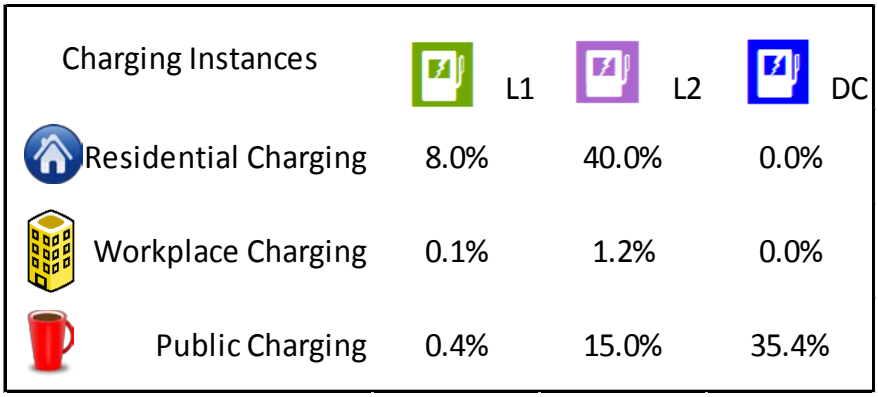


Figure 4 Percent of Charging by General Location in Sacramento County

Existing	L1	L2	DC
Residential	n/a	n/a	n/a
Workplace	17	114	0
Public	59	582	81

High	L1	L2	DC
Residential	11,596	57,982	0
Workplace	28	246	0
Public	103	1,404	275

Medium	L1	L2	DC
Residential	9,236	46,179	0
Workplace	26	219	0
Public	94	1,237	235

Low	L1	L2	DC
Residential	5,273	26,366	0
Workplace	22	174	0
Public	79	956	169

Figure 5 Number of New EV Chargers by Forecast Scenario in Sacramento County in 2036.

Based on the factors described above in Table 3; a high, medium, and low scenario for charging needed to support the EV forecast for Sacramento County was created. Results are found in Figure 5.[6]

These scenarios only differ in the number of chargers, the ratios between location and levels stays constant. For existing chargers, 15% are workplace and 85% public. Because of the growth in the demand for public fast charging, this ratio changes to 13% workplace and 87% public in the future. In addition, 9% of existing chargers are DC fast chargers, this increases to 13% in the future.

The number of vehicles, the total miles driven by an EV in a day, the number of charging instances needed, and the amount of charging by location determine the aggregate number of chargers needed to meet demand. Exactly where those chargers are needed depends on where people live, work, shop, and play.

The following sections describe, through forecasted EV households and driving and charging behavior, where chargers are likely to be located.

[6] The number existing residential chargers is unknown as many either do not have permits, or use existing infrastructure.

4. Forecasting EV Households in Sacramento County

The first step of forecasting EV trips is forecasting which households are likely to own an EV. The forecasted EV-owning households are crucial for understanding how to most efficiently distribute charging infrastructure throughout the Sacramento County, in terms of both energy use and cost.

Residential charging can take place during off-peak hours of electricity demand (i.e. overnight) and, for Level 1 charging, uses cables included with the purchase or lease of an EV. With no electrical work, a household can charge at Level 1 from a standard 110-volt wall outlet. With minor electrical work, a household can purchase and install a Level 2 charger and charge from "empty" to full charge over the course of several hours. The distribution of households likely to own EVs, illustrated below in Table 4, allows for a broad and decentralized EV charging infrastructure network at low cost to the consumer, the utility companies, and Sacramento County. Because of the energy and infrastructural efficiency afforded by off-peak charging, the overall impact of EVs in reducing greenhouse gases significantly increases.

Review of academic and governmental literature and reports provided insight to the common demographic characteristics associated with plug-in electric vehicle owners. The majority of these characteristics were available from the US Census and included age, household income, educational attainment, homeownership, housing type, number of persons in household, number of vehicles in household, owning a hybrid electric vehicle (HEV), and living in a house with solar panels. These characteristics are summarized in Table 4 below.

TABLE 4: PEV Ownership - Summary of Characteristics & Indicators

Age	50% between 43 and 58 years 80% between 37 and 65 years old Median 50 years
Household income	79% have household income ≥$100K
Educational attainment	87% have Bachelor's degree or higher
Homeowner	96% are homeowners
Housing type	91% live in single-family home with attached garage
Number of persons in household	93% live in multiple-person household
Number of vehicles in household	95% own ≥2 cars
Owning - hybrid electric vehicle	68% have owned HEVs at some point
Solar household	42% have solar panels on their house

Census tract level data for Sacramento County was used based on each of these demographics, and included all factors above except owning a hybrid electric vehicle, which was not available.

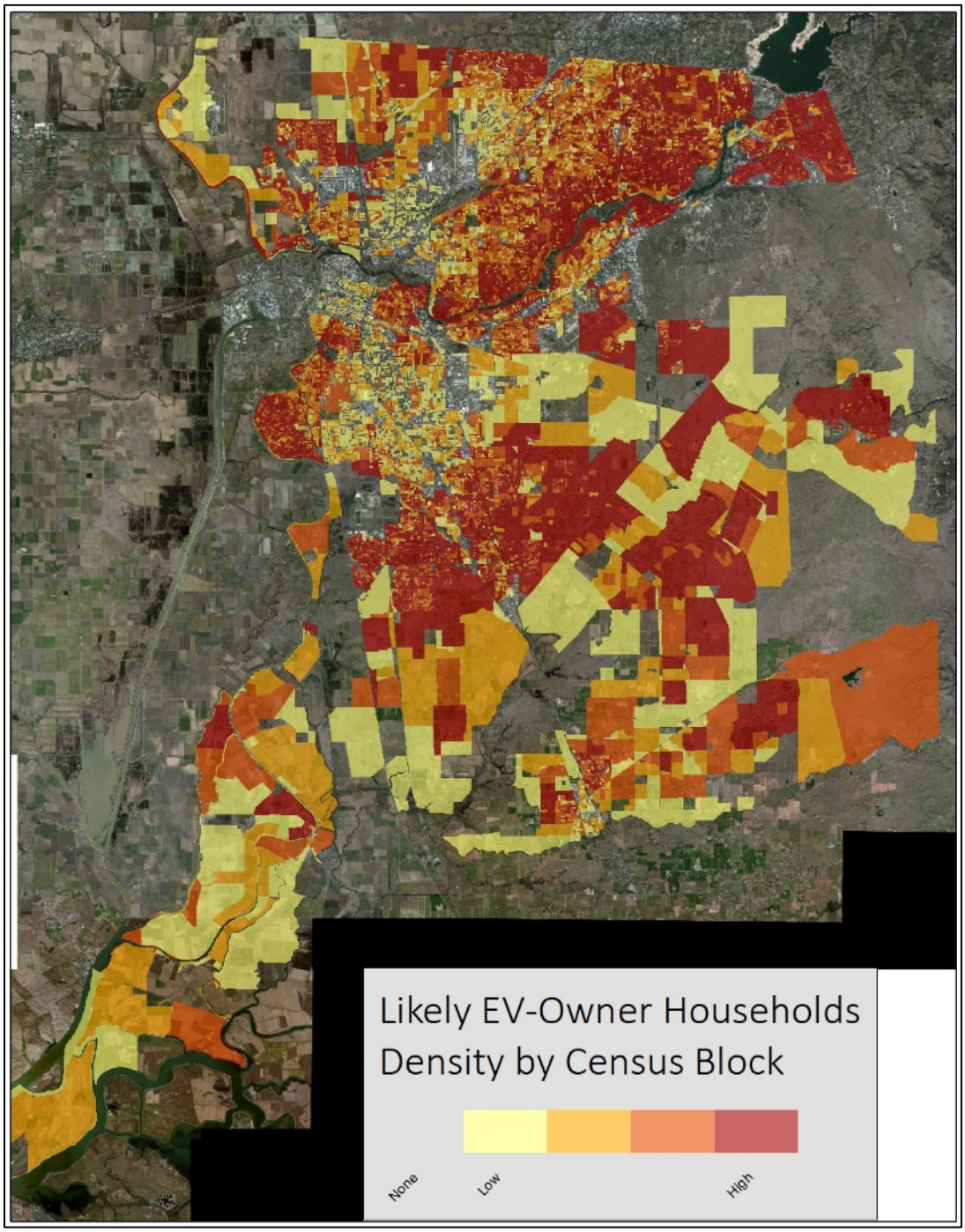


Figure 6 Map of Likely EV Households

The results, shown left, in Figure 6, offer a heat-map of where likely EV households exist within the county.

These data are helpful in identifying area's where residential charging is likely to be high, where EV trips are likely to occur, and where workplace and public charging demanded.

Information, including the top 100 sites for public and workplace charging from this report can be found at: http://arcg.is/1yGP9O.

5. Forecasting EV Trips in Sacramento County

This section answers the question "where will EVs likely go, today and in the future?" It is tempting to use the map in Figure 6, showing EV sales by census tract or EV households by census block, to plan and locate public charging infrastructure in tracts where there is a high density of EV ownership. However, EVs are mobile technology and move their owners between destinations. Thus, this analysis utilizes a tool that estimates those movements to show not just where EVs "live" but where they work, shop, run errands, et cetera. In short, the travel model shows where likely EV owners are likely to drive and thus may need charging if and when charging at home is not sufficient.

Methods

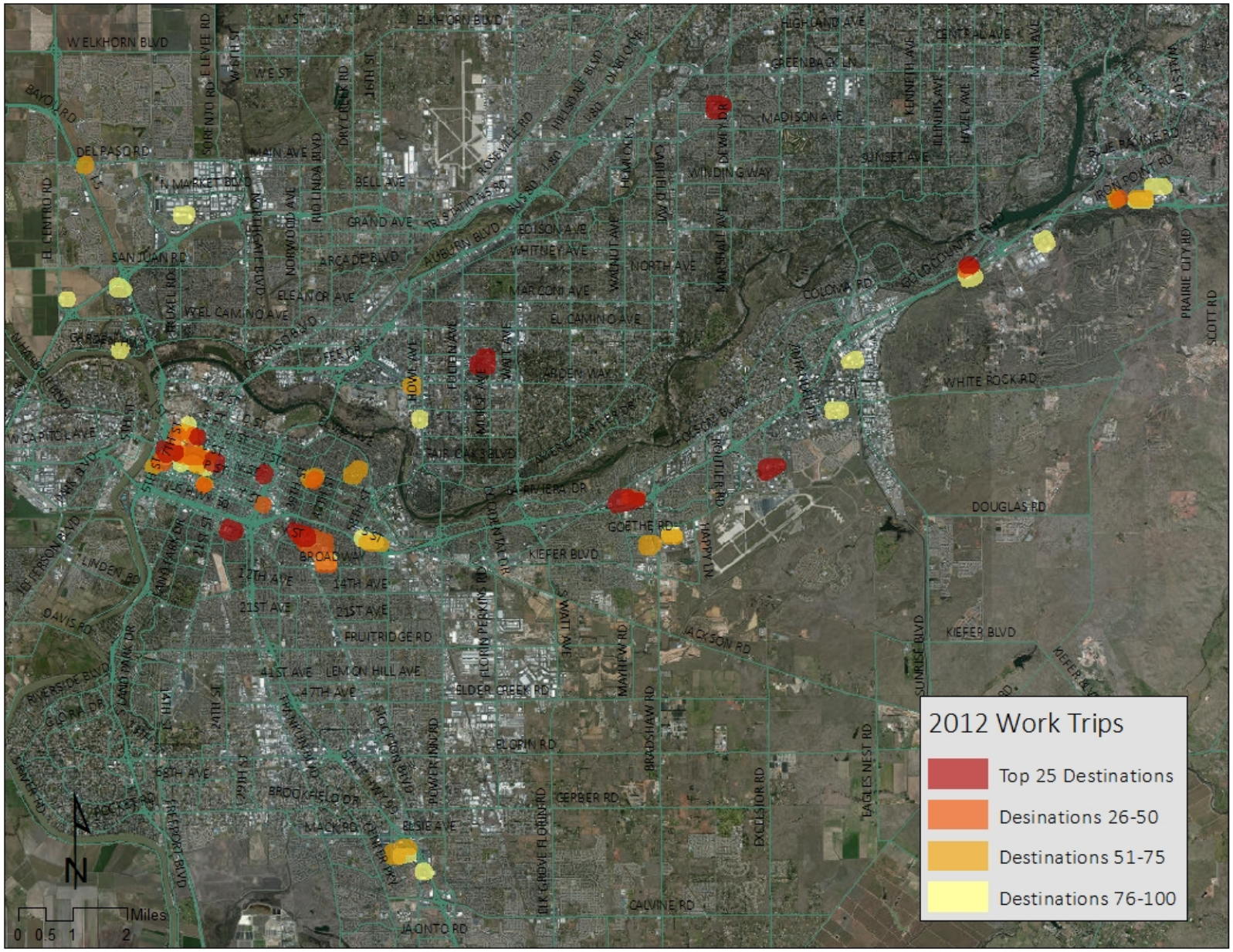
A trip table was created with data from SACOG's travel demand model, SACSIM. It tabulates the ends of automobile trips (called destinations) within Sacramento County made by likely EV drivers. It tracks destinations at the parcel level. For example, a likely EV driver who lives in Placer County and works in Folsom would be tallied in the trip table as they park at their workplace, because it is in Sacramento County. If that person stops at a coffee shop or grocery store in Sacramento County before returning home, the coffee shop and grocery store parcels are also accounted for in the trip table. Such a tabulation illustrates where EVs stop for any length of time, thus where there is opportunity for a charging instance. This identifies where charging infrastructure investments would be utilized and therefore should be located.

