Draft Central Sierra Zero-Emission Vehicle Readiness Plan

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Prepared for
Tuolumne County Transportation Council

Prepared by
Center for Sustainable Energy

CALAVERAS COUNCIL
of GOVERNMENTS

TUOLUMNE COUNTY TRANSPORTATION COUNCIL

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Executive Summary

Alternative fuel technology in the State of California is quickly moving towards the electrification of vehicles. As evidence, Executive Order B-16 tasked the California Energy Commission (CEC) and other state agencies to support benchmarks to bring 1.5 million zero-emission vehicles (ZEVs) to California's roads by 2025 (extended to 5 million ZEV by 2030) and the California Air Resource Board developed the Innovative Clean Transit regulation, to electrify transit fleets throughout the State. Due to its size, population, and tourism draw, the Central Sierra Region plays an important part in helping the State reach these goals. Building a network of ZEV infrastructure will continue to support the draw to the Region as a center for visitor attractions as well as support the continued adoption of ZEV among Central Sierra residents.

This Zero-Emission Vehicle (ZEV) Readiness Plan (the Plan) was developed by Tuolumne County Transportation Council (TCTC) in collaboration with the Center for Sustainable Energy (CSE). The Plan places the Central Sierra Region (Region) on a pathway to accelerate the transition to electrified transportation, respond to evolving driver needs, and reduce greenhouse gas emissions related to vehicle travel. The Plan profiles existing ZEV conditions, identifies barriers to ZEV deployment in rural communities, recommends siting for infrastructure, and actions to support continued adoption.

The Region is located along the western slope of the Sierra Nevada mountain range and includes a four-county area: Alpine County, Amador County, Calaveras County, and Tuolumne County. The Regional population is approximately 139,438 people, 45% whom are close to retirement and live locally year-round. The second largest segment of individuals within the Region (10.2%) are also close to retirement but reside in the area seasonally. Despite the relatively small permanent population, the Region is home to several historical state and national parks with beautiful scenery and recreational activities that attract year-round visitors.

The Region has existing ZEV drivers and ZEV infrastructure but has not achieved wide-adoption. Zero-emission vehicles encompass two distinct types of vehicle technology: hydrogen fuel-cell electric vehicles (FCEVs) and plug-in electric vehicles (PEVs). Both types of technology are considered "zero-emission" due to the lack of combustion exhaust generated during their operation. This Plan primarily addresses PEV planning due to limited current FCEV registrations and lack of State funded FCEV infrastructure projects proposed in the Region before 2025.

There are currently 203 plug-in hybrid electric vehicles (PHEVs) and 196 battery electric vehicles (BEVs) in the Region according to 2018 vehicle registration data from the State of California. This accounts for just 0.16% of total vehicle registrations in the four-county Region. EV vehicle growth projections identify two scenarios for PEV growth in the Region: Scenario A and Scenario B. Scenario A, High PEV Projection, anticipates 2,233 PEVs in the Region by 2025, representing 0.17% of the estimated statewide PEV fleet. Scenario B, Low PEV Projection, estimates 1,548 PEVs in the Region by 2025, representing 0.12% of the estimated statewide PEV fleet.

Currently, there are 27 sites that offer EV charging with a total of 70 charging ports. While the current charging infrastructure is sufficient in terms of number of charging plugs per vehicle, analysis of geographical coverage of existing public charging stations shows that these charging stations are heavily concentrated in southern and western portions of the Region and are mainly located in small cities in the foothills. Existing infrastructure is means there are opportunities for deployment along

major travel routes that lead over the Sierra Nevada's or state/national parks located further east in the Region.

Demand projections suggest that in order to meet resident demand, a minimum of 230 EV charging units will be required with a maximum estimate of 320 charging units in the Region by 2025. Charging station plug projections will require 191 to 249 destination Level 2 charging station plugs in the Region and 39 to 71 direct current (DC) fast charging plugs to support the expected growth in number of EVs by 2025. This means that the number of destination level 2 charging plugs will need to increase nearly 5-fold over the next 7 years and the number of DC fast charging plugs will need to increase nearly 7-fold over the same time.

The California Statewide Regional Travel Model estimates that 23,299 daily trips originated outside and ended within Central Sierra in 2010; that count is projected to increase by 89% to 44,068 daily trips in 2040 (California Department of Transportation, 2014). On average, daily EV visitors to each County in 2025 is expected to be: Alpine County 27, Amador 647, Calaveras 801, Tuolumne 758.

Combining resident and visitor travel projections, EVI investment for 2025 increases to 8 ports for Alpine, 130 for Amador, 122 for Calaveras, and 128 for Tuolumne (388 total ports).

To meet the expected demand, the Central Sierra Region should:

1. Create and maintain a Regional EVI collaborative;
2. Integrate this Plan into local planning efforts;
3. Utilize and promote fuding opportunities;
4. Track Plan progress and report to community;
5. Prioritize investment in DCFC at a 20-mile radius;
6. Develop a Regional EVI expert & technical advisory program;
7. Plan for ZEB transition for small transit fleets;
8. Engage with the business community and other stakeholders; and
9. Prioritize Level 2 infrastructure at public sites and destinations (e.g., hospitality and recreation).

INTRODUCTION

Introduction

Governor Edmund G. Brown Jr.'s Executive Order B-16-2012 tasked the California Energy Commission (CEC) and other state agencies to support benchmarks to bring 1.5 million zero-emission vehicles (ZEVs) to California's roads by and in conjunction make sure that Californians have easy access to ZEV infrastructure to charge those vehicles by 2025. Further committing to the adoption of ZEVs, Governor Brown signed Executive Order B-48-18 in January 2018, committing to the adoption of 5 million ZEVs on the road by 2030. With the transportation sector being the largest contributor to greenhouse gas (GHG) emissions in California, ZEVs are integral for meeting GHG emission reduction goals identified in AB 32, AB 197, and SB 32, and play a significant role in meeting regional targets identified in Tuolumne County Transportation Council's (TCTC) Rural Sustainable Strategies from the 2016 Tuolumne Regional Transportation Plan. To meet state and regional targets, TCTC engaged the Center for Sustainable Energy (CSE) to develop a Central Sierra ZEV Readiness Plan (the Plan) for the four-county area: Alpine County, Amador County, Calaveras County, and Tuolumne County.

The goal of the Plan is to improve opportunities for ZEV Readiness in the Central Sierra Region (Region) and resolve barriers to the widespread deployment of private and public ZEV infrastructure. In pursuit of this goal, the following critical project objectives were identified:

1. Evaluate the current state of the ZEV market;
2. Study and analyze site locations needed for ZEV infrastructure deployment;
3. Evaluate opportunities to streamline ZEV permitting, installation, and inspection to facilitate the timely approval and construction of ZEV infrastructure;
4. Study and analyze the feasibility of ZEV adoption in municipal fleets;
5. Create a venue for stakeholder coordination and gain input from key stakeholders on the ZEV Readiness Plan;
6. Identify funding sources for an implementation program.

Stakeholders and Contributors

The development of this Plan required input and advisory from a diverse array of regional stakeholders. As part of the project, a Working Group was assembled with leaders from each of the four Counties and Regional Transportation Planning Agency (RTPA). A full listing of stakeholders and contributors are listed below.

Project Leads
Darin Grossi and Alex Padilla - Tuolumne County Transportation Council
Scott Walsh, David Lange, Kevin Wood, Derek Ichien - Center for Sustainable Energy
RTPA Members
Brian Peters - Alpine County Community Development
John Gedney, Nancy Champlin, and Felicia Bridges - Amador County Transportation Commission
Amber Collins - Calaveras Council of Governments
Tuolumne County Transportation Council (see above)

Plan Structure

Section	Description
Section I. Introduction	Describes the project goals, outlines the structure of the document and recognizes regional contributors to the Blueprint development and deployment.
Section II. Regional Overview	Describes the Region (e.g., electrical infrastructure, geography, etc.)
Section III. ZEV Technology	Provides an overview of existing ZEV Technology and Alternatives.
Section IV. EVCS Technology	Provides details on EV charging equipment, EV infrastructure (EVI) processes, associated costs, business models to consider, and innovations.
Section V. Existing Conditions	Discusses the current state of EVI in the Region.
Section VI. Gaps Analysis	Identifies the infrastructure needed to support the deployment of EVs and the projections of tourism in the Region.
Section VII. Recommendations	Details site recommendations for destinations and public L2 and DC Fast chargers (DCFC) along highway corridors and at regional and tourist destinations.
Section VIII. Implementation	Provides recommendations for Plan implementation and an overview of the tools to utilize in implementing regional EVI.
Section VIX. EV Charging Station (EVCS) Planning Tools	Provides an overview of the Utility Coordination Guidebook, Permitting Guidebook, and Fleet Adoption.

Policy Context

Over the past 20 years, there have been an increasing number of national- and state-level policies that have improved and guided the climate for ZEVs. Policy is typically directed at one of two areas: the vehicles themselves or the infrastructure used to fuel them, commonly referred to as hydrogen fueling stations for fuel-cell electric vehicles (FCEVs) and electric vehicle charging stations (EVCS) for plug-in electric vehicles (PEVs).

ZEV Vehicles

Historically, one of the largest barriers to EV adoption was the price premium associated with buying a ZEV over an internal-combustion vehicle. To combat this, in 2010, the Internal Revenue Service (IRS) implemented Code Section 30D, which offers a national-level tax credit for the purchase of a plug-in hybrid, battery-electric, or fuel-cell-electric vehicle, set to sunset on a per-manufacturer basis as each manufacturer sells 200,000 cumulative eligible vehicles in the United States.

In 2012, California Governor Edmund G. Brown Jr. set a mandate for 1.5-million ZEVs to be on the road by 2025. This mandate was supplemented in 2018 by of Executive Order B-48-18, which set a goal of 5-million ZEVs on California roads by 2030. Additionally, several bills (Assembly Bill 32 (AB 32), AB 197, and State Bill 32 (SB 32) have been adopted to reduce statewide greenhouse gas (GHG) emissions. With the transportation sector contributing over 40% of GHG emissions in California, ZEVs are am integral component of meeting GHG emission reduction goals.

Charging Infrastructure

Electric Vehicle Charging Stations (EVCS)

As part of Governor Brown's ZEV mandate, the state of California has set a statewide goal for 250,000 EVCS by 2025. Throughout the state, critical stakeholders are working to incentivize and install stations to meet that goal. The state's three largest utilities – Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E) – all offer some form of financial incentive to potential site hosts who are interested in installing public EV charging on their properties.

Fuel Cell Electric Vehicles and Infrastructure

In January of 2018, Governor Edmund G. Brown Jr. signed Executive Order B-48-18, boosting the use of ZEV including hydrogen refueling infrastructure in California. Part of this order calls for a hydrogen station network development target of 200 hydrogen fueling stations by 2025 with proposed funding activities totaling $20 million in annual awards to meet this goal.