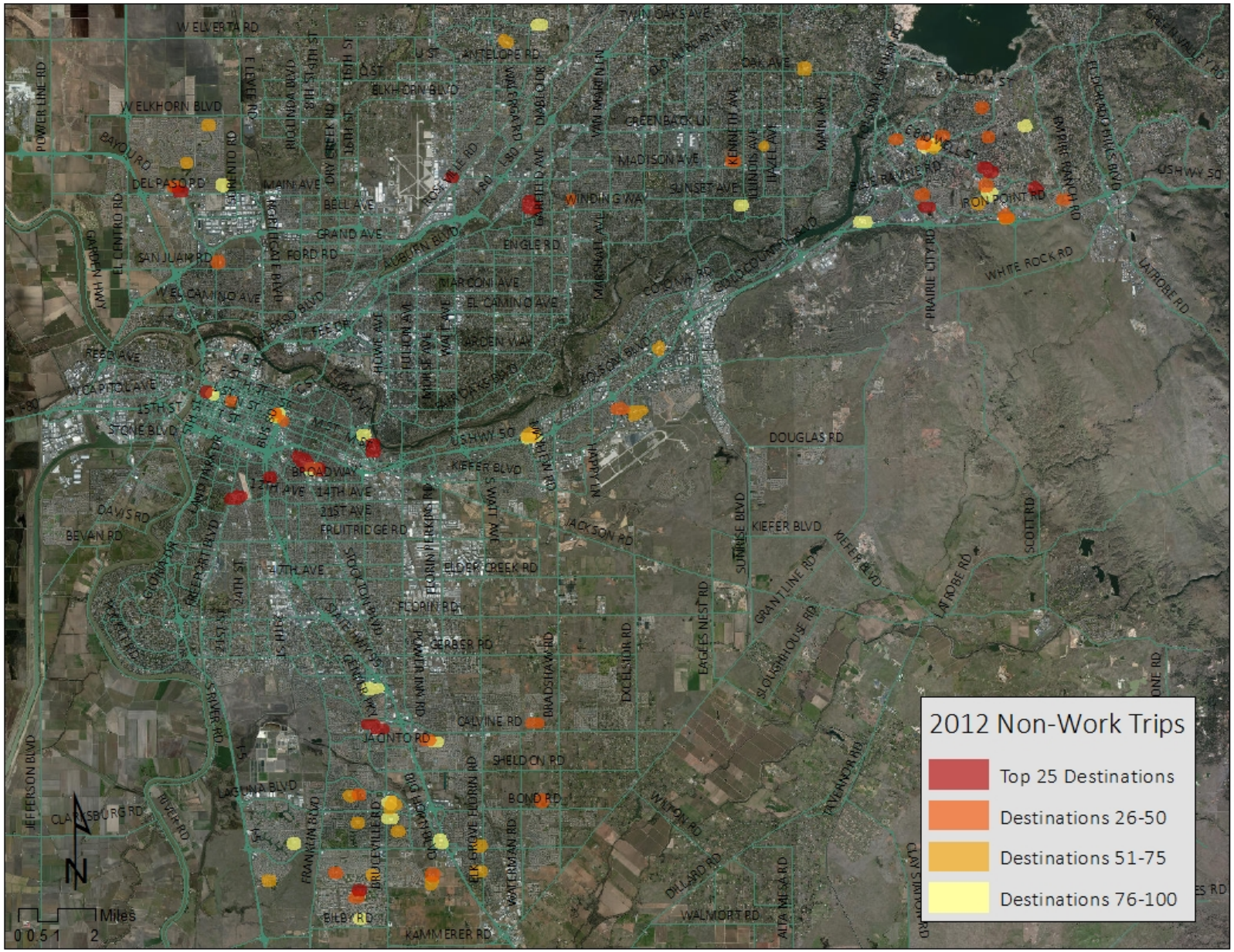
Four trip tables were created with SACSIM trip data. Two of these tables use 2012 trip data, and break apart commute trips (called work trips) from other trip purposes such as errands, shopping, medical appointments, et cetera (called non-work) trips. The other two trip tables use 2036 trip data with the same two designations of work and non-work trips.

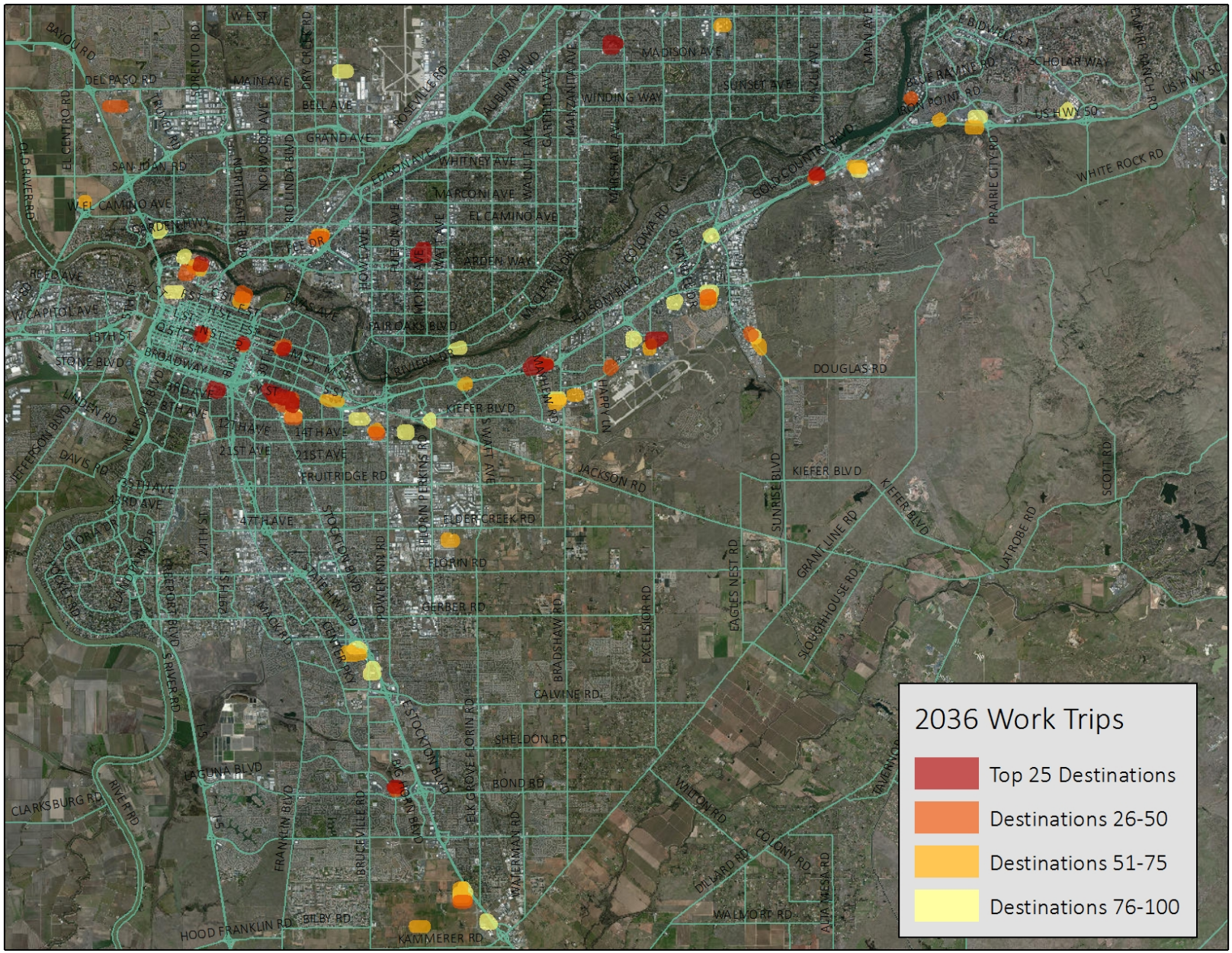
These trip purposes were separated because they have a few crucial differences that influence EV charging. A vehicle is likely to be parked at a workplace destination for upwards of 10 hours, depending on the length of the individual's workday. A 10-hour layover allows for Level 1 and 2 charging infrastructure, which charges EVs more slowly than the rapid and more expensive DC Fast Chargers. Non-work trips are oftentimes errands, shopping trips, and appointments where a vehicle would be parked anywhere between a few minutes and a few hours. These destinations would be better served by Level 2 and DC Fast Chargers.

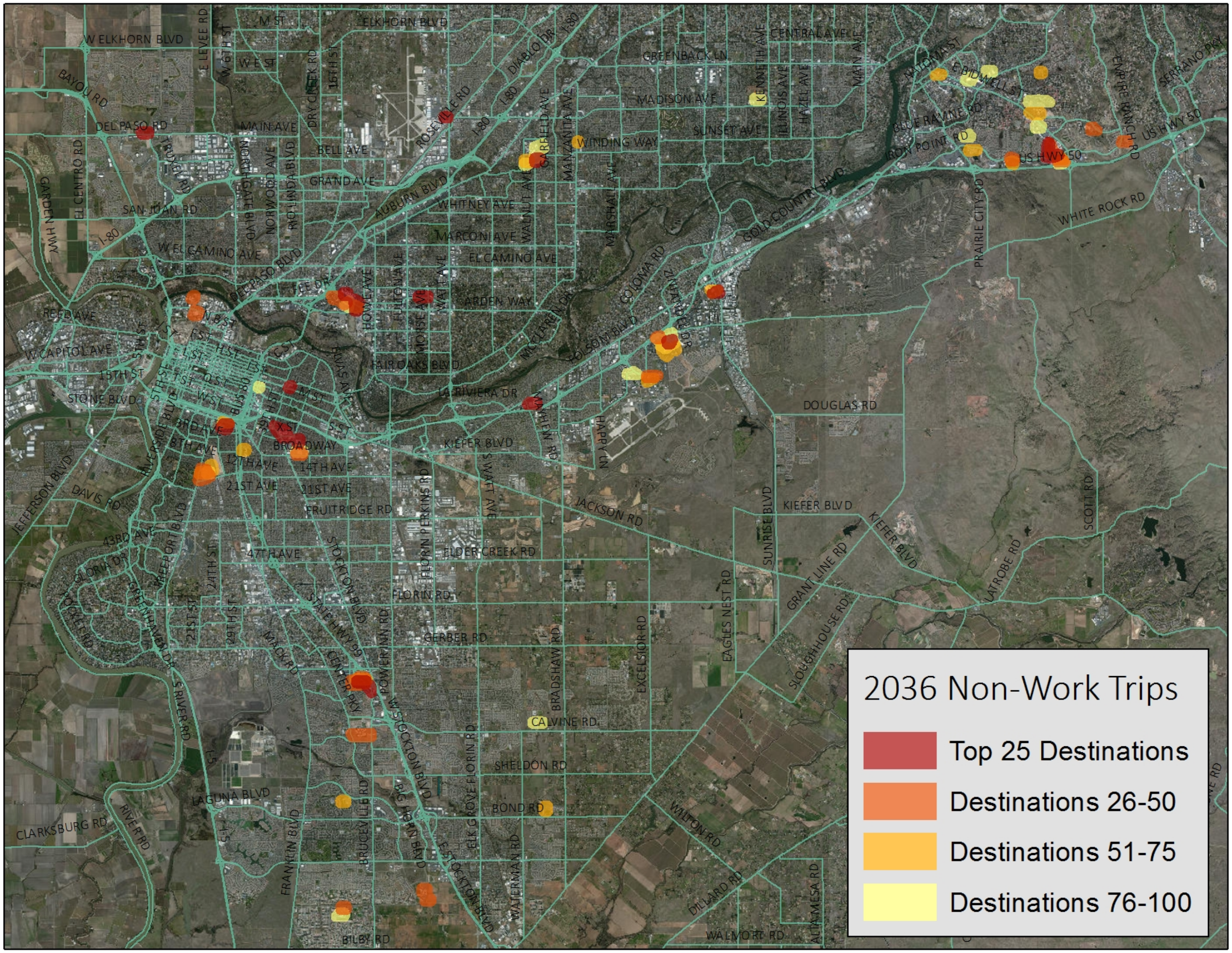
These trip tables are illustrated by maps that show the top 100 destinations of likely EV trips, broken apart by years and by trip purpose. These maps provide actionable information for the prioritization of EV infrastructure investments throughout Sacramento County. Further, a residential parcel map of likely EV households illustrates the large potential for residential EV charging.