The California Fuel Cell Partnership (CaFCP) members recently published an ambitious shared vision for the potential growth of the industry to 2030. In their vision, the targets of the Executive Order are a

stepping stone on the path to 1,000,000 FCEVs on the road by 2030, supported by a network of 1,000 hydrogen stations. Accomplishing these goals in such a short period of time requires a significant change in the pace of developments going forward, along with combined resolve and commitment from all stakeholders.

Building Codes

The 2016 California Green Building Standards Code (CALGreen Code), effective since January 1, 2017, identifies mandatory and voluntary codes for EV infrastructure in buildings and parking lots within California. These codes establish construction requirements for new residential and commercial buildings.

- Section 4.106.4 of the CALGreen Code describes EV charging guidelines for new residential construction, detailing parking space dimension designations and electrical configurations in accordance with California Electrical Code, Article 625. New single- and two-family dwellings must have raceways installed that accommodate 208/240-volt circuits for every unit, while 3% of multi-unit dwellings (MUDs) with 17 or more units must accommodate 40-amp circuits (California Building Standards Commission, 2016). Service or subpanels with EV charging circuits must be marked as "EV CAPABLE" to support future EV charging.
- Section 5.106.5.3 provides codes for new construction at commercial locations, which provides electrical configuration and parking space requirements for EV charging spaces. Newly designated EV charging spaces are required to support 40-amp circuits and mark EV-capable panels for future spaces.
- Section 4.106.8 provides additional code tiers for residential locations that facilitate future EV charging installation. Under this mandate, new single- and two-family dwellings and townhomes with attached private garages must meet mandatory requirements and be labeled as EV-ready for future installations. For MUDs, 5% of total spaces for buildings with 17 or more units will be designated EV charging spaces. This was amended in 2018 to require that 10% of parking spaces must be "EV Capable" starting on January 1, 2020.
- Section A5.106.5.3 introduces additional tiers for new commercial development.

Table 1: Regional Transportation Planning Goals Supporting EV Infrastructure

County	Plan	Goal	Policy or Objective
Tuolumne	2016 RTP Regional & Interregional Transportation Chapter	TSM Goal: Develop a transportation system that maximizes the use of transportation facilities in the most efficient and cost-effective way.	Policy: Develop and support a regional Electric Vehicle Infrastructure Implementation Plan for Tuolumne County.
Tuolumne	2016 RTP Rural Sustainable Strategies Chapter	Goal 3: Practice environmental stewardship by protecting air quality, natural resources, and historical and cultural assets. (Regional Goal 5)	Policy 6: Support the planning and construction of plug-in electric vehicle charging stations.
Tuolumne	2016 RTP Rural Sustainable Strategies Chapter	List Of Rural Sustainable Strategies	Zero-Emission Vehicles (ZEV) – Support and facilitate ZEV planning and infrastructure projects which help improve air quality and reduce greenhouse gas emissions.
Alpine	Alpine County Regional Transportation Plan (2015)	Goal 10: Reduce Greenhouse Gas (GHG) Emissions.	Objective: Ensure that transportation projects contribute to the goal of lowering vehicle emissions. Policy: Promote projects that can be demonstrated to reduce air pollution, such as alternative fuel programs.
Amador	2015 Amador County Regional Transportation Plan	Goal 9A: Implement a comprehensive set of transportation improvements that will collectively result in regional air quality improvements	Policy 9A: Invest in efficient and effective public transportation infrastructure, transit services, alternative strategies, and emerging technologies that will help improve air quality throughout the Region.
Calaveras	Calaveras 2017 Regional Transportation Plan	Goal 3: Enhance sensitivity to the environment in all transportation decisions.	Objective 3B: Promote and design transportation projects that will reduce greenhouse gas emissions and thereby positively contribute to meeting statewide global warming emissions targets set in the Global Warming Solutions Act of 2006 (AB 32).

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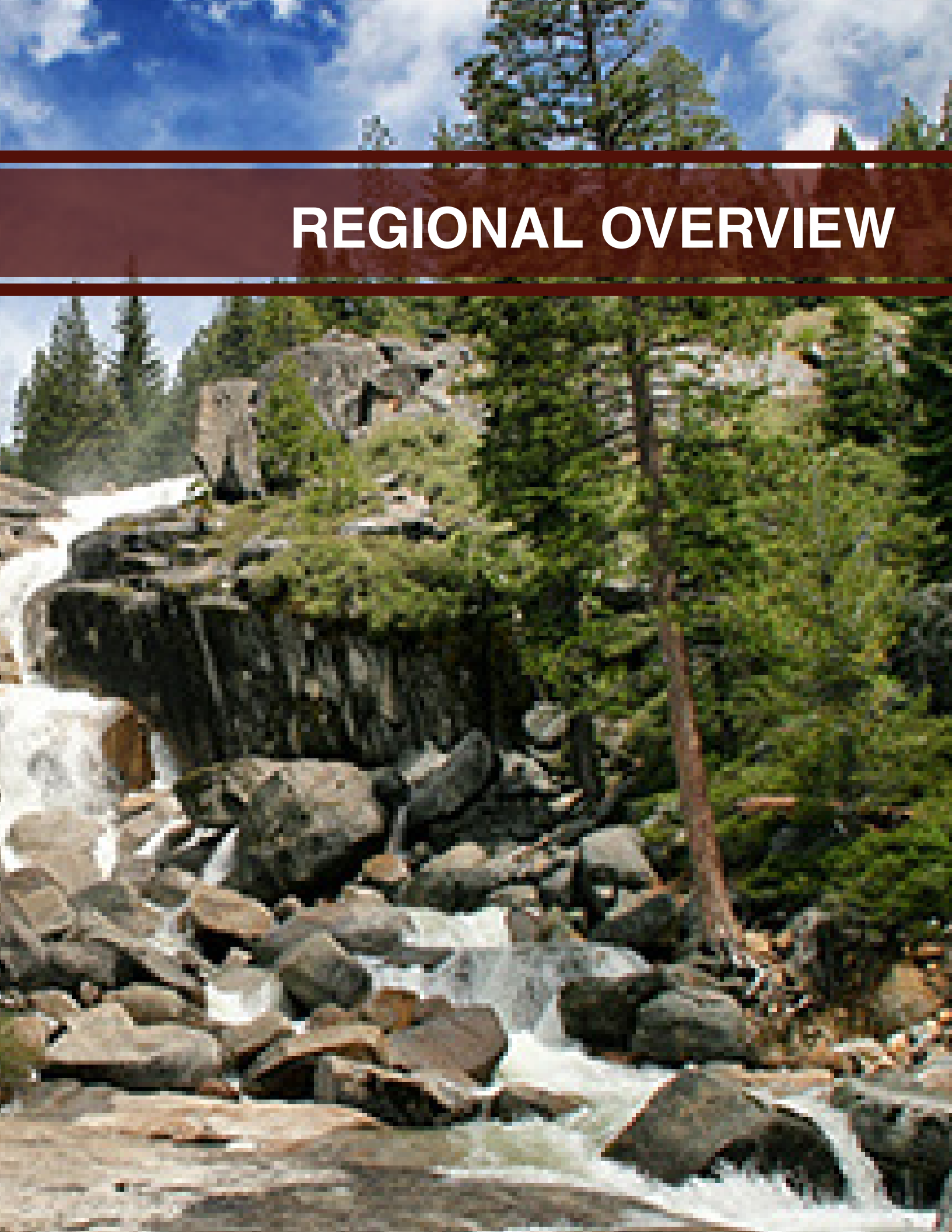
REGIONAL OVERVIEW



Geography

The Region is located along the western slope of the Sierra Nevada mountain range and includes Alpine County, Amador County, Calaveras County, and Tuolumne County (Figure 1). Communities within the Region trace their roots to California's gold rush era, and the current population lives along the same waterways and small valleys in the Sierra foothills that were once dominated by placer mining (CSEDD, 2017). The Region features 4,500 square miles of rolling hills, forest lands, and high mountain peaks with a change in elevation ranging from near sea level to approximately 13,000 feet above mean sea level.

Figure 1: Counties in the Central Sierra Region

Source: Center for Sustainable Energy, 2018.

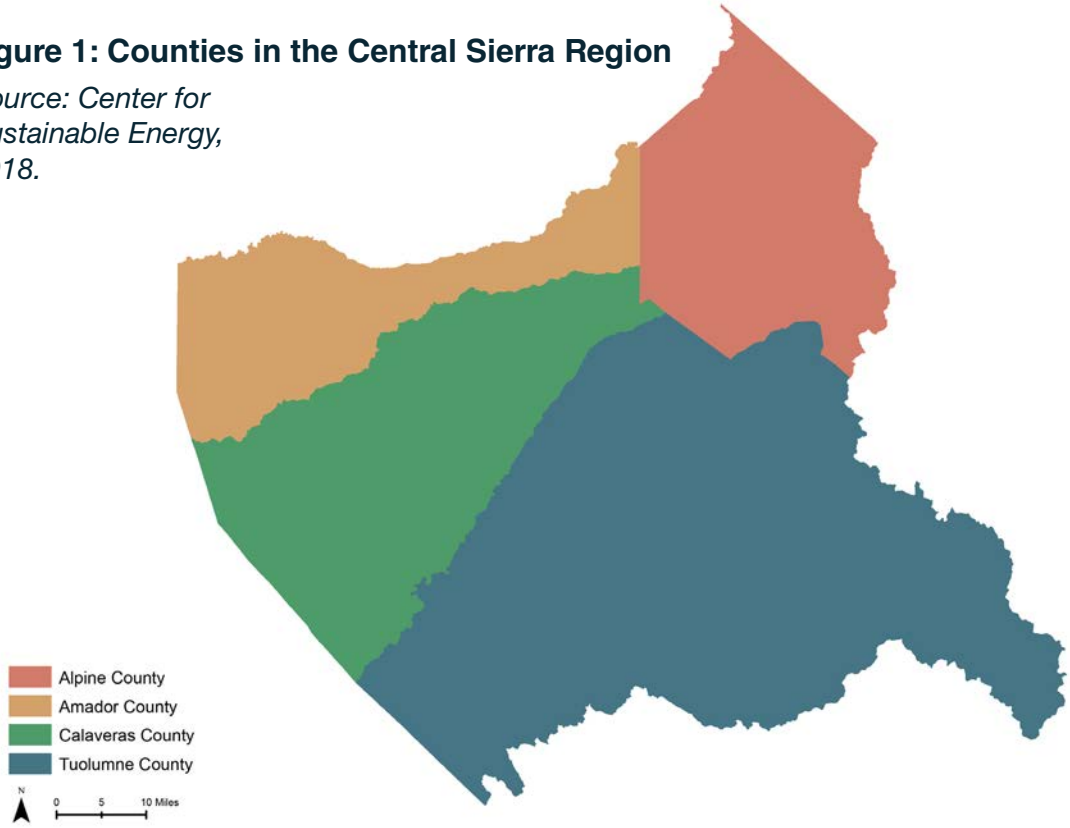
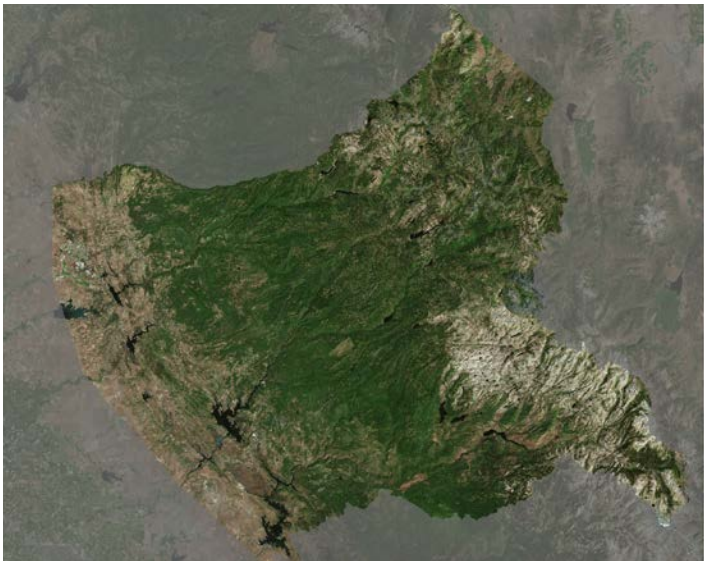


Figure 2: Aerial View of the Central Sierra Region



Source: Center for Sustainable Energy, 2018

Electrical Infrastructure

According to the California Energy Commission, in 2014, 98 percent (%) of the electrical generation capacity generated inside the Region was from hydro power, 2% was from biomass, and less than 1% was from solar; the Region does not have natural gas electricity generation capacity (CSEDD, 2017).

The Region is serviced by Pacific Gas & Electric, Liberty Utilities, Kirkwood Utilities Department, and the Tuolumne Public Power Agency, which have unique power portfolios and renewable energy percent mix. Figure 3 depicts the existing transmission infrastructure.

Although less than 1% of electricity is currently generated via photovoltaics, the Region has good year-round solar potential, as depicted in Figures 3 and 4.

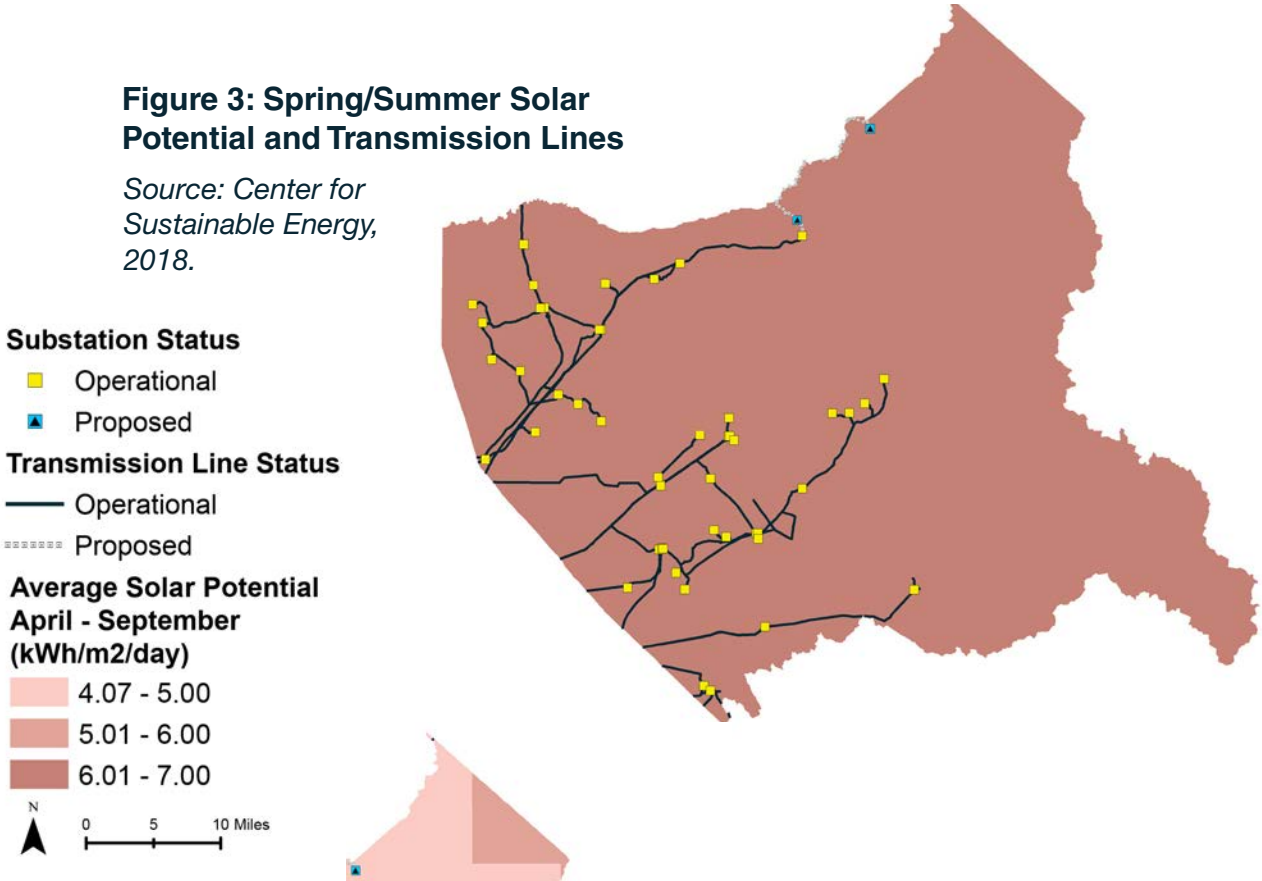


Figure 3: Spring/Summer Solar Potential and Transmission Lines

Source: Center for Sustainable Energy, 2018.

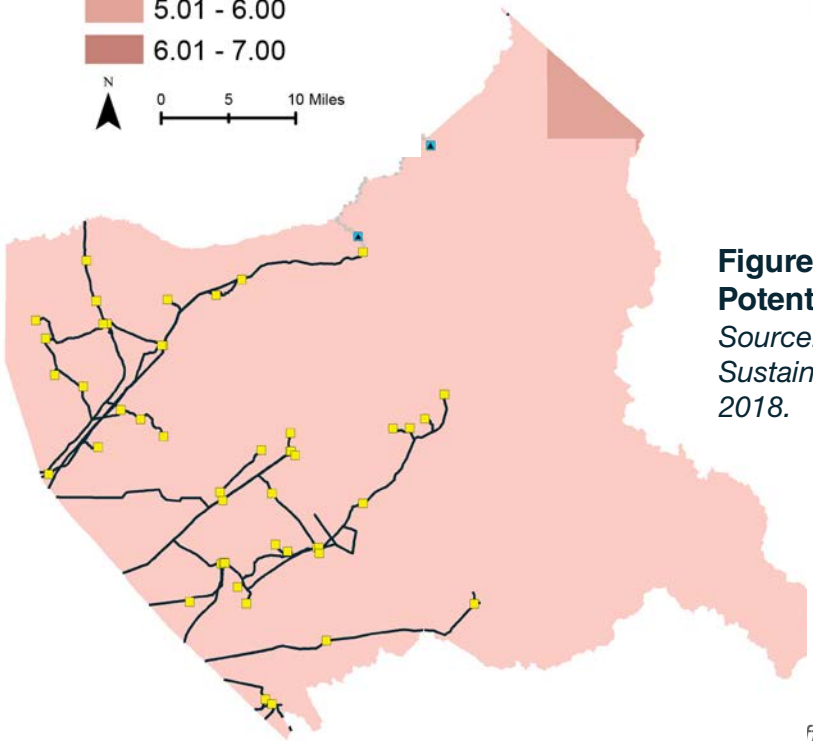


Figure 4: Fall/Winter Solar Potential and Transmission Lines

Source: Center for Sustainable Energy, 2018.

Population

The Region population of approximately 139,438 people accounted for less than 1% of the statewide population, according to State of California Department of Finance's January 1, 2017 population estimates. The region has seven incorporated cities and 50 smaller, unincorporated census-designated places (CDP). The unincorporated population accounts for nearly 82% of the region's total population. Figure 5 and Table 2 provides an overview of population counts by county and location and Table 3 identifies the cities and communities within the Region.

Table 2: Cities and Communities in the Region by County

Alpine	Amador	Calaveras	Tuolumne
Bear Valley CDP Mesa Vista CDP Kirkwood CDP Alpine Village CDP Markleeville CDP	Amador City Ione City Jackson City Plymouth City Sutter Creek City Fiddletown CDP Drytown CDP Camanche North Shore CDP Camanche Village CDP Pine Grove CDP Pioneer CDP Red Corral CDP Buckhorn CDP Volcano CDP Buena Vista CDP Martell CDP River Pines CDP	Angels City Dorrington CDP Douglas Flat CDP Forest Meadows CDP West Point CDP Copperopolis CDP San Andreas CDP Mokelumne Hill CDP Vallecito CDP Hathaway Pines CDP Rail Road Flat CDP Valley Springs CDP Rancho Calaveras CDP Arnold CDP Mountain Ranch CDP Avery CDP Murphys CDP Wallace CDP	Sonora City Groveland CDP Phoenix Lake CDP Cold Springs CDP Soulsbyville CDP Pine Mountain Lake CDP Columbia CDP Tuolumne City CDP Long Barn CDP Mi-Wuk Village CDP Tuttletown CDP East Sonora CDP Twain Harte CDP Mono Vista CDP Strawberry CDP Cedar Ridge CDP Jamestown CDP Chinese Camp CDP Sierra Village CDP