More information on the top 100 sites for public and workplace charging from this report can be found online at: http://arcg.is/1yGP9O.


2012 Work Trips
Top 25 Destinations
Desinations 26-50
Destinations 51-75
Destinations 76-100
N
0 0.5 1 2 Miles
W ELKHORN BLVD
DEL PASO RD
N MARKET BLVD
SAN JUAN RD
EL CENTRO RD
W EL CAMINO AVE
ARCADE BLVD
GRAND AVE
AUBURN BLVD
MAIN AVE
BELL AVE
ELEANOR AVE
MARCONI AVE
EL CAMINO AVE
NORTH AVE
WHITNEY AVE
EDISON AVE
WALNUT AVE
MARSHALL WAY
ARDEN WAY
FAIR OAKS BLVD
LA RIVIERA DR
WINDING WAY
MADISON AVE
GREENBACK LN
HIGHLAND AVE
SUNSET AVE
COLOMA RD
WHITE ROCK RD
DOUGLAS RD
GOETHE RD
KIEFER BLVD
JACKSON RD
FLORIN RD
GERBER RD
CALVINE RD
ELDER CREEK RD
FRUITRIDGE RD
BROADWAY
12TH AVE
14TH AVE
21ST AVE
41ST AVE
47TH AVE
LEMON HILL AVE
BROOKFIELD DR
MACK RD
BLUE GROVE FLORIN RD
EAGLES NEST RD
SUNRISE BLVD
PRAIRIE CITY RD
SCOTT RD
HAZEL AVE
ILLINOIS AVE
KENNETH AVE
MAIN AVE
CENTRAL AVE
WATT AVE
HAMILTON ST
GARFIELD AVE
HOWE AVE
FULTON AVE
MISSION AVE
ROSEVILLE RD
RIO LINDA BLVD
NORWOOD AVE
DEL PASO BLVD
SORENTO RD
E LEVEE RD
W ST
M ST
L ST
K ST
J ST
I ST
H ST
G ST
F ST
E ST
D ST
C ST
B ST
W CAPITOL AVE
US HWY 50
BAYOU RD
LINDEN RD
DAVIS RD
RIVERSIDE BLVD
GLORIA DR
FRANKLIN BLVD
STOCKTON BLVD
POWER INN RD
FREEPORT BLVD
JACINTO RD
BLUE BANNER RD
IRON POINT RD
FLORIN PERKINS RD
COURTLAND AVE
RUTLER RD
HAPPY LN
MAYHEW RD
BRADSHAW RD
EXCELSIOR RD


2012 Non-Work Trips
Top 25 Destinations
Destinations 26-50
Destinations 51-75
Destinations 76-100
N
Miles
0 0.5 1 2
W ELVERTA RD
ELKHORN BLVD
W ELKHORN BLVD
DEL PASO RD
MAIN AVE
BELL AVE
GRAND AVE
FORD RD
SAN JUAN RD
W EL CAMINO AVE
EL CAMINO AVE
MARCONI AVE
ARDEN WAY
AUBURN BLVD
ENGLE RD
WINDING WAY
MADISON AVE
SUNSET AVE
GREENBACK LN
OAK AVE
TWIN OAKS AVE
ANTELOPE RD
DOUGLAS RD
KIEFER BLVD
JACKSON RD
GRANT LINE RD
ELDER CREEK RD
FLORIN RD
GERBER RD
CALVINE RD
SHELDON RD
BOND RD
WILTON RD
DILLARD RD
WALNUT RD
KAMMERER RD
BILBY RD
BROADWAY
12TH AVE
14TH AVE
21ST AVE
FRUITRIDGE RD
47TH AVE
BEVAN RD
DAWS RD
STONE BLVD
15TH ST
CAPITOL AVE
REED AVE
U.S HWY 50
IRON POINT RD
WHITE ROCK RD
LATROBE RD
PRAIRIE CITY RD
SUNRISE BLVD
SCOTT RD
EAGLES NEST RD
SLOUGHHOUSE RD
EXCELSIOR RD
BRADSHAW RD
WATERMAN RD
ELK GROVE FLORIN RD
FRANKLIN BLVD
LAGUNA BLVD
CLARKSBURG RD
JEFFERSON BLVD
POWER LINE RD
EL CENTRO RD
BAYOU RD
RIVER RD
ALTA MESA RD


2036 Work Trips
Top 25 Destinations
Destinations 26-50
Destinations 51-75
Destinations 76-100


2036 Non-Work Trips
Top 25 Destinations
Destinations 26-50
Destinations 51-75
Destinations 76-100

Results

These maps show the clusters of destinations throughout Sacramento County over the 25-year horizon of Sacramento's regional land use and transportation plan. As land use and development patterns and travel behavior shift, so do the top vehicle destinations in the county. A few key clusters emerge from these maps:

Downtown Sacramento: This is a primary destination for work trips in 2012 and will continue to be in 2036. The decrease in Downtown destinations in 2036 is in large part a result of increased walk, bike, and transit trips to the Downtown employment center. Therefore, EV infrastructure planning should be careful not to replace these other modes with vehicle trips; instead they should work to incentivize those remaining vehicle trips to be made with EVs whenever possible. Aside from where chargers are installed, policies on pricing can help (see Attachment D for more information on pricing).

Universities, Colleges, and Hospitals: Many trips to these uses can also be made by walking, biking, or taking transit. These areas attract many work trips and non-work trips that could be made by EVs, and are key opportunities for locating workplace and public charging.

Corridors: Clusters of EV destinations appear along highway and major road corridors. Highways and major roads are higher-density areas for vehicle trips and their adjacent parcels are frequent destinations for drivers, that can include commercial shopping centers. Highway and major road corridors also attract land uses that bring larger magnitudes of people than smaller, local streets. These areas can accommodate all EV users, including those living in multifamily housing units. Corridor charging is meant for trip continuation and may not be near a primary trip destination. The driver must interrupt his or her trip to recharge and continue the journey.

These findings were compared to analyses performed by the Plug-In Hybrid & Electric Vehicle (PHEV) Research Center and the University of California, Davis. UC Davis' PHEV Research Center analyses use a spatial model to predict where public "charging events" are likely to be needed based upon origins, destinations, route choice, EV range (the distance driven per charge), and travel behaviors. These exclude charging events that would happen at private residences.

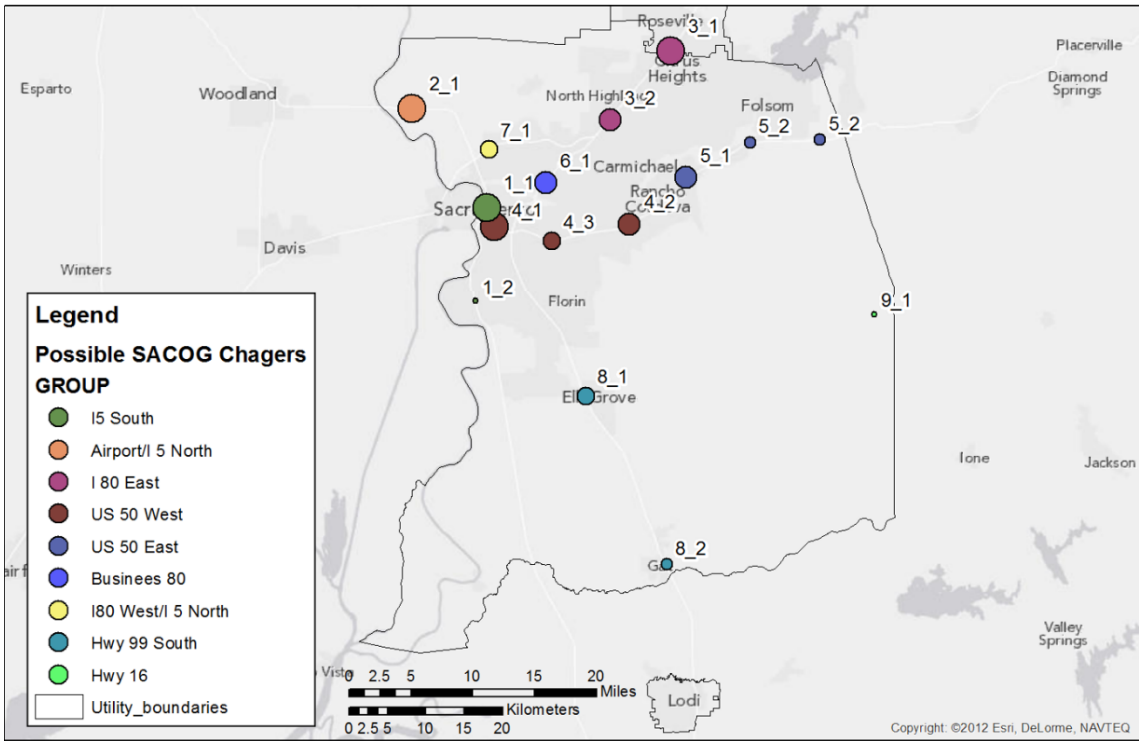
The PHEV Research Center focused its analysis along corridors, giving each highway corridor a priority and then prioritizing destinations along each corridor. The results of this analysis show similar clusters to the analysis performed with SACOG's travel demand model data. These clusters

focus within Downtown Sacramento, at the Sacramento International Airport, and along Highway 50 and Interstate 80 in the eastern parts of Sacramento County.

These same clusters appear on the maps for both work trips and non-work trips in 2012 and 2036. Rankings are shown below in Table 5.

TABLE 5: UC Davis PHEV Research Center Public Charging Demand Analysis

Corridor	Corridor Rank	Location	Location Rank
Interstate 5 South	1	1004	2
Interstate 5 South	1	1016	1
Airport/Interstate 5 North	2	1013	1
Interstate 80 East	3	1010	1
Interstate 80 East	3	1011	2
US 50 West	4	1001	2
US 50 West	4	1002	1
US 50 West	4	1007	3
US 50 East	5	1003	1
US 50 East	5	1008	2
US 50 East	5	1009	2
Business 80	6	1012	1
Interstate 80 West / Interstate 5 North	7	1014	1
Highway 99 South	8	1005	2
Highway 99 South	8	1006	1
Highway 16	9	1015	1



The first number in the sub-group ranking indicates the rank of the charging area while the second number shows which charger in the group was superior. A rank of 5-2 would indicate that the area was the 5th best and the charger was the second choice in the 5th best group.

Prioritized Charging

The maps shown on pages 17-20 represent charger locations for the top 100 destinations in Sacramento County by work and non-work trips in 2012 and 2036. The 2012 destination maps should be considered the highest priority areas for charger installations as they represent areas with the highest existing demand. The work trips represent employment clusters that are conducive to workplace charging for level 2, while the non-work trips are corridors and areas with high trips and are more conducive to public charging opportunities at level 2 or DC fast charging.