Source: U.S. Census Bureau Places, 2017

Figure 5: Population by Census Tract, 2010

Source: Center for Sustainable Energy, 2018

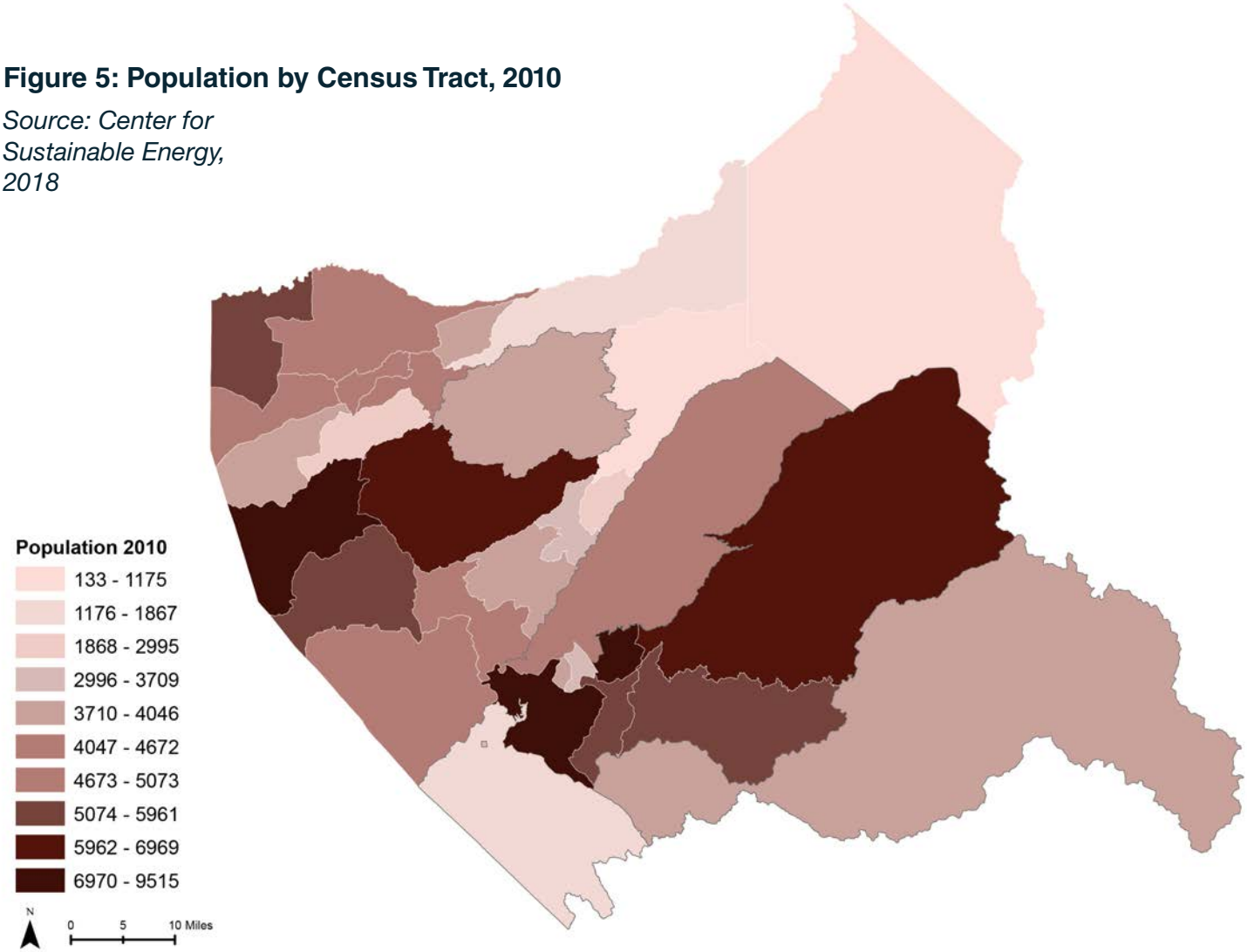


Table 3: Population Estimates by County as of January 1, 2017

County	Population Counts by Location		Total Population
Alpine	Unincorporated Area	1,156	1,156
Amador	Amador	190	38,382
	Ione	7,683	
	Jackson	4,761	
	Plymouth	1,010	
	Sutter Creek	2,505	
	Unincorporated Area	22,233	
Calaveras	Angels City	4,108	45,175
	Unincorporated Area	41,067	
Tuolumne	Sonora	4,876	54,725
	Unincorporated Area	49,849	
Total Population in the Region		**139,438**	

Source: State of California Department of Finance, 2018

Highways

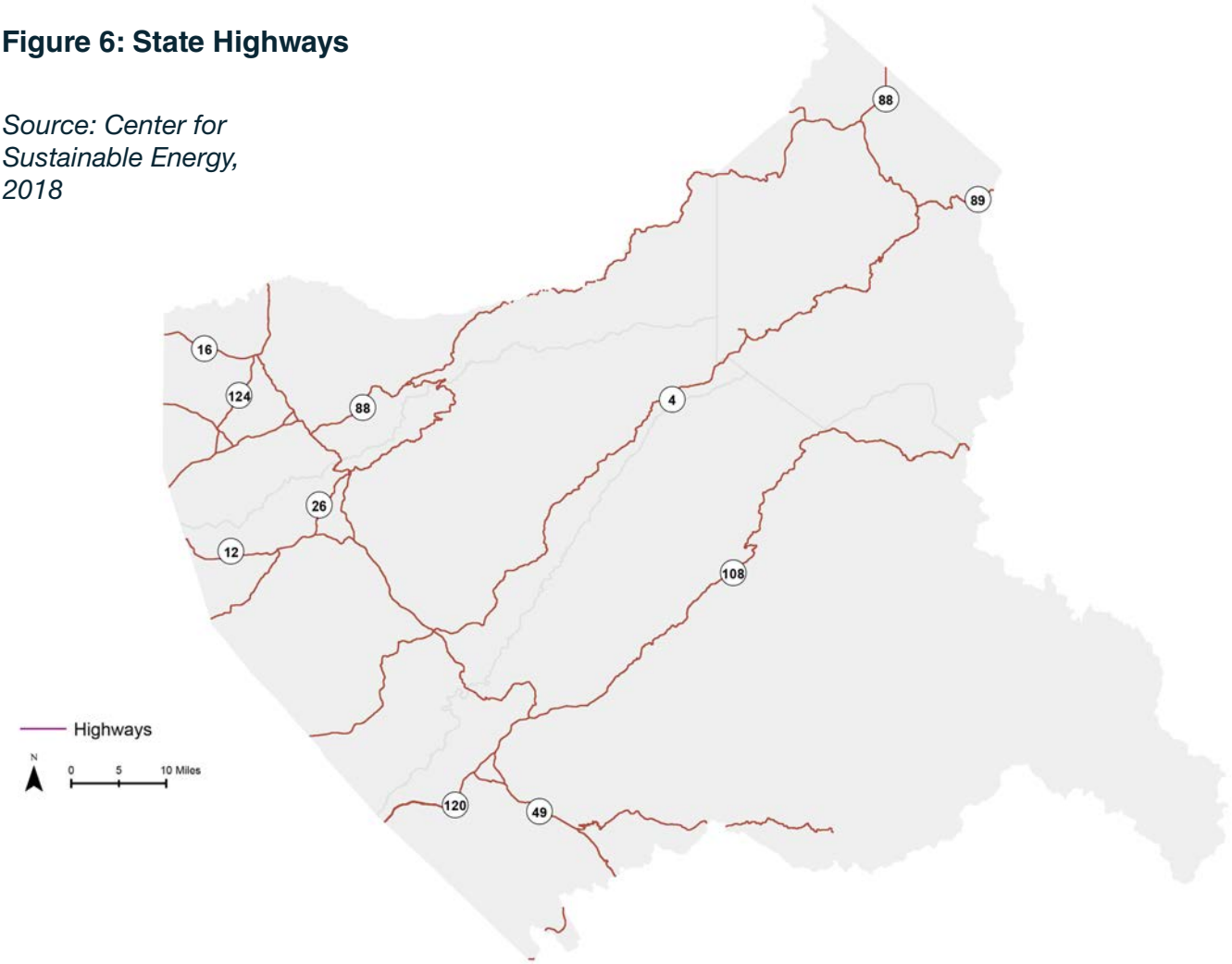
State and county highways are the backbone that connect communities and provides access to coveted destinations. California State Route 49 is a vital north-south artery for foothill communities. Four east-west gateways, Highway 4 (Ebbetts Pass), Highway 108 (Sonora Pass), Highway 88 (Carson Pass), and Highway 120 (Tioga Pass) crest the Sierra Mountains. State Route 120 provides access to Yosemite National Park. Highways in the Region include:

- State Route 49: North-South through, Amador, Calaveras, Tuolumne
- State Route 89: North- South through Alpine County
- State Route 88: East-West through Amador County
- State Route 4: East-West through Alpine and Calaveras County
- State Route 12: East-West through Calaveras County
- State Route 26: East-West through Calaveras County
- State Route 108: East-West through Tuolumne County
- State Route 120: East-West through Tuolumne County

Based on California Department of Transportation (Caltrans) 2016 traffic data, State Route 49 through Tuolumne County has the highest average annual daily traffic volume (AADT) in the Region (255,500 vehicles). Figure 6 shows the locations of major highways in the county.

Figure 6: State Highways

Source: Center for Sustainable Energy, 2018



Tourism & Destinations

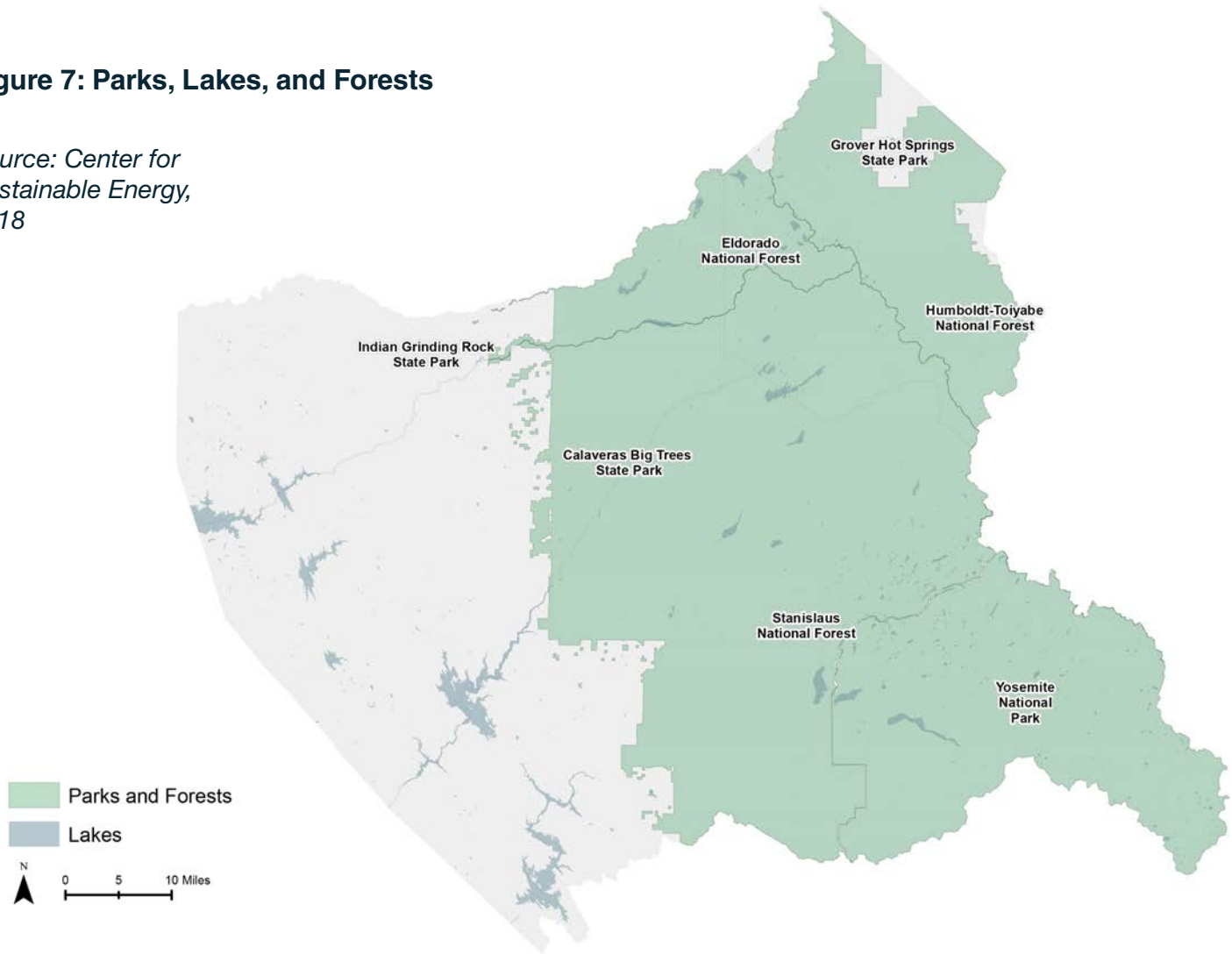
Parks

Despite the relatively small permanent population, the Region is home to several historical state and national parks with beautiful scenery and recreational activities that attract visitors. Popular destinations include Yosemite National Park, Calaveras Big Trees, and the Columbus State Historical Park. According to the National Park Service, Yosemite National Park had over 4.3 million recreational visitors and nearly 1.9 million vehicles during 2017. Approximately three-quarters of 2017 visitors attended the park between May and October. Traffic volumes is greatest at the Arch Rock Entrance compared to the park's South Entrance (Badger Pass, Big Oak Flat, Hetch Hetchy) or Tioga Pass, which represented only about 30% of the total volume in 2017.

The Central Sierra has five major state parks: Calaveras Big Trees, Columbia State Historical Park, Railtown 1897, Indian Grinding Rock, and Grover Hot Springs. Table 4 lists those parks and their annual attendance and revenue.

Figure 7: Parks, Lakes, and Forests

Source: Center for Sustainable Energy, 2018



Recreation

The Central Sierra Region has a rich historical past with remnants of gold mining, an old-west atmosphere, and historical landmarks. Calaveras County is home to the Mark Twain Cabin which is a California Historical Landmark and inspiration for Calaveras County's Fair and Jumping Frog Jubilee which has grown to over 45,000 attendees annually.

The Region's diverse natural landscape supports numerous recreational activities including camping, hunting, fishing, and skiing. Although most alpine campgrounds close for the winter season, visitor travel is sustained as ski resorts become recreational destinations. The Kirkwood resort, accessed by Highway 88, attracts visitors who are visiting resorts in the South Lake Tahoe area. The Bear Valley resort, accessed by Highway 4, offers a quieter alternative to larger ski resorts. The Region is also home to wineries and casinos; Amador and Calaveras counties have more than 50 wineries; casinos operated by Native American tribes are spread throughout the Region.

Table 4: 2017 Yosemite National Park Recreation Visitors per Month

Month	Visitors	Visitor %
January	120,025	3%
February	119,421	3%
March	166,793	4%
April	302,553	7%
May	471,844	11%
June	565,702	13%
July	633,351	15%
August	615,892	14%
September	566,279	13%
October	429,827	10%
November	217,927	5%
December	127,276	3%
2017 Totals	**4,336,890**	**100%**

Source: U.S. National Parks Service, 2017

Table 5: Central Sierra State Park Visitor for FY 2015-16

		Visitor Attendance				Revenue
Park Name	County	Paid Use Day	Free Day Use	Camping	Total Visitor Attendance	Total Revenue
Calaveras Big Trees State Park	Tuolumne/ Calaveras	175,486	4,231	27,903	207,620	$1,095,305
Columbia State Historical Park	Tuolumne	0	451,701	0	451,701	$448,158
Railtown 1897 State Historical Park	Tuolumne	19,298	26,813	0	46,111	$99,819
Indian Grinding State Historical Park	Amador	9,990	2,414	1,811	14,215	$40,905
Grover Hot State Park	Alpine	51,446	8	32,378	83,832	$525,740

Source: California Department of Parks and Recreation, 2017

Transit

Public fleets operating in the Region include the four counties, incorporated cities, community services districts, and school districts. State and Federal fleets operate in the Region; no local fleets were identified.

There are four primary transit operators in the Region: Tuolumne County Transit, Alpine County Local Transportation Commission, Calaveras Transit, and the Amador Regional Transit System.

The Yosemite Area Regional Transportation System (YARTS) also operates a seasonal route (from May to September) through the Region: Sonora – Hwy 120. At peak service (June through August), the Sonora route operates 7 days a week with six trips (YARTS, 2018). YARTS operates along four highway corridors including SR 140 and SR 41. Figure 8 shows the transit routes throughout the Region.

Based on 2017 data from the Federal Transit Administration's (FTA) National Transit Database, Regional transit agencies operate a total of 62 transit vehicles that account for 1,441,720 annual vehicle revenue miles and 68,441 annual vehicle revenue hours (National Transit Database, 2017).

Fixed-route bus vehicles make up 69% of Regional transit vehicles in the Central Sierra Region; they operate on fixed routes and serve a large group of commuters. Demand response vehicles (27% of regional transit vehicles) generally operate within transit agency's fixed route boundaries and serve seniors and passengers with disabilities; limited demand response vehicles operate as a door-to-door service. Commuter bus vehicles only operate in Amador, providing service between business centers and outlying residential regions; They typically operate during traditional peak commute times with limited stops and account for only 3% of the regional transit vehicles.

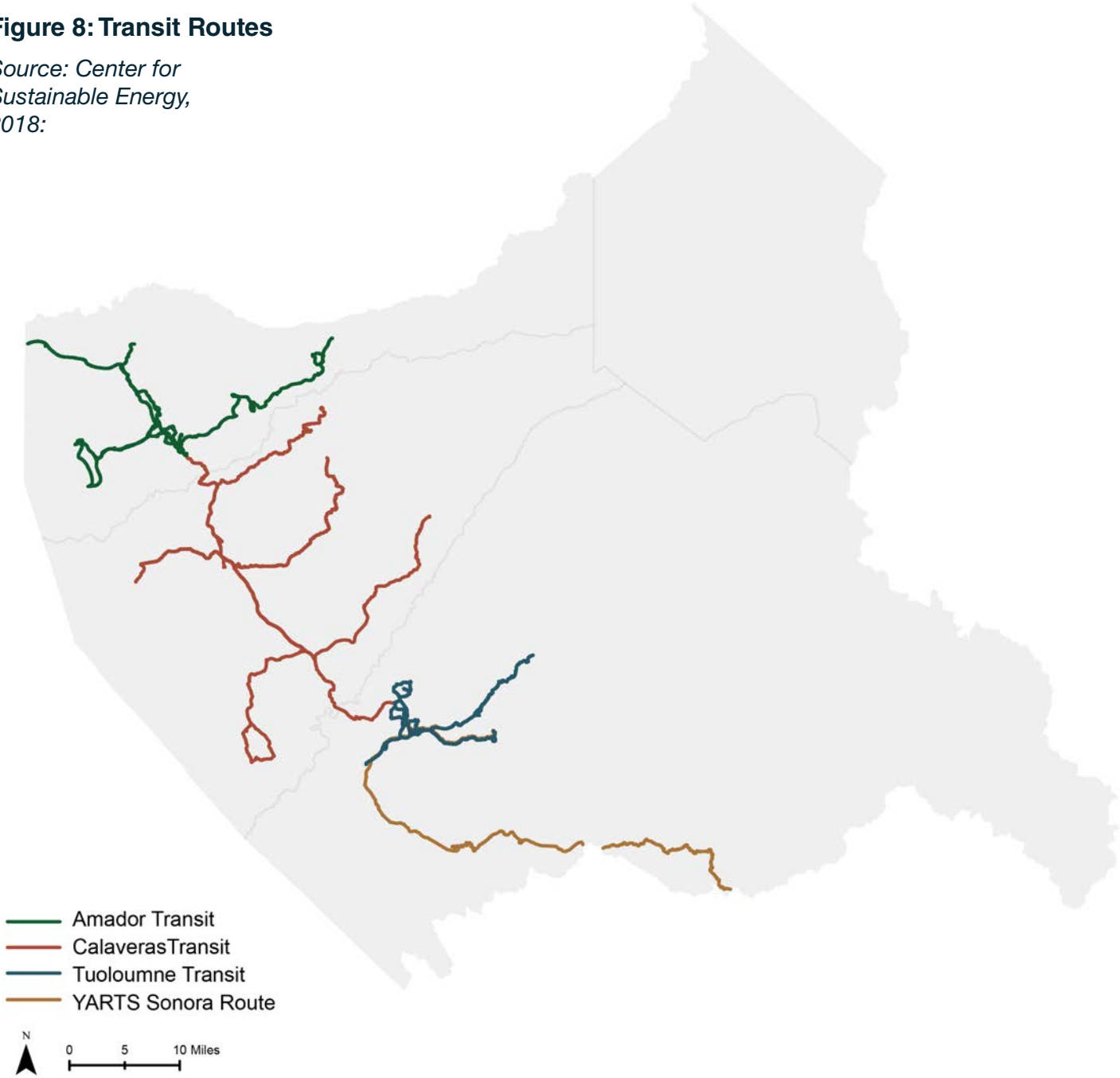
Table 6: Central Sierra Region 2017 Annual Agency Profile

	Commuter Bus Vehicles	Demand Response Vehicles	Fixed Route Bus Vehicles	Annual Vehicle Revenue Miles	Annual Vehicle Revenue Hours
Tuolumne County Transit	0	10	10	378,823	22,770
Alpine County Local Transportation Commission	0	2	0	13,683	750
Calaveras Transit	0	0	14	353,495	13,216
Amador Transit	2	5	9	293,090	14,574
Yosemite Area Regional Transportation System (YARTS)	0	0	10	402,629	17,131
Total	**2**	**17**	**43**	**1,441,720**	**68,441**

Source: National Transit Database, 2017

Figure 8: Transit Routes

Source: Center for Sustainable Energy, 2018:



Barriers

The Central Sierra Region has several barriers to EV and EVI adoption including high variability in weather, change in elevation, and network access. These barriers are explored below.