Multifamily Charging

Much attention has been paid to the availability of charging in multifamily (MF) housing, including apartment complexes, townhomes, studios, and condos. While these types of housing represent a sizable share of the housing supply in Sacramento County, charging an EV in multifamily units presents more difficulty than a single-family home. Despite state legislation making the installation and use of charging in multifamily units easier, barriers still exist. The major barriers of installing charging stations are politically and technically difficult to overcome. They can be categorized as stakeholder-related, site-related, and cost-related:

Stakeholder-related

- Homeowner Association codes, covenants and restrictions (CC&Rs) and landlords may prevent installation of charging stations in multi-family.
- Property owners or managers may see conversion of parking spaces as a hassle.
- Renters may fear repercussions of lobbying too hard for EVSE.

- Landlords and property managers may not want to assume responsibility for managing equipment.
- Turnover of tenants in multi-family may mean that at a given time, no residents will have electric vehicles and charging stations will go unused.
- Potential lost value if renters leave their multi-family units and paid for EVSE installation.

Site-related

- Physical limitations of buildings, such as number of parking spaces for residents, inadequate electrical capacity, configuration of carports and parking areas, distance between parking sites and electrical outlets, unable to access Wi-Fi in underground parking if it's a networked charger, complying with Americans' with Disabilities Act (ADA) requirements, etc.

Cost-related

- Uncertainties about who will assume responsibility for paying for electrical upgrades, installation, maintenance, electricity usage, etc.
- Homeowner Associations are not eligible to receive many of the major subsidies and rebate programs that can offset the costs of installing EVSE.
- Costs to retrofit existing parking lots and structures can be expensive and prohibitive.

The analysis conducted for this project consider these difficulties and, in addition to exploring charging along corridors, explored charging in retail and commercial areas given that many multi-family complexes are adjacent or in near proximity to these areas. See attachment C for further analysis of retail charging as a proxy for multifamily.
Charging in multi-family affordable housing complexes can be even more challenging, where EV ownership by residents is less likely to exist. A pilot is currently underway between the Sacramento Metropolitan Air Quality Management District and two Affordable Housing Developers to locate electric car share programs (PEVs and charging infrastructure) at 4 MF complexes. This pilot will provide valuable information regarding demand, EV use and EVSE as well as how to advance more EVs in lower income/disadvantaged communities.

6. Policies and Actionable Steps

While this plan does not set specific goals for the County of Sacramento, or jurisdictions within the county, it is important to have a set of clear steps defined in order to increase the purchase and use of EVs in the county, and support EV's across the region. These steps should follow the SMART process, where each actionable step is **s**pecific, **m**easurable, **a**ttainable, **r**elevant, and **t**ime-based.

Readiness Policies

Based on the EV readiness assessment, Sacramento County appears well situated for more EVs on local roads, corridors, and highways. Continued work on building and development codes that require more EV charging infrastructure, monitoring of EV charger permitting and installation processes, and offering more public and workplace charging will further support county EV readiness. Below are specific policy recommendations related to EV readiness. While geared

towards the County of Sacramento, these recommendations are presented for consideration by other municipalities in the county, as relevant:

- Building & Development Codes
    - Adopt Tier 1 or Tier 2 voluntary green building codes to increase the number of EV charging ready parking spaces and parking standards for multifamily and non-residential projects.
    - Research the cost and policy implications of requiring the installation of EV chargers in new multifamily dwelling units and/or commercial centers adjacent to MF complexes.
    - Require all new Master Plans and Specific Plans to address and incorporate EV charging infrastructure.

- Monitoring
    - Develop a quarterly process to track the EV charging permitting and inspection process, and utilize the Sacramento area PEV Collaborative to identify and overcome any barriers that exist, particularly if the timing of the permit process lengthens.
    - As jurisdictions adopt Climate Action Plan measures for employee commuting and fleet EV usage; set annual targets for fleet and employee EV use for 2018 through 2025 that reflect the county's portion of the statewide EV targets. Measurements can be made through the number of occupied EV charging spaces, employee surveys, fleet vehicle use reservation records, etc.

- County-wide Charging Infrastructure
    - Explore whether existing chargers at County, City and State facilities can be made available to employees, and where feasible, the public.
    - Create an inventory of workplace and public chargers at public facilities and inform EV drivers of their availability. Utilize the Sacramento area PEV Collaborative, County area TMA Coordinators and collaborate with others to distribute this information.
    - Utilizing the Sacramento area PEV Collaborative, County area TMA Coordinators and others, monitor and evaluate the use of EV parking spaces and charging to identify when additional chargers may be needed, particularly where additional load capacity exists.

- Fleets (EV and ZEV)
    - Explore public and private fleet adoption policies, similar to the City of Sacramento, where “30% of fleet purchases to be alternative fuel.” Assess opportunities for shared EV infrastructure when fleet is in use and charging is available.
    - Where EVs are a viable fleet choice, expand EV infrastructure to support migration of fleet light duty passenger cars to Zero Emission Vehicles (ZEVs) where it is more cost effective over the vehicle’s life cycle and duty cycle requirements can be met.
    - Convert fleet fuel consumed from traditional fossil sources for liquefied natural gas (LNG) and compressed natural gas (CNG) to LNG and CNG produced from renewable sources, or feasible electric and zero emission technologies as they become available.

Similarly, convert fleet fuel from traditional petroleum diesel to renewable diesel or zero emission alternatives.

Incentives

Early EV adoption utilized incentives from federal, state, and local sources to help lower upfront purchase prices, charger installations, charging costs, and EV usage and parking. Existing and new incentives are needed to continue the growth of EVs in Sacramento County. Below are specific policy recommendations related to incentives for EVs and charging:

- Financial
    - Utilize the Sacramento Area PEV Collaborative (SacPEVC) to explore providing cash incentives for purchasing EVs, and/or purchasing and installing EV charging infrastructure. Incentives could include rebates, parking discounts, tax incentives, grants, and loans.
    - Continue to seek grants to further reduce costs and provide incentives.
    - Explore an EV Purchase pilot similar to that done by Sonoma Clean Power "Group Buy Discount" program, which provided significant discounts on EV purchases.
    - Explore incentives (i.e. reduced parking rates, free charging) for workforce EV/ZEV adoption.

- Convenience
    - Offer preferred parking to EVs at publicly-owned and maintained facilities.
    - Continue to work with SMUD on residential time-of-use rates within the county to encourage charging at home.

- Partnerships
    - Continue work with SMUD and others on charging infrastructure incentives. Utilize SacPEVC resources to work with host locations on incentivizing new and existing locations for charger purchase and installation.

    - Use the preferred location analysis map (http://arcg.is/1yGP9O) in two ways:
        1. **Proactive**: identify potential host locations (identify parcel numbers APN), market to property owners and managers in the area to install chargers, and create flags in the permit database to identify the need and demand for charging in the area and work with host location on incentives to install charging equipment.
        2. **Reactive**: flag areas in the permit database, and if property owner or manager applies for a permit with work being done that is conducive to installing chargers (examples include redoing a parking lot, upgrading electrical panel, installing solar, etc.), work with host location on incentives to install charging equipment. Execute similar procedure when Planning entitlement applications are submitted, engage with applicant to include EV charging.

    - Work with project partners to install the high priority charging locations identified in this report, and the "quick win" list compiled by SMUD and project partners. See Appendix E for the quick win list.

- Engage with business on a larger scale through the Clean Air Partnership, State PEV Collaborative, and others in advancing workplace and public charging.
- Create a recognition program to recognize EV friendly workplaces.

Funding Policies

Many federal and state funds allow for the purchase and installation of EV charging infrastructure. Working with other county departments on the prioritization and/or inclusion of EV chargers in county projects will further increase EVs in the market. Below are specific policy recommendations related to funding:

- Internal Focus
  - Recommend: The County and jurisdictions in the county should prioritize and include EV chargers in county and city public projects. This should be included for new facilities being constructed and for existing and leased buildings. Various incentive programs exist that the county and cities can take advantage of. For example: include EV infrastructure when applying for state and/or federal transportation funds (chargers are allowable with CMAQ funds and the Community Development Block Grant). SMUD is currently offering $1,500 towards installation of charging infrastructure.

- External Focus
  - Work with small business owners, Clean Air Partnership, SacPEVC, State General Services and others to use the CalCAP program to design, purchase, and install EV chargers.

7. Disadvantaged Communities

According to the CVRP, less than 1% of EV rebates in the state of California come from residents within a state designated disadvantaged community as defined by CalEPA and the CalEnviroScreen tool. More than 70% of these sales are within the Los Angeles county area. However, residents in disadvantaged communities make up approximately 25% of California's population and 18% of the state's light-duty auto sales. Some of this discrepancy in EV ownership between residents in disadvantaged communities (DAC) and those outside of these areas is due to the high entry cost of EV ownership. Other reasons could include, but are not limited to things such as the inability to charge at home, a lack of nearby charging infrastructure, or only having one car in the household and needing more transportation options.

Sacramento has a disproportionate share of residents that live in disadvantaged communities. According to CalEnviroScreen 3.0, 36 percent of residents in the city of Sacramento live in the top 25 percent of disadvantaged census tracts statewide, exceeding the statewide proportion of approximately 24 percent of California residents that live in such communities. Sacramento's disadvantaged communities also rank in the top 10 percent of disadvantaged census tracts in the State.

Incentives

Beginning in November of 2006, the state rebate for the purchase of an electric vehicle increased from $1,500 to $2,000 for low-to-moderate income households, as defined by the federal poverty level. According to research conducted by the California Air Resources Board, 80% of disadvantaged community residents who purchased an EV stated that the rebate was either a very or extremely important reason for them to purchase an EV. This highlights the need to continue the statewide EV incentive program, and underscores the need for local action as well.

The Sacramento Metropolitan Air Quality Management District is currently developing an Enhanced Fleet Modernization Program for the Sacramento region in conjunction with the California Air Resources Board. This program will be an anticipated $3.3 million to $6.6 million program to assist low-income residents in disadvantaged communities to turn in older, higher emitting cars in exchange for new or newer low- to zero- emission cars. The program is expected to launch in late 2017, and will offer additional financial rebates and incentives to income-eligible households for the vehicle purchases.

Residential Type and Tenure

As shown in Attachment B, the type of home and whether it is owned or rented is a significant factor of who is a likely EV owner. Those data show that 91% of EV owners live in a detached single-family home, and 96% own their home. In California's disadvantaged communities, however, only 72% live in a detached single-family home, and only 33% of low-income households in the state own their home. While this might be an indicator of likely EV ownership, it could be seen as a barrier to EV ownership as installing a charger could be difficult. It would still be possible to use a Level 1 charger without the need to install charging equipment, so education about charging options, and providing some ride and drive or similar events to increase exposure to EV's, could alleviate some of these issues.

A 2016 report by the California Energy Commission[7] outlines many issues to energy efficiency and renewable energy use in disadvantaged communities that are pertinent to EVs. Barriers such as high entry costs, home ownership, and age of the structure (making retrofits difficult) can make it difficult for EV ownership in disadvantaged communities. Some would argue why install EV chargers in DACs when most residents cannot afford an EV. The other side of this argument is if there is nowhere to charge, why would someone living in a DAC purchase an EV. This becomes an issue of equity and requires a multi-prong approach.

This infrastructure plan looks at different ways of providing infrastructure and increasing exposure and adoption of EVs in the county and particularly in disadvantaged communities. One way is to directly place charging infrastructure within disadvantaged communities. This could be through public and workplace charging within those areas. Another is in a way that benefits disadvantaged communities, such as public and corridor charging. This method looks at where people living within a disadvantaged community tend to travel and placing charging in those areas. Visibility of EVs in

[7] Scavo, Jordan, Suzanne Korosec, Esteban Guerrero, and Bill Pennington. 2016. *A Study of Barriers and Solutions to Energy Efficiency, Renewables, and Contracting Opportunities Among Low-Income Customers and Disadvantaged Communities.* California Energy Commission. Publication Number: CEC-300-2016-009-SD.

disadvantaged communities will increase awareness that EVs are for everyone. Residents need to be informed of the EV ownership incentives and pricing reductions available to certain income levels, along with promoting the reduced costs of the used EV market. This will help shift the common thought that only "rich people" can afford to own and drive an EV.