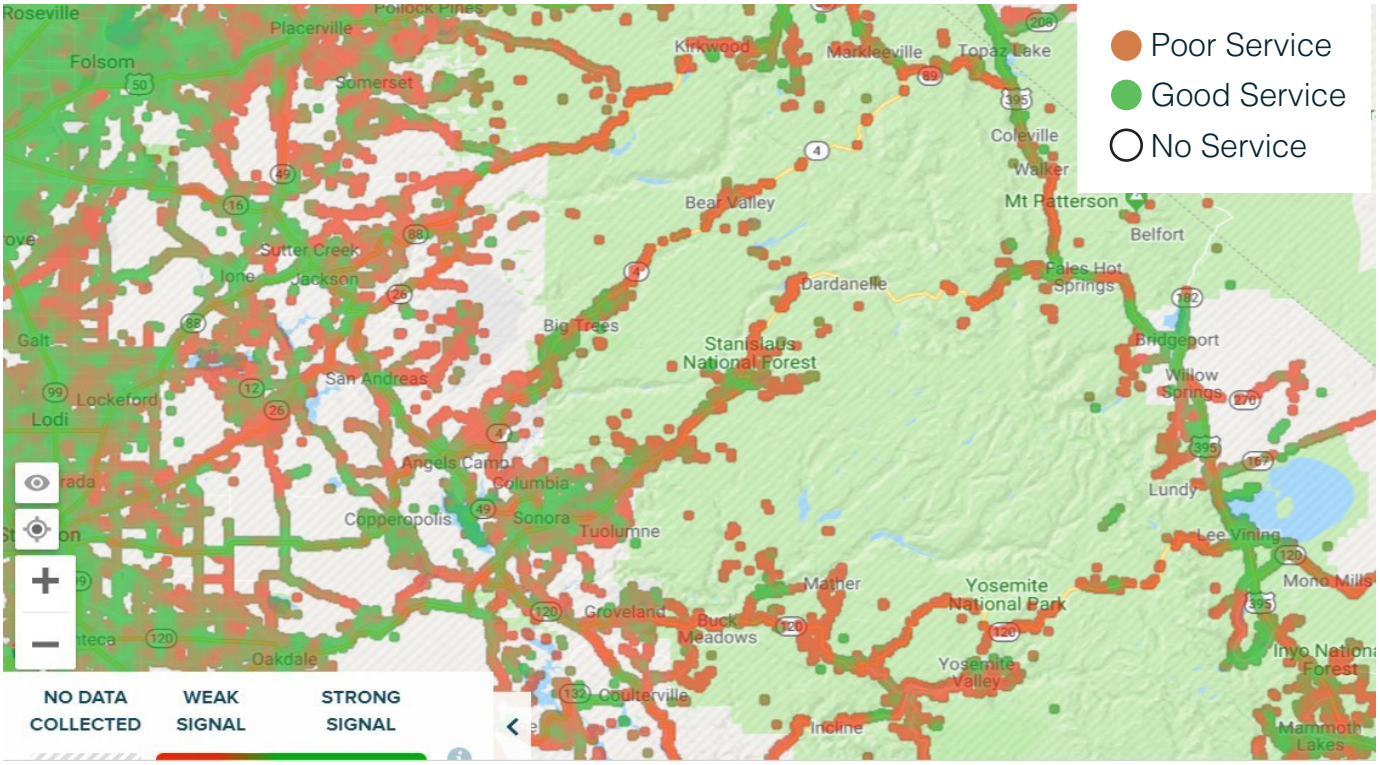
Network Connectivity

To collect data on usage and costs of utilizing EV charging stations, they must be "network-capable," meaning they are able to communicate with a backend network operations center which collects, stores, and manages data from the EV charging stations. To have this capability, EV charging stations communicate via Wi-Fi, 3G/4G cellular communication, or through a local area network (LAN) which utilizes a wide area network (WAN). As a result, networked EV chargers must be deployed in areas with adequate cellular network coverage and/or internet cable running to the station.

To better understand the type and strength of cellular coverage in certain regions, OpenSignal has developed an online mapping tool which shows the strengths of 2G, 3G, and 4G cellular coverage. OpenSignal data indicates that cellular coverage in the Region is a potential barrier for EV charging station connectivity (and potentially wider EV adoption), except along major travel corridors. Figure 9 shows the strength of cellular coverage in the Region and surrounding areas.

The cellular coverage in the Region limits the areas where networked charging stations can be deployed, especially in remote regions and along certain travel corridors. To accept payments for usage, the charging stations must either have a credit card reader that is connected to Wi-Fi or a cellular network or facilitate payment through an app, which also requires the charging station be connected to the internet via Wi-Fi or cellular connection. In remote locations, where cable service for internet does not exist, installing charging stations will require significant confidence in the cellular coverage (Figure 9). As a result, installing networked charging stations in remote locations and along remote travel corridors face significant challenges because the station operators will not have a reliable means to charge for their services and monitor their stations.

Figure 9: Cellular Coverage Map



Source: Open Signal, 2018

Maintenance

The Region has seasonal climates with varied weather conditions including significant sunshine, wind, and precipitation events (e.g., rain, snow, and ice), which increases the risk of damage to EV charging stations from acute or prolonged exposure. This may require more frequent maintenance and an increased cost to maintain, especially for stations located in remote areas.

Elevation

The Region is largely rural, covers a large geographical area with low population density, requires large travel distances between communities, and features mountainous terrain, which are unique challenges to the successful deployment of Zero-Emission Vehicles. Elevation affects zero-emission buses (ZEBs) and ZEVs because climbing requires more power than traveling the same distance without elevation change. When grade changes are significant, vehicle range diminishes which requires more charging infrastructure be installed to provide adequate coverage. As is shown in Figure 10 the Region's elevation changes from 500 ft. near the valley to almost 13,000 in the mountainous terrain.

In the YARTS Short Range Transit Plan, YARTS has committed to transitioning to an all-ZEB fleet. However, there are known regional barriers such as route grade and distance that make purchasing and operating ZEBs a challenge. The YARTS routes are longer with steeper grade compared to the surrounding transit agency territories that have purchased or are in the process of purchasing battery-electric buses (BEBs) (YARTS Short Range Transit Plan Draft, 2018). These agencies include:

- South Lake Tahoe: Received grant funding to purchase 3 vehicles
- Park City Transit: 5 BEBs
- San Joaquin RTD System: 17 BEBs

Yosemite National Park operates shuttle buses throughout the Yosemite Valley, covering more than 436,000 annual operating miles. The shuttle service helps to reduce congestion and the environmental impacts associated with automobiles in the Valley. The park has ordered two Proterra electric buses to add to the fleets, representing the first deployment in the Region (Proterra, 2017).

Purchasing BEBs is a significant investment for transit agencies due to the high cost of the vehicles and necessary infrastructure. As YARTS notes, there are funding opportunities to offset the high cost of these vehicles, but significant charging investment along transit routes is necessary to enable the transition to BEBs on regional routes due to the length and elevation change (YARTS Short Range Transit Plan Draft, 2018) as noted in Figure 14.

The YARTS Short Range Transit Plan also identifies the local electrical system capacity as a limitation for switching to ZEBs and BEBs (YARTS Short Range Transit Plan Draft, 2018). As the National Park Service integrates the Proterra buses into their fleet, the agency continues evaluating existing charging infrastructure and grid capacity; NPS is currently conducting a capacity study for the electrical system in the Region. Completion of the study will benefit the Region by increasing understanding of the electrical grid and identifying infrastructure alternatives.

Figures 11-14 show the elevation change along the Regional transit agency's routes. The longest route, the YARTS Sonora route, is 177 miles roundtrip.

Figure 10: Elevation
Source: Center for Sustainable Energy, 2018

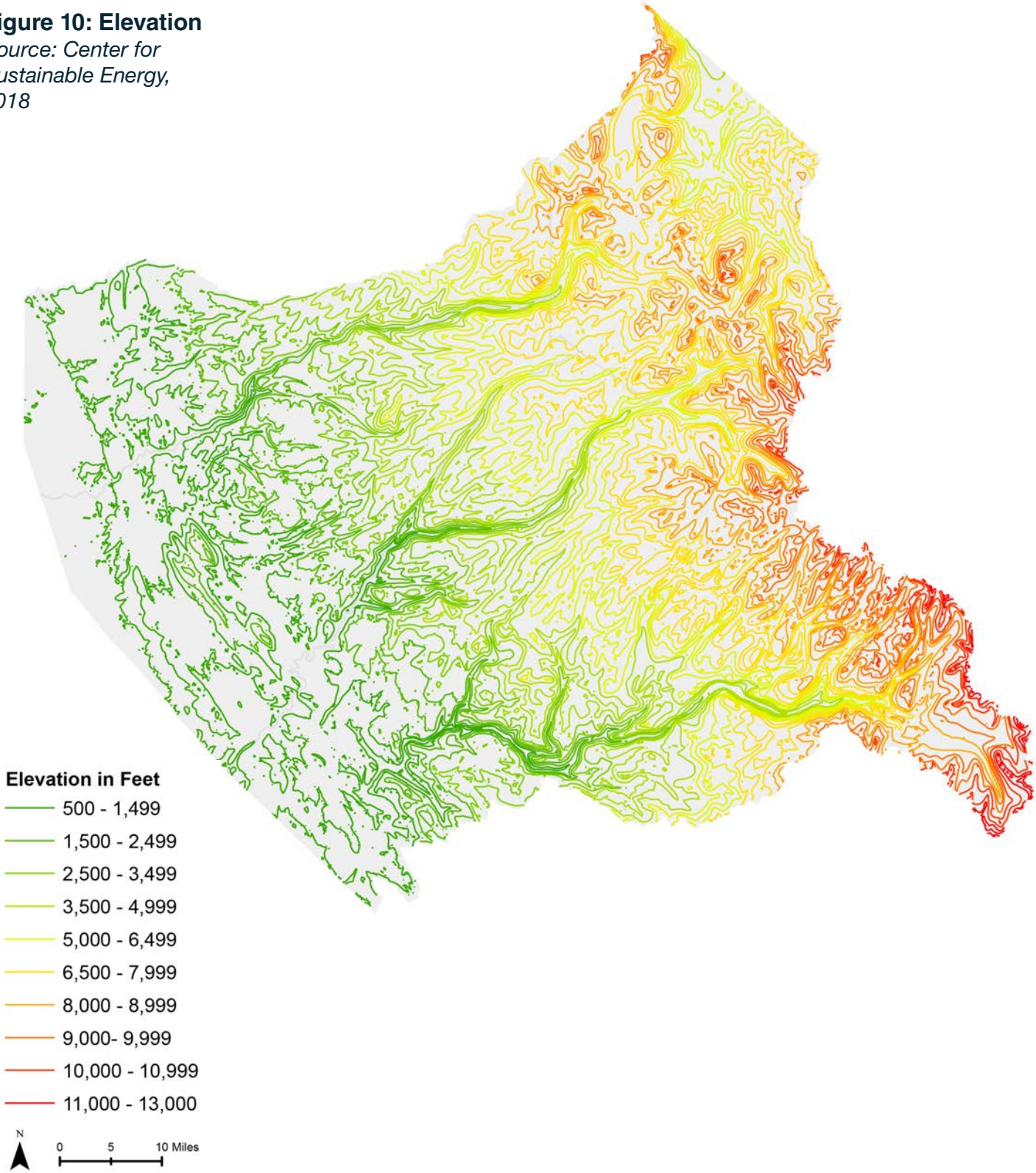
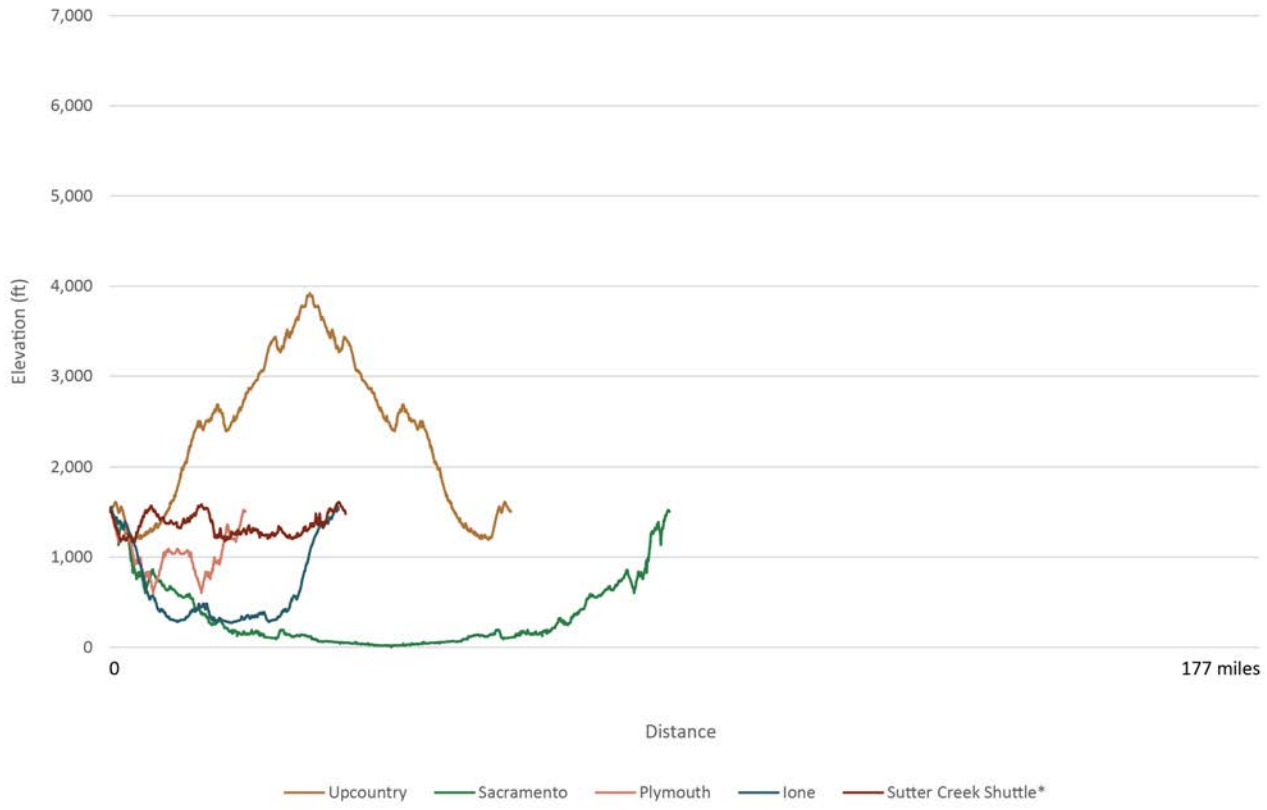


Figure 11: Amador Transit Route Elevation

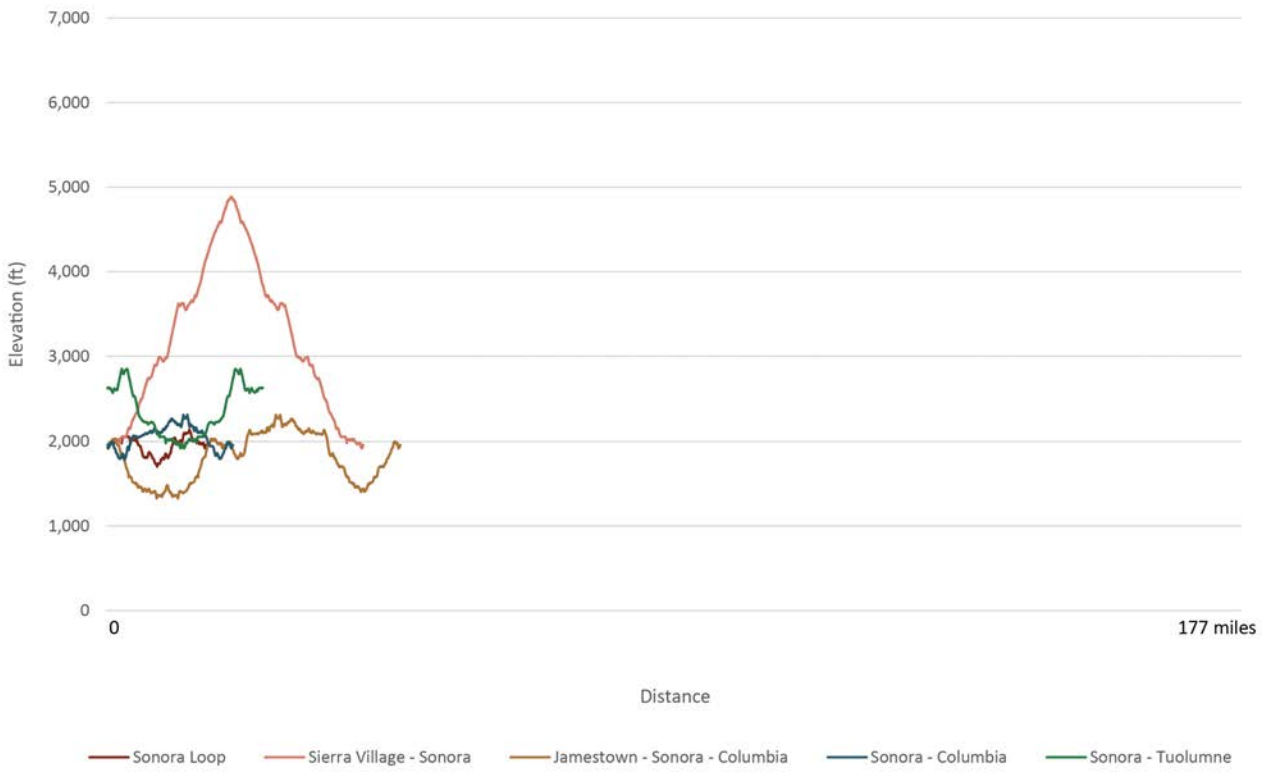


Source: Center for Sustainable Energy, 2018

Figure 12: Calaveras Transit Route Elevation

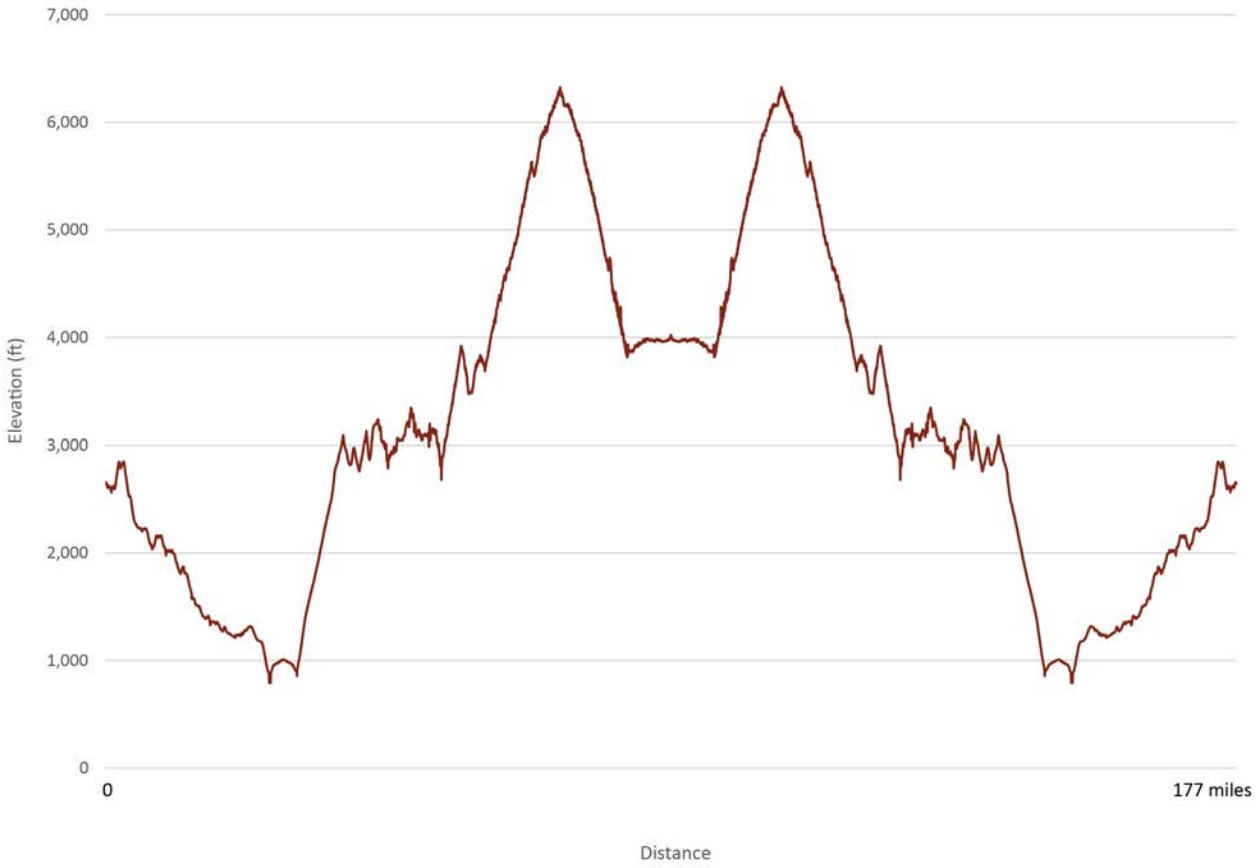
Source: Center for Sustainable Energy, 2018