EV Car Share pilot is currently underway by the Sacramento Metropolitan Air Quality Management District and Affordable Housing Developers to locate EVs and Chargers at four affordable housing complexes in DACs, and make the EVs available through a car share program. This is the first such affordable housing EV car share program in the state and is highly replicable. Similar chauffer-type programs are being developed to give rides to senior citizens who cannot afford to own a car or who do not have drivers' licenses and will help address the transportation and access issues in DACs. Public Libraries and other community buildings also rise as desirable locations for early charging infrastructure.

The identified and prioritized charging in this plan is general in nature and does not specifically consider disadvantaged communities. However, it does have the opportunity to benefit residents of these areas.

8. Future Considerations

Technology associated with EVs and related charging equipment is rapidly changing. With advancements in battery and vehicle technology, there is continually an array of new vehicles available for purchase. This will change who buys EVs and where they travel, but also how and where the vehicles are charged. Due to this shift in the market, SACOG will continue to examine the state of EVs in the region, and work with project partners and SacPEVC to ensure the latest information is being considered for readiness, infrastructure planning and implementation. Below is a list of potential changes that would impact the work in this plan, and a high-level discussion on how it would be addressed.

Battery and Vehicle Technology

- Further advancement in batteries and vehicle technologies will increase the range of vehicles. While some of this was factored into the modeling work, range will only increase, thus shifting driving and charging behavior. Any increases in average range should be captured in future plan updates.

- With new EV choices on the market, including crossovers and SUVs, the consumer market will grow. This is true for new and used vehicles, which will further broaden price-point entry

to the EV market. This will change who purchases and drives EVs, and where EV charging is most needed. Future updates should examine available vehicles, future price points for EVs, and purchasing trends for hybrids and EVs.

- Connected and electric autonomous vehicles (AV) could have major impacts on travel behavior, charging demand, charging locations, charging behaviors, and land uses. Example questions include: Will AVs decrease the need for parking? If fewer parking garages are available, where will chargers be located? How will the charger be different in an autonomous EV? Does having an autonomous EV allow different demographics to enter into EV ownership? How will peoples' travel patterns change in the future and what influence will this have?

- What influence will battery storage and mobile energy sources to support the grid play in all this?

There are few or no answers to these questions, now, but future updates should examine the impacts from connected and autonomous vehicles.

Financial Considerations

- Will there be changes in the cost of EVs? If upfront costs are further reduced, the market for EVs could expand. On the other hand, the loss of incentives could decrease the market. How does the resale of used EVs change the market charging demographics and behavior?

- Are there lessons to be learned from the paddle chargers? Will inductive charging be more prevalent and what are the impacts of that? Solar storage, battery swaps, etc.

- The region is pursuing new funding sources and partnerships. One opportunity may include funding from the VW Settlement and the ZEV Investment Plan, released in March 2017 which identified the Sacramento region for investments in community charging infrastructure and Green City Programs. (As of the time of writing, the proposed investment plan is still pending approval by CARB).

    - The City of Sacramento and SMUD are being approached by various electric vehicle auto makers who are interested in opportunities in Sacramento.
    - Evaluate the Our Community EV CarShare Program for expansion to other affordable housing sites.
    - City of Sacramento will be working with EVgo for the installation of a curbside, high-speed DC fast charging plaza at Southside Park. This will be the first curbside "high-power" charging station in the country, charging 3 times the speed of typical DC fast chargers (i.e. a 300 mile range EV can get a full charge in 20-30 minutes).

As stated earlier, the world of ZEV information and technology is rapidly changing. We also know that having a sufficient number of reliable charging points will be necessary to provide confidence to potential EV buyers and existing EV owners. SACOG will continue to examine the state of EVs in the region, and work with project partners and SacPEVC to ensure the latest information is being considered for readiness, infrastructure planning and implementation.

Attachment A – Initial Sacramento County EV Readiness Scorecard – January 2016

Figure 6 Sacramento County EV Readiness Score

Overall, the county scored well on the self-assessment and received an "On the Right Track" grade based on the questions answered. Figure 7 shows the overall score for Sacramento County from the DOE EV Readiness Scorecard. There are, however, several areas that the assessment highlighted as needing attention. Each element is described below. *NOTE: A new assessment was done in January 2017. The overall score for Sacramento County improved from "On the Right Track" to "Great Job!"

Charging Infrastructure Planning

The infrastructure planning area received the highest score on the assessment. This is mainly due to the efforts of the various project partners like SACOG, Sacramento Municipal Utility District (SMUD) and others in planning, purchasing, and installing Electric Vehicle Supply Equipment (EVSE) - or simply charging infrastructure - throughout the county. While this score is highest, work can be done to solidify partnerships moving forward and identify locations for public, workplace, and residential charging opportunities.

Market Conditions

Market conditions refers to the availability and existing penetration of EVs into public and private fleets. Being the home county for the state's capitol and having all EVs released available for sale in California, Sacramento is well-positioned for high EV market penetration. As of the writing of this document, Sacramento County has over 2,500 EVs being driven on its roads by county residents[8]. This high number of vehicles has led to an increase in the number of charging stations permitted and installed in the county, with more continuing to be added. The actual number of charging stations is difficult to estimate, as not every EV charging station installation requires or receives a unique permit. Based on a web search from various sources, there are between 90 and 140 publicly available charging stations in the county. It is likely that there are many more private workplace and residential charging stations throughout the county, but this number is unknown. This lack of understanding of the existing charging landscape is what lowers the county's score for Market Conditions.

Utility Involvement

The involvement of SMUD, the local electrical utility, has augmented both the understanding of today's charging landscape and current EV penetration in the county. SMUD has been a leader in the electric vehicle field, with the creation of specific EV charging electricity rates, understanding and education of EV impacts on the grid, planning and analysis of EVs, and a general commitment to

[8] Center for Sustainable Energy (2016). California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics. Data last updated March 02, 2016. Retrieved [insert date retrieved] from https://cleanvehiclerebate.org/rebate-statistics

engagement on the topic. Additionally, SMUD has purchased and installed many charging stations in their service territory. This work leads to a very high grade in this area of the assessment. The only item that was discounted is a notification system of when EV charging infrastructure can be or is installed in existing and planned developments.

Education and Outreach

Education and outreach was a large part of the early regional effort with the creation of an EV council, regular meetings, and outreach to various interested parties and stakeholders. It is, however, in need of refreshing, which is why the score is not perfect. The county and its partners including SMUD, City of Sacramento, Sacramento Metropolitan Air Quality Management District, SACOG, Clean Cities and others will be leveraging the State's education and outreach campaign that is currently under development.

Laws, Incentives, and Financing

There are federal and statewide incentives; however, there is little in the way of local efforts to increase EV purchases and use, or purchase and installation of necessary charging infrastructure. The county has taken some effort by allowing by right EV charging in all zoning and land use designations, but the assessment's score is reduced because of the lack of incentives and stronger policies on EV use and charging. Sacramento County also has adopted and has made available PACE financing that allows property owners to fund energy efficiency and renewable energy projects for residential or commercial properties with little or no upfront costs.

Permit and Inspection Process

Of the six focus areas in the assessment, the EVSE Permitting and Inspection Process in January 2016 received the lowest score. This was largely due to lack of a specific fee and permit process for EVSE installation. There are some simple steps and elements from the regional plan that can be applied for increased readiness in this area, but the biggest increase in score would likely need to come from a revamp of the permit process. This project, however, will continue to place emphasis on this area. (Note: Since the initial assessment, Sacramento County has created and is implementing expedited installation of charging infrastructure).

Figure 8 below highlights the EV readiness scores from the January 2016 DOE assessment for Sacramento County.

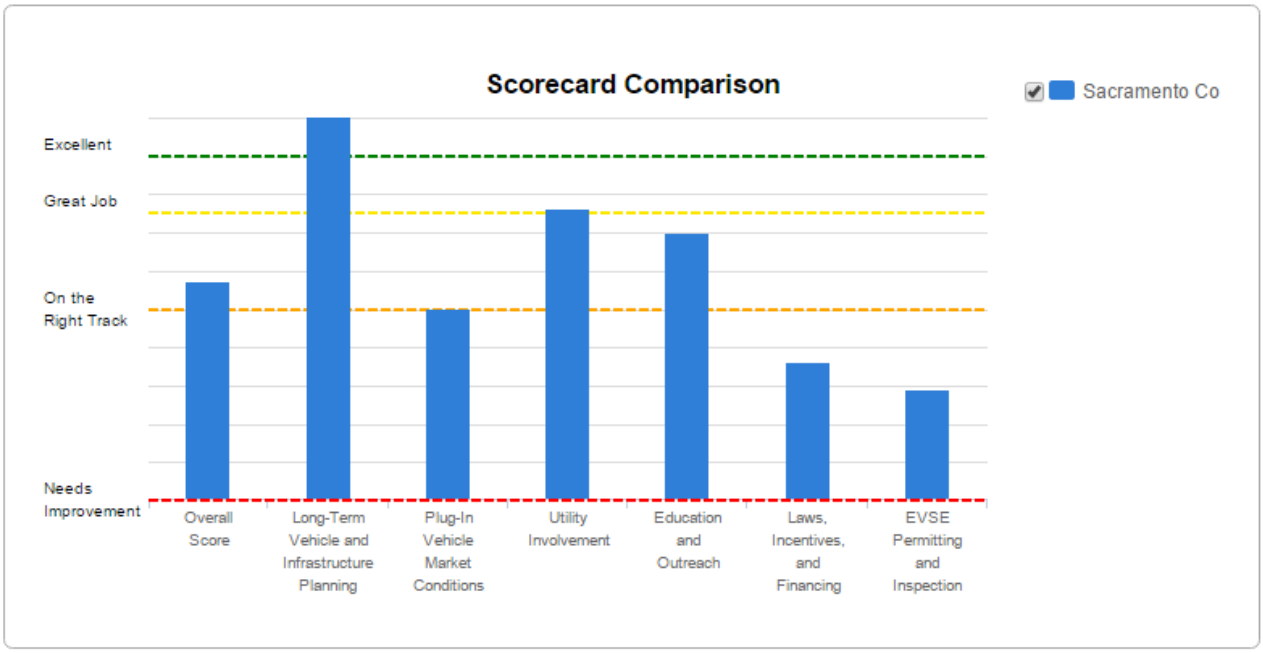


Figure 7 Sacramento County EV Readiness Scorecard

Recommended Actions

A list of recommended actions was compiled based on the EV assessment. These actions include those that are needed to adhere to state regulations, as well as optional best practices that may be considered for adoption. These actions will be used throughout the project to increase the level of EV readiness in the county. While not all actions from this list will be implemented, using the list as a guide will raise awareness within the county about what is needed to prepare for increased EV adoption and use.

1. Streamline construction permitting and inspection processes

Sacramento County has already created and is implementing expedited installation of charging infrastructure for purchasers of EVs, including an on-line permitting process that allows a vehicle purchaser to have charging infrastructure installed rapidly. Streamlined permitting for residential chargers typically has a 24-hour turn-around time; for non-residential charger permits only, a permit is typically issued within 7 days. County compliance with AB1236 is already in affect and cities within the county can similarly adopt these streamlined practices. Cities with populations under 200,000 have until September 30, 2017 to comply with AB1236.

Best Practices for EV Readiness:

In October 2015 AB1236 was adopted streamlining EV charging station permitting and provides for consistent statewide standards to achieve timely and cost-effective installation of EV charging stations. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1236. AB1236 referenced the Office of Planning and Research, "Zero-Emission Vehicles in California: Community Readiness Guidebook" and the "Plug-In Electric Vehicle Infrastructure Permitting Checklist" as a resource. https://www.opr.ca.gov/docs/ZEV_Guidebook.pdf A systematic guide to EVSE permitting, including checklists can be found in Attachment F, that meet the requirements of AB1236.

2. Update building codes

Comply with California State Building Codes by including charging infrastructure and dedicated circuits for charging infrastructure, as appropriate, in new construction and major renovations. Encourage building energy efficiency upgrades to offset new electric vehicle charging loads. Consider utilizing Tier 1 or Tier 2 voluntary green building codes to increase the number of EV charging ready parking spaces for multifamily and non-residential projects.

Mandatory Measures for EV Readiness:

Attachment B taken from the California Green Building Code (CALGreen), which highlights the EV-related measures that are mandatory to achieve various tiers under the CALGreen code. More information about CALGreen can be found here: http://www.bsc.ca.gov/Home/CALGreen.aspx

Best Practices for EV Readiness:

The following examples were collected as resources:
Electric Vehicle Charging Station Installation Best Practices, A Guide for San Diego Region Local Governments and Contractors, June 2016
http://energycenter.org/sites/default/files/docs/nav/transportation/plug-in_sd/Plug-in%20SD%20Installation%20Best%20Practices%20Report.pdf

3. Update zoning and parking rules

Implement local ordinances as are necessary to facilitate the installation and access to publicly available charging infrastructure. Attention should be given to compliance with American with Disabilities Act if applicable. Additionally, signage and parking enforcement best practices should be adopted for both information and regulatory (e.g. parking restrictions) purposes.

Sacramento County took positive steps to address EV parking when it allowed EV designated spaces and charging infrastructure to count toward parking requirements, and total parking square footage, with updates to the County Zoning Code Development Standards 5.9.3.A.8 and 5.9.5.C.f.[9]

5.9.3.A.8 Electric Vehicle Parking**.** Parking spaces providing electric vehicle charging stations shall be designed to comply with the California Building Standards Code and other federal and state regulations. Electric vehicle charging station may qualify for parking reductions, as addressed in Section 5.9.5.C.1. Parking spaces designated for electric vehicle charging stations shall be counted toward meeting the minimum parking requirement.

5.9.5.C.f Provision of Electric Vehicle Charging Station. Each electric vehicle charging station shall be permitted to substitute for two (2) vehicular parking spaces. The area needed for charging equipment shall count toward meeting the parking space requirements.

Best Practices for EV Readiness:

Zoning rules for EVs ensure that charging is an outright allowed use in any zone, as it complements many land uses. EV charging does not alter the purpose of a land's use, but complements existing

[9] http://www.per.saccounty.net/LandUseRegulationDocuments/Documents/Zoning%20Code%20Final%20Adopted%20July%2022%202015/Updates%20to%202015%20Zoning%20Code/Effective%20April%202016/Zoning%20Code%20Effective%20September%2025%2c%202015%20%5bAmended%2004-07-16%5d.pdf

uses by alternative transportation modes. Sacramento County has taken big steps in this direction by outright allowing EV charging in all zoning designations.

TABLE 3.2: ALLOWED ACCESSORY USES[86] [AMENDED 04-07-2016]

KEY

P= Permitted Primary Use | CZ = Conditional Use Permit by the Zoning Administrator | Grey Boxes = Refer to Applicable Use Standards in Sections Identified

MC= Minor Use Permit | A = Permitted Accessory Use

Zoning Districts	Agricultural			Agricultural-Residential		Residential						Recreation			Mixed Use			Commercial			Industrial			Use Standard
Use, Service, or Facility	AG-160, AG-80, AG-40, AG-20	UR	IR	AR-10, AR-5	AR-2, AR-1	RD-1, RD-2	RD-3, RD-4	RD-5, RD-7	RD-10, RD-15	RD-20, RD-25, RD-30, RD-40	RM-2	RR	O	C-O	NMC	CMC	NMZ	BP	LC[87]	GC[88]	MP	M-1	M-2	
CC. Electric Vehicle Charging Station	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	

In California, the EV Collaborative's work on accessibility and signage (http://www.EVcollaborative.org/sites/all/themes/EV/files/EV_Accessibility_120827.pdf) has been implemented in various jurisdictions throughout the state, and offers a good collection of best practices related to signage.

4. Implement training and education programs

Training and education necessary to ensure that vehicles and related electric charging equipment is installed, maintained, and operated in a safe and proper manner. This could include training for:

- City and County inspectors, construction permitting officials, and plan checkers
- Electric charging point users,
- First responders and public safety officers,
- Electrical contractors in the county and region
- General Services maintenance staff

Best Practices for EV Readiness:

As part of the regional EV readiness project, a list of EV related training opportunities was created. This list is provided as Attachment G.

Additional Actions

5. Create and implement a plan for effective marketing, outreach

a. Outreach should include EVs, charging services, and infrastructure; local utility rate programs and support services

b. Communicate available incentives for plug-in vehicle owners and those considering EV ownership. These may include:

- Rebates of part of the purchase price of the vehicle;
- Reductions in sales taxes or registration fees;
- Rebates or reductions in the costs of permitting, purchasing, or installing home plug-in electric drive vehicle charging infrastructure; and
- Rebates or reductions in State or local toll road access charges;
- Preferred parking spaces or single-rider access to high-occupancy vehicle lanes for plug-in electric drive vehicles;

- Programs for reduced or free charging at select locations (i.e. Spare The Air, transit stations, etc.).

c. Engage project partners and others (BERC, Economic Development, Sacramento Clean Cities, ZEV dealerships, shopping center owners, etc.)
d. Strengthen the used EV market through education effort focused on cost, availability and usability of EVs for second and third owners.

6. Public charging station site selection

Create a methodology and a 3- to 5-year charging station site plan for deploying workplace and publicly available charging infrastructure, including:

a. Review land-use patterns, core residential and workplace locations, and travel routes;
b. Create primary and secondary charging locations preferences, building types, etc.;
c. Evaluate charging level necessary at public locations (Level 1, Level 2, DC Fast Charge);
d. Evaluate how charging infrastructure should integrate with (and compliment) mass transit, walk/bike thorough ways, car share, etc.;
e. Establish policy for charging at street-side parking;
f. Adopt surface street signage policies (using state/federal signs) to direct drivers to public charging (also acts as outreach to encourage EV usage) and parking space signage for EV use only.
g. Implement corridor planning between urban centers along major travel routes.

7. Work with local employers to encourage workplace charging

Develop outreach actions to inform local employers and property owners of the benefits of providing workplace charging (to employees), and approaches for implementation.

8. Work with utilities to manage grid impacts and rate structures

Policies and plans for accommodating the deployment of EVs, including:

a. Implement utility notification protocols;
b. Analysis of potential impacts to the grid;
c. Plans to minimize the effects of charging on peak loads, including new technology like solar battery back-ups;
d. A proposed plan for making widespread utility and grid upgrades;
e. A plan for ensuring that the charging infrastructure or EV be able to send and receive the information needed to interact with the grid.

9. Addressing multi-unit dwelling (MUDs) and Disadvantaged Communities (DACs)

a. Identify and address the unique challenges of installing infrastructure at multifamily residential buildings, particularly affordable housing projects and disadvantaged communities;
b. Conduct outreach to local HOAs to work through their concerns and building challenges;
c. Utilize resources such as Greenlining.org to engage with underserved communities. http://greenlining.org/wp-content/uploads/2015/01/Electric-Carsharing-in-Underserved-Communities-spreads.pdf

10. Purchase EVs for local government fleets

a. Set a target for number of EVs to purchase over a time horizon;
b. Establish purchase and evaluation criteria that accounts for increased purchase cost but lower operating costs over time. Additional criteria should include reduced environmental impact and how EVs in the fleet can help meet a jurisdiction's climate action plan (CAP);
c. Co-locate fleet charging stations with public access to allow for shared use, also providing additional outreach capability (fleet vehicles charging).
d. Take advantage of rebates and purchasing incentives.

11. Create new incentives and expanded outreach efforts

a. Identify new incentive programs that may be necessary to encourage vehicle purchase and use in the county. Expand the focus to include benefits of used EVs as well as new EV purchases.
b. Work in collaboration with Clean Cities, Sacramento EV Owners, Plug In America and other initiatives to provide vehicle test drive and/or vehicle loan programs to get numerous residents "behind the wheel" for extended periods of time.

12. Encourage Renewable Energy

Local governments and private developers should encourage and implement renewable energy installations associated with EV charging, such as solar carports and residential rooftop solar installations. The county and cities could include solar requirements in all master plans, specific plans, etc.

13. State Partnerships

Continue working with the California Air Resources Board, DriveClean CA, CA PEV Collaborative, the Department of Energy, Governor's Office of Planning and Research and others to optimize data and efforts to deliver ZEV infrastructure and information to residents. Utilize the many resources and progress tracking information provided by the state.

Attachment B – Technical Documentation of Destination Charging Analysis

This analysis, conducted by SACOG, identifies the best areas to target installation of public electric vehicle charging infrastructure in the greater Sacramento area on who currently drives EVs. The results were created by the following methodology and data analysis.

METHODS

LITERATURE REVIEW & DATA COLLECTION

To identify current EV drivers, academic literature and governmental reports were reviewed to find which, if any, demographic characteristics are associated with EV owners. Several characteristics were found: middle-aged, high household income, high educational attainment, homeownership, living in a single-family home, multi-person households, multi-vehicle households, hybrid-electric vehicle ownership, and having solar panels installed on the property. These characteristics are summarized in the table below.

Characteristic	Indicator	Data Source
Age	50% between 43 and 58 years 80% between 37 and 65 years old Median 50 years	Campbell et al. 2012, Hidrue et al. 2011, Ozaki et al. 2011, CARB 2012, Tal et al. 2012
Household income	79% have household income ≥$100K	Deloitte 2010, Ozaki et al. 2011, CARB 2012, Tal et al. 2012
Educational attainment	87% have Bachelor's degree or higher	Campbell et al. 2012, Hidrue et al. 2011, CARB 2012
Homeowner	96% are homeowners	Campbell et al. 2012, CARB 2012, Tal et al. 2012
Housing type	91% live in single-family home with attached garage	Campbell et al. 2012, Hidrue et al. 2011, CARB 2012, Tal et al. 2012
Number of persons in household	93% live in multiple-person household	CARB 2012
Number of vehicles in household	95% own ≥2 cars	Campbell et al. 2012, Deloitte 2010, Hidrue et al. 2011, Ozaki et al. 2011, CARB 2012, Tal et al. 2012
Owning hybrid-electric vehicle	68% have owned HEVs at some point	Tal et al. 2012
Solar household	42% have solar panels on their house	Tal et al. 2012

Demographic data were individually mapped with ArcGIS 10 to show each characteristic's prevalence and geographic distribution in the population. The resulting maps also showed which characteristics were reliable and useful for analysis. Some characteristics were contradictory in indicating EV ownership and some were too homogenously distributed to be useful. For example, Census tracts with a high percentage of single-family homes were the inverse of Census tracts with a high percentage of advanced educational attainment; however, housing type was too homogenous across the region to be a useful indicator. The same was true for solar households.

ANALYSIS

The region was first analyzed by educational attainment as it was the strongest indicator of EV ownership that was most diversely distributed across the region. Census tracts where at least 25% of the population held Bachelor's degrees or higher were extracted and matched with SACOG's travel model data. This showed all transportation trips made by residents of these Census tracts. Attached to these trips were data about the location of the resident's household, where the trip started, where it ended, what mode was utilized (auto, transit, carpooling, walking, bicycling, et cetera), the purpose of the trip (work, school, social/recreation, shopping, et cetera), and the distance of the trip.

Next, the trips were analyzed by querying the additional EV ownership indicators. Within the Census tracts with high educational attainment, households were filtered out if they were multi-person (number of persons in household greater than 1), had a yearly income greater than or equal to $100,000, and owned two or more vehicles. Furthermore, these needed to be trips that could be made with an EV, so trips were further filtered by mode to include only personal vehicles (driving to or from transit, carpools, and driving alone). Because the scope of this study is interested in the installation of public charging stations, the data were sorted to exclude trips to work and home. Data analysis was done in Microsoft Access. It is interesting to note that a similar methodology could be employed for exploring where to site workplace charging stations, where data are sorted to include only trips to work.

The output of this analysis was a database of automobile trips made by SACOG-region residents who fit the likely "early adopter EV owner" profile, including where each trip ended (the destination parcel) as provided by the travel model. From this database, trips were aggregated by destination parcel to quantify how many trips end at each parcel. These destination parcels and quantities were then mapped in GIS to display these quantities geographically. The clusters of destinations on this map give an approximation of the macro areas that could be targeted for public EVSE installation.

To focus the analysis on destination areas instead of parcels, a 0.25 mile buffer was drawn around every parcel that had a daily destination count of at least 100 trips. Many of these 0.25 mile buffers overlapped. Therefore, the total number of trips was summed by each aggregated buffer zone, which produced a map with densities of "likely EV" trips shown by macro area.
Buffer zones were analyzed, and categorized by the number of trips they attracted in a day. These zones are intended to be used as quantitative guides to select sites for installation of EVSE, set thresholds and develop prioritization strategies.

Finally, current EVSE was drawn onto the map to illustrate where charging infrastructure is already located. These charging station data were collected from the California Department of Energy in November 2012.

Attachment C – Analysis for Multifamily Housing Charging at Nearby Retail Locations

SACOG performed analysis for viability of multifamily resident charging to be done in nearby retail and commercial centers. Analysis can be applied to all communities regardless of income. SACOG's EV retail analysis was driven by two important issues:

1. The significant challenges surrounding EV charging for residents living in multifamily housing.
2. SACOG's support (as stated in the 2035 MTP/SCS) for diverse housing choices, with an emphasis on high density, attached, multifamily housing.

Both of these issues pointed to a clear need to investigate charging opportunities for EV drivers that live (or will live) in multifamily housing. Given the political challenges (i.e. landlords, property managers or Homeowners Associations) and site-specific obstacles (electrical wiring, unreserved parking, etc.), SACOG determined that off-site charging with physical proximity to multifamily housing could be an acceptable proxy for residential charging.

The purpose of the land use and transportation analysis was to identify a destination that is routinely traveled to by car. This would create a charging opportunity that was not an added burden (either in trip frequency or by mode choice) to an EV driver.

Using travel model data, grocery stores throughout the region emerged as a strong candidate for "multifamily proxy" charging. Aside from the sheer volume of physical grocery stores in the region (over 200), trips to the grocery store were conducive to EV charging for the following reasons:

1. Grocery shopping trips are unlikely to be replaced with another mode of transportation because vehicles offer convenient storage space for bulky grocery items.
2. Travel model data confirmed that people are often patrons of grocery stores that are close to where they live. The incidence of shopping at a local grocery store, as opposed to driving across town makes grocery shopping a convenient opportunity to charge.
3. According to the American Time Use Survey (ATUS)[10], the average time spent grocery shopping–not including time spent getting to and from the store–is 41 minutes. Additionally, the average person makes 2.1 trips a week to the grocery store. These shopping patterns are conducive to getting a top off charge from a Level 2 charge or nearly a full charge from a DC Fast Charger. Of note is that SMUD installed chargers in a Raley's parking lot off Antelope Road, in the City of Citrus Heights. This is providing valuable data for future use. Special

[10] The ATUS is a national survey that samples Americans how they spend their time over a 24-hour period. The grocery store estimate is based on the responses of 38,229 adults from the 2005, 2006, and 2007 ATUS. "Who Does the Grocery Shopping, and When Do They Do It?" Goodman, Jack. The Time Institute. October 2008. http://www.timeuseinstitute.org/Grocery White Paper 2008.pdf Brown, Cheryl and Tatiana Borisova. "Understanding Commuting and Grocery Shopping Using The American Time Use Survey". International Association of Time Use Research XXIX Conference. Washington, D.C. 17-19 October 2007. www.atususers.umd.edu/wip2/papers_i2007/CBrown.pdf

attention will need to be given to DACs, particularly where there are “food deserts” and generally fewer grocery stores.

The methodologies of SACOG’s analysis were as follows:

1. Used parcel-level housing data for the region to identify medium, medium-high density housing, as designated in the MTP/SCS.
2. Overlaid point locations of grocery stores in the region.
3. Built a 2.6-mile buffer around grocery stores to see what housing locations were served by the potential EVSE location. The 2.6-mile buffer was derived by taking the regional average of 25.8 VMT per capita per day. If an individual drives 3 consecutive days without charging, they will have traveled 77.4 miles. Assuming 80 miles per charge, this leaves 2.6-miles to get to a grocery store to charge. Going to the grocery store a few times a week to charge their car is consistent with typical shopping trips in a week.

This analysis is strictly a hypothetical and theoretical exercise; it makes no formal recommendations for where charging stations should be installed. Its purpose is to look at how much of the region’s multifamily housing occupants could “reasonably” (i.e. fit within the 2.6-mile buffer) use grocery stores as a proxy for residential charging.

Attachment D – Analysis on Pricing for EV Charging

SACOG conducted a study on the appropriate pricing strategy for EV charging in the greater Sacramento area. The purpose of the analysis was to explore different costs to charge and park an EV, as compared to the cost to take transit or drive and park an internal combustion vehicle. This was done as a way to incentivize conversion of current commute Vehicle Miles Traveled (VMT) to electric VMT while still incentivizing transit use, per the VMT reduction targets set by SB 375 and the MTP/SCS 2035. This can take two forms, the first is to set the price as to find price points that were higher than riding transit, but lower than fueling and parking an internal combustion vehicle. The other is to create "congestion" pricing for on-peak charging.

Congestion pricing is an economic strategy for pricing congestible public goods with higher peak charges during busy times, and incentivizes use during non-peak times or utilizing alternative modes during peak times.

Pricing Policy Study Area: Downtown Sacramento

Transit	Full Fare	Subsidized– 75%
Minumum transit pass cost	$100	$75
Maximum transit pass cost	$180	$135
Average transit pass cost	**$122**	**$91**

Electric Vehicle	Single	Carpool
Avg off-peak electricity cost ($/kWh)	$0.11	$0.11
Average fuel economy (m/kWh)	3.1	3.1
Average commute distance (roundtrip, miles)	22.22	22.22
Average fuel cost per day ($)	$0.77	$0.77
Average fuel cost per month ($)	$16.83	$16.83
EV parking cost per month ($)	$143.65	$106.44
Total EV commute cost per month	**$160.49**	**$123.27**

Gasoline Vehicle	Single	Carpool
Average gas price per gallon ($/gallon)	$3.80	$3.80
Average fuel economy (m/g)	22	22
Average commute distance (roundtrip, miles)	22.22	22.22
Average fuel cost per day ($)	$3.84	$3.84
Average fuel cost per month ($)	$84.44	$84.44
Average parking cost per month ($)	$144	$106.44
Total gas vehicle commute cost per month	**$228.09**	**$190.87**

	Cost	Cost Increase
Transit Subsidized	$91	
Transit Full Fare	$122	($30)
EV Carpool	$123	($32)
EV Single	$160	($69)
Gas Carpool	$191	($100)
Gas Single	$228	($137)

Data for Reference

Commute Distance by Community Type	**Miles**
center/corridor	14
established	20
developing	24.1
rural	32.5
regional	20.5

Fuel Economy (2010 models)	**MPG**
Focus	28
Camry	26
LD SUV	22
F150	16
Minivan	18

Electric Fuel Economy	**m/kWh**
Focus Electric	3.1
Leaf	3.4
Volt	2.8
Tesla	2.9

Transit	**Full**	**Subsidized– 75%**
Amtrak monthly pass (Davis-Sac)	$144	$108
Regional Transit monthly pass	$100	$75
Yolobus monthly + Express pass	$110	$83
El Dorado Transit monthly	$180	$135
Yuba-Sutter commuter monthly	$128	$96
Roseville Transit Commuter monthly	$110	$83
eTran monthly commuter	$100	$75
Folsom Stage Lines monthly	$100	$75

Parking	**Single**	**Carpool**
City Hall Garage (10th & I, 11th & I)	$185	$138.75
Capitol Garage (10th & L)	$185	$138.75
Downtown Plaza West Garage (3rd& L)	$135	$101.25
Downtown Plaza Central Garage (5th & J)	$330	
Downtown Plaza East Garage (6th & L, 6th & J, 7	$145	$108.75
Old Sacramento Garage (2nd & I)	$115	$86.25
Tower Bridge Garage (Front & Capitol Mall)	$130	$97.50
Memorial Garage (14th & H St.).	$135	$101.25
East End Garage (17th, Between L St. & Capitol	$40	
Lot 293 (5th & I St. – SVS/Amtrak)	$120	
Lot 297 (7th & G St.)	$110	
Lot D (12th & I St.)	$135	
Lot X (2nd & N St.)	$105	$79.00
Lot Y (2nd & O St.)	$6/day	
Metro Lot (7th & L St.)	$120	
On-street meters (monthly)	$247.50	

Electricity Cost (SMUD Residential)	**$/kWh**
winter on-peak	$0.1093
winter off-peak	$0.0989
summer on-peak	$0.2414
summer off-peak	$0.1124

Attachment E – EVSE Quick Win List

Project Name	L2	DC Fast Charge	L2	DC 50KW
Sacramento International Airport	2	1	2	2
Citrus Heights Raley's Supermarket	1	1	1	2
Sacramento Valley Trains Station (Downtown Amtrak Station)	0	2	0	3
Sacramento Food Cooperative	2	1	1	2
Elk Grove Nugget Market	2	2	2	3
Sacramento Valley Station	0	0	9	2
Sacramento County Fleet Services Facility expansion of Level II EVSE				
Sacramento County DGS Fleet Services Facility expansion of Level II EVSE				
Sacramento County DGS Fleet Services Facility expansion of Level II EVSE				
Sacramento County DGS Fleet Services Facility expansion of Level II EVSE				
Sacramento County DGS Facility Management expansion of Level II EVSE				
Sacramento County DGS Facility Management expansion of Level II EVSE	0	0	2	0
Sacramento County DGS Facility Management expansion of Level II EVSE	0		1	
Sacramento County DGS Facility Management expansion of Level II EVSE	0	0	1	1
Sacramento County Library Facility replacement/expansion of Level II EVSE	1		1	
Sacramento County Library Facility replacement/expansion of Level II EVSE	0		2	
Sacramento County Library Facility replacement/expansion of Level II EVSE	0		1	
Sacramento County Library Facility replacement/expansion of Level II EVSE	0		2	
Sacramento County Library Facility replacement/expansion of Level II EVSE	0		2	
Sacramento County Library Facility replacement/expansion of Level II EVSE	0		2	
Fairytale Town / Sacramento Zoo / Funderland Amusement Park	0	0	4	0
Sacramento Marina	0	0	4	0
Franchise Tax Board	0	0	4	
City of Elk Grove	2		8	
SMUD Headquarters Campus		1		1
Sacramento Valley Trains Station (Downtown Amtrak Station)		2		2
Elk Grove Nugget Market	2	2	2	1
SMUD Headquarters Campus Redesign		1		4

Attachment F – EVSE Permitting Checklist

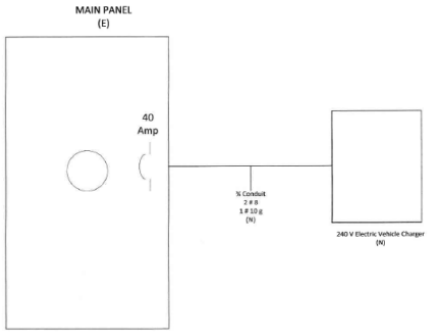
Your Logo and Department Information Here

Submission Checklist for Electric Vehicle Supply Equipment (EVSE) Installations

Article 625 – 2010 California Energy Commission

Submittal Requirements:

Sample Single Line



1. One-line diagram; showing:

   - Location(s) of new and existing meter/sub meter and charge controller.
   - Wire sizing and routing path from the main panel to the EVSE.
   - Indicate main panel amperage and EVSE breaker.

2. Provide manufacturer installation details and specifications for the EVSE.

3. Complete the Electrical Load Calculation Worksheet (Form CDD-0213) and provide load calculation of electrical service – include the electrical load required to charge the vehicle at 125%.

4. Note the voltage (120V or 240V) of the EVSE on the Single Line Drawing.

5. All EVSE shall be UL listed.

General Requirements:

1. Coupling means of electric vehicle supply equipment shall be stored or located at a height of not less than 18” and not more than 48” above the floor level.

2. Electric vehicle supply equipment rated 125 volt, 15 or 20 amp may be cord and plug connected. All other EV supply equipment shall be permanently connected and fastened in place.

3. If both 120v and 240v circuits are desired to be monitored by a dedicated electric vehicle meter, a meter with distribution will be required.

Your Logo and Department Information Here

Electrical Load Calculation Worksheet
N.E.C. 220.82

THIS SHALL BE ON THE JOB SITE AT ALL TIMES SUBMIT (number)

COPIES Permit #_____ Date:_____

Contractor/Owner:_____

Job Address: _____ Total SF_____

Phone # _____ Email:

Number	Item	Watts
	Sq. Ft, @ 3 Watts per Sq. Ft - 220.12	
	20 Amp. Appliance circuits @ 1500 watts each - 220.52(A)	
	Range (Nameplate Rating = N.P.R.)	
	Oven (N.P.R.)	
	Cooking Units (N.P.R.)	
	Water Heater (N.P.R.)	
	Dishwasher (N.P.R.)	
	Disposal (N.P.R.)	
	Washer [(1500 watts min. N.E.C. 220.52(B)]	
	Dryer [(5000 watts min. or N.P.R. if larger) N.E.C. 220.54]	
	Motors (N.P.R.)	
	Other (N.P.R.)	
	Other (N.P.R.)	

Air Conditioning Example
(not heat pump)

Compressor 20 amps
Fan 5 amps

Unit Total Load = 25 amps x 240V

Elec. Furnace @ N.P.R.= 6000 watts x 65% = 3900 watts
Use 6000 watts since it is larger

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Heat Pump Example

Compressor 20 amps
Fan 5 amps

Unit Total Load = 25 amps x 240V= 6000 watts

Aux. Heat Strip = 6000 watts x 65% = 3900 watts
Total Heat Pump Load = 9900 watts

Heat Pump Note:
When doing load calculations where heat pumps are installed, the load for most heat pumps that are equipped with auxiliary heat strips will be larger under the demand for heat. For purposes of load calculations only, on heat pump compressor and fans use 65% of auxiliary heat load to show total heat pump load.

Air Conditioning Equipment Air Conditioning [cooling @ (N.P.R. x 100%)] =	Subtotal = _____ (Loss 1st 10KW – 10,000 @ 100% = 10,000 Watts)
Electrical Heating @ (N.P.R. x 65%) =	**Remainder @ 40%** _____ **@ 40%** _____ **Watts**
NOTE: Use the largest load - Heat or Cool =	**Total Air Cond. and/or heat pump load =** _____ **Watts**
Heat pump (compressor & fans) x 100% =	**Total Service Load =** _____ **Watts**
Aux. Heat strips (or elect. furnace) x 65% =	**Total Service Load** _____ **Watts/240V =** _____ **Amps**
Total Heat Pump Load =	Service Size _____
NOTE: Amps x Circuit Voltage = Watts	
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Attachment G – Plug-in Electric Vehicle Training Resources

1) Initial Occupations List

a. **Infrastructure Installation** (Electricians, Building Inspectors, Fire Marshal)
b. **Infrastructure Repair and Maintenance:** (Electricians, Facilities Maintenance Workers)
c. **Electrical Vehicle Manufacturing** (Assembly Workers)
d. **Electrical Vehicle Maintenance, Repair, and Conversions** (Automotive Mechanics & Technicians) http://www.calmis.ca.gov/file/occguide/Alternative-Fuel-Vehicle-Tech.pdf
e. **Safety First Responders: (**Firefighters, Law Enforcement Officers, and Tow Truck Drivers.)
f. Sales and Marketing: Auto dealers show room staff
g. Management: Facilities Managers, Safety Managers, Automotive Managers

2) Installation for both residential and commercial charging stations

a. http://evsolutions.avinc.com/services/installer_network/certification_program/
    i. In order to join the ranks of AV's Certified Installer Network, each licensed independent electrical contractor must participate in a rigorous training program provided by AV. Training includes:
        1. Technical requirements and FAQ
        2. Oracle CRM systems trainings
        3. Response time requirements
        4. Customer orientation
        5. Inventory management
        6. On-site safety
        7. Troubleshooting
        8. Customer communications and appearance

b. www.ontility.com/training/ev-charging-station-classes Become a Certified EV Charging Solution Professional

c. http://www1.eere.energy.gov/cleancities/toolbox/pdfs/electric_vehicle_infrastructure_training.pdf
    i. A structured platform for delivering training and certification for the installation of Electric Vehicle Supply Equipment (EVSE's) across Residential, Commercial & Public Markets

3) Electric vehicle mechanic training programs

a. http://www.greencareersguide.com/Electric-Vehicle-Conversion-Specialist.html The career outlook for an Electric Vehicle Conversion Specialist is good. They make on average $39-$59 thousand a year.

b. Ameriskills http://ameriskillstech.com/courses/electric-vehicle/

c. Clean Tech Institute http://www.cleantechinstitute.org/

a. National Alternative Fuels Training Consortium: http://www.naftc.wvu.edu
   i. ABRAM FRIEDMAN OCCUPATIONAL CENTER (ATC)
      Nate Davis – natesmoggdogg@sbcglobal.net
      (213) 765-2400, x2559 Los Angeles, CA
   ii. RIO HONDO COMMUNITY COLLEGE (NTC) http://www.riohondo.edu/tech/auto/
      Mike Slavich – mslavich@riohondo.edu
      (562) 463-7368 Whittier, CA
   iii. TRANSFER FLOW, INC (Small Business)
      Bill Gaines – bgaines@transferflow.com
      (530) 893-5209, ext. 22 Chico, CA
   iv. YUBA COLLEGE (NTC)
      Edward Davis – edavis@yccd.edu
      (530) 741-6853 Marysville, CA

d. Cerritos College https://cms.cerritos.edu/auto/

e. Skyline College Automotive Hybrid Technician Training
   http://www.smccd.net/accounts/skysmog/classes.html
   http://www.skylinecollege.edu/programsofstudy/business/automotive/automotiveDegrees/asAutoTechnology.html

f. College of Marin
   http://www.marin.edu/departments/CareerEducation/AutomotiveTechnology/

g. San Diego Miramar
   http://www.sdmiramar.edu/academics/programs/progdetail?pgid=AUTO

4) Safety training for first responders

a. http://www.evsafetytraining.org/ The National Fire Protection Association's (NFPA) Electric Vehicle Safety Training project is providing firefighters and first responders with the information and materials necessary to respond to emergency situations involving electric vehicles.

b. http://www.naftc.wvu.edu/curricula_training/course_workshop_information/first_responders First Responder Safety Training offered through the National Alternative Fuels Training Consortium (NAFTC)

c. http://mydocs.epri.com/Docs/PublicMeetingMaterials/1009/4FNWWJ9XQWB/407589_E234984_Pauly_UL_EV_Infrastructure_Training_Programs.pdf Underwriter's Laboratory presentation on their safety training plans.

5) Electric vehicle manufacturing and assembly training

6) Other Related Websites:

a. UC Davis Plug In Hybrid and Electric Vehicle Research Center http://phev.ucdavis.edu/

b. https://sites.google.com/site/greentransportationcommp/home/resources Green Transportation Collaborative Resource Links

c. http://projectgetready.com/category/menu

d. NEMA EVSE Charging Station User Manual & Installation Instructions
    i. www.geindustrial.com/publibrary/checkout/DEH-44160?TNR=Installation%20and%20Instruction%7CDEH-44160%7Cgeneric

e. www.ev-chargeamerica.com/electric-vehicle-charging-stations.html
    i. Each user on the network is provided with a small RFID (Radio Frequency Identification) tag that they carry on their key ring that only works in the proximity of a charging station. When they arrive at a charging station, the RFID tag authenticates them as a subscriber to the service and the station is activated, electricity is turned on, and the charging unit further secures their plug-in cord so that it cannot be removed by anyone else.

f. www.greentechmedia.com/articles/read/coulomb-technologies-will-install-nearly-5000-ev-charging-stations/Charging station owners, or hosts, as Coulomb likes to call them, can set up a payment system to recoup the cost of electricity and maintenance (similar to a parking meter), while utilities can monitor the usage to help coordinate demand-side management. The data collected will be analyzed by Purdue University and Idaho National Labs. The results of this program will help Coulomb and its partners determine whether customers will want programs like reserved charging, which is not currently available.

g. www.pluginamerica.org/

h. www.hybridconsortium.org/

i. http://evsolutions.avinc.com/products/at_home/Charging at Home

j. http://avt.inl.gov/pdf/phev/phevInfrastructureReport08.pdf Plug-in Hybrid Electric Vehicle Charging Infrastructure Review – U.S. Department of Energy 2008

k. http://energy.sourceguides.com/businesses/byGeo/US/byP/ev Electric Car Manufacturers

l. http://www1.eere.energy.gov/cleancities/news_detail.html?news_id=16685 Rewarding communities that invest in EV's through competitive grants, rebates

m. http://www.calcars.org/about.html The California Cars Initiative (CalCars.org) is a Palo Alto-based nonprofit startup of entrepreneurs, engineers, environmentalists and consumers promoting 100+MPG plug-in hybrid electric vehicles (PHEVs).

n. http://www.afdc.energy.gov/afdc/fuels/electricity.html DOEn information.

o. www.afdc.energy.gov/afdc/laws/state_summary/CA DOEn information & links about California laws & resources

p. http://www.ul.com/global/eng/pages/offerings/industries/powerandcontrols/electricvehicle/ Underwriters Laboratory's page on PEV infrastructure safety.

Attachment H – Sacramento International Airport EVSE Infrastructure Plan: Electric Vehicle Supply Equipment (EVSE) Plan for Sacramento International Airport (SMF) Parking Facilities

Background:

In 2015, The Sacramento County Department of Airports (Department) entered into a Memorandum of Understanding with the Departments of Waste Management and Recycling and General Services to fund the Take-Charge Sacramento Zero-Emission (ZEV) and Plug-In Electric Vehicle (PEV) Infrastructure Implementation Plan (Plan).

California leads the nation in the adoption of electric vehicles which includes battery Plug-in electric and plug-in hybrid electric types. Improved battery technology, increased vehicle make and model choices, state incentives and volatile gasoline prices are a few of the reasons why this market continues to grow. As electric vehicles become more mainstream, the demand for public charging stations increases in kind.

Current EVSE technology includes Level 1, Level 2 and Direct Current (DC) fast chargers. All electric vehicles can use Level 1 and Level 2 chargers. DC fast chargers, however, require vehicles to have a specific DC connection.

- Level 1 chargers provide the slowest charge (four miles of range for every hour of charging).
- Level 2 provide a moderate rate of charge (20 miles of range for every hour).
- DC fast chargers are the fastest (150 miles of range for every hour) and require more supporting infrastructure.

Current EVSE Infrastructure:

When the Parking Garage was constructed in 2004, two Level 2 inductive paddle charging stations were installed in priority parking stalls on each floor plus two additional inductive paddle charging stations were installed in the Daily Lot for a total of 14 public EV charging stations at SMF.

In 2012, in an effort to conform to the industry standard J1772 connector configuration and utilizing a grant from the California Energy Commission (CEC) administered and matching funds provided by ClipperCreek Inc., one legacy inductive paddle station was removed from each floor of the Parking Garage and replaced with two Level 2 charging stations. One legacy paddle conductive station was removed from the Daily Lot and four Level 2 J1772 charging stations were installed. A total of 16 industry standard chargers and 8 inductive paddle charging stations were available for use.

In 2016, the Department of Airports partnered with SMUD to install an electric vehicle fueling station in the Free Waiting Area parking lot. The station has one DC fast charger and two Level 2 chargers along with the electrical infrastructure for an additional DC Fast charger. SMUD charges 24 cents per kWh for DC fast charging.

In 2017, the Department of Airports installed 12 Level 1 chargers in the Parking Garage near the Terminal B elevators and removed all of the obsolete inductive paddle charging stations from the Parking Garage.

At this time, there are 12 Level 1 and 12 Level 2 chargers in the Parking Garage and four Level 2 chargers and one legacy paddle charger in the Daily Lot. A total of 29 EVSE are available for passenger use in addition to the DC fast charger and two Level 2 chargers in the Free Waiting Area which are accessible to the public.

Future EVSE Locations and Recommended Infrastructure:

The Department of Airports is fully supportive of the Take-Charge Sacramento Zero-Emission (ZEV) and Plug-In Electric Vehicle Infrastructure Implementation Plan. The Department has recently initiated the development of its environmental Sustainable Management Plan (eSMP), which is anticipated to be completed by the 3rd quarter of 2018. The Department will update the SMF EV Charging Plan upon the completion of the eSMP.