Figure 13: Tuolumne Transit Route Elevation

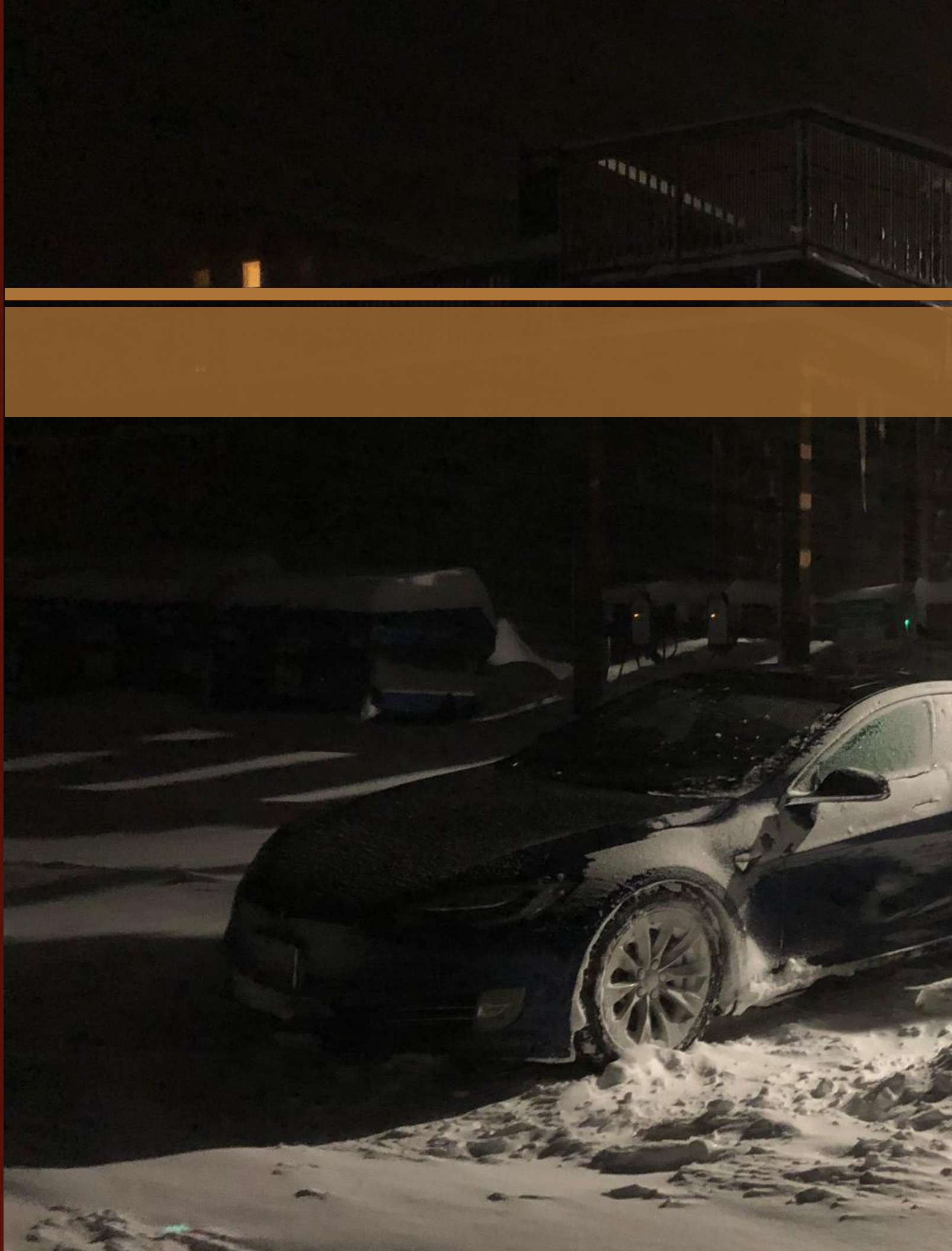


Source: Center for Sustainable Energy, 2018

Figure 14: YARTS Sonora Route Elevation



Source: Center for Sustainable Energy, 2018



ZEV TECHNOLOGY

Kirkwood Ski Lodge, Kirkwood CA

Electric Vehicle Technology

Plug-in Electric Vehicle (PEV)

A plug-in electric vehicle (PEV) is a vehicle in which there is an onboard battery that is powered by energy delivered from the electricity grid. It is commonly referred to as just an electric vehicle (EV). There are two types of plug-in electric vehicles: a battery electric vehicle (BEV) and a plug-in hybrid electric vehicle (PHEV). BEVs run exclusively on the power from their onboard battery. PHEVs have both an onboard battery and a gasoline tank that is used when the car's battery is depleted.

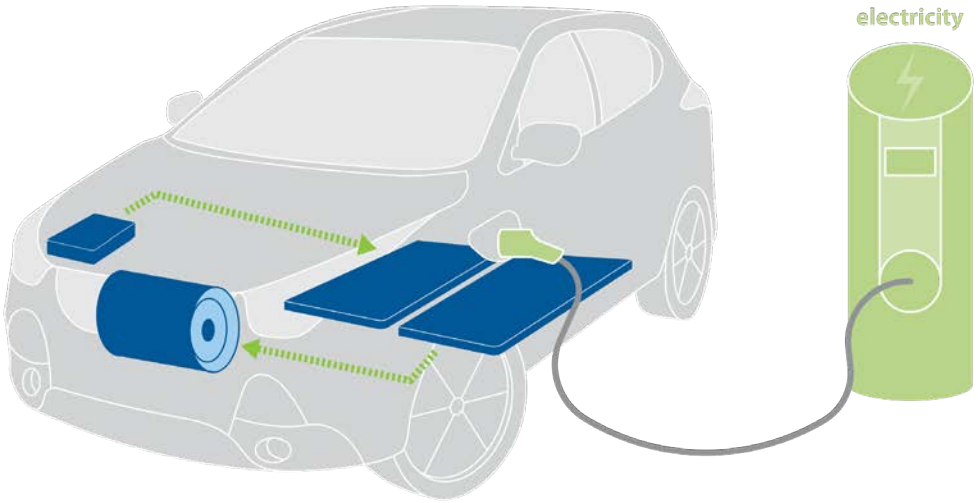
Electric vehicles come in all shapes and sizes. They are no longer limited to light-duty passenger vehicles.

- Passenger vehicles
- Vanpool shuttles
- Pickup trucks
- Medium-duty vehicles
- Transit buses
- Forklifts
- Low-speed vehicles (golf carts and similar)

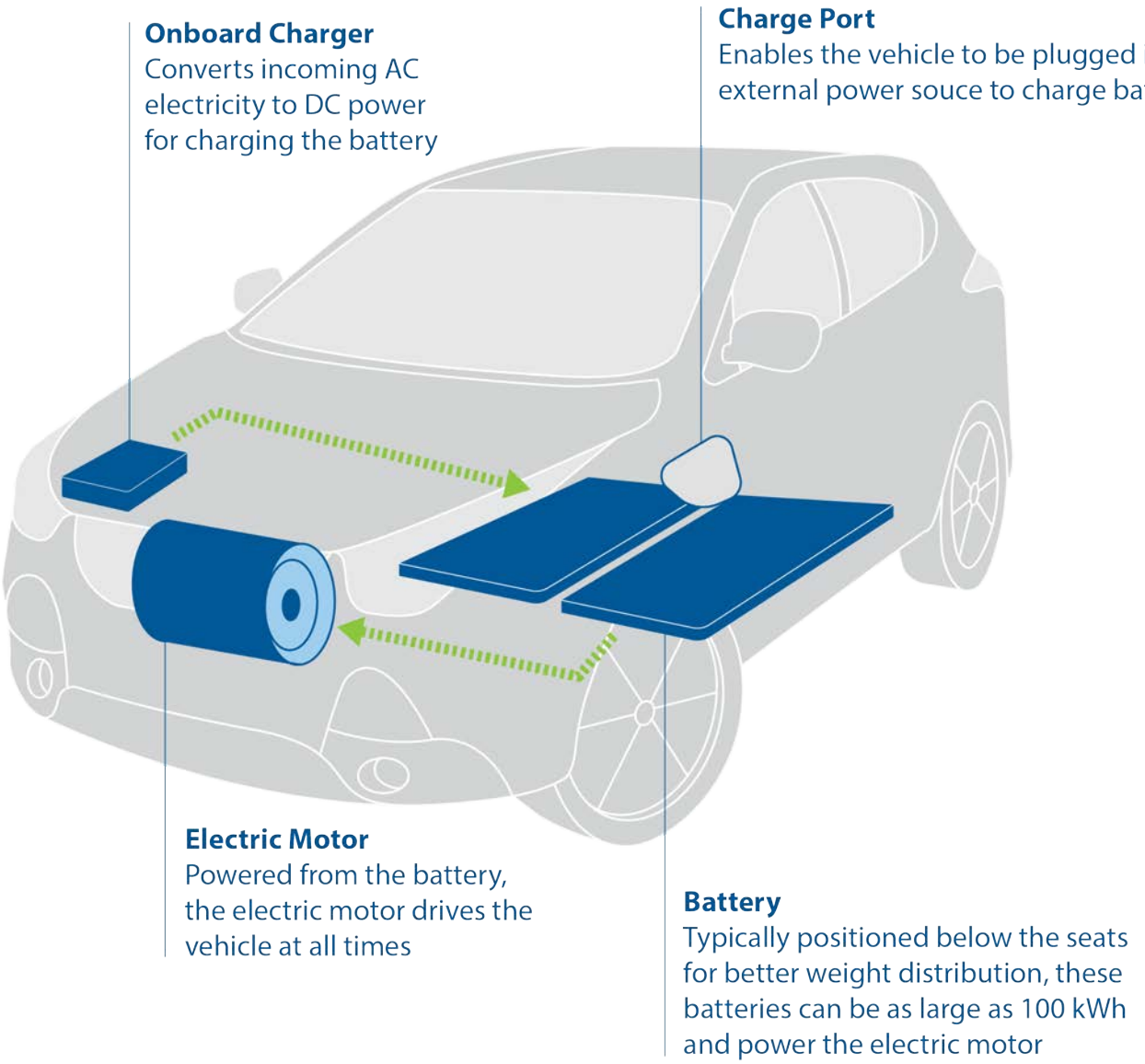
Battery Electric Vehicles (BEV)

A battery electric vehicle (BEV) doesn't use gasoline and produces zero tailpipe emissions. Instead, it has a large battery that powers one or more electric motors. Battery electric vehicles run entirely on the energy stored on an onboard battery. The vehicle is charged by electricity from the grid. On average, the vehicle's range is upwards of 80 miles on a single charge. BEVs can be plugged in at home, work or public charging stations. In addition, there is limited maintenance; the vehicle will never require an oil change.

BEV



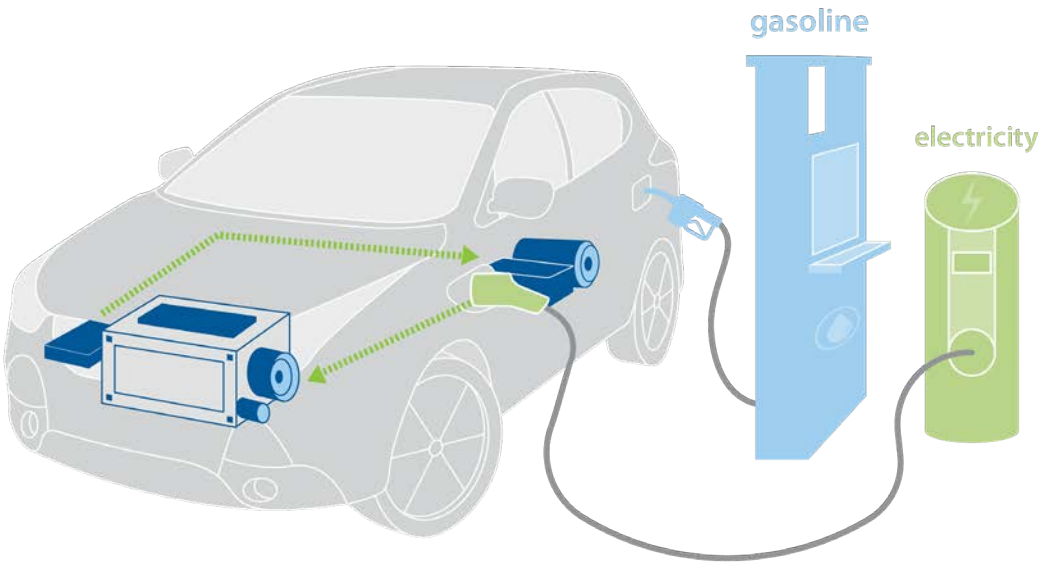
BEV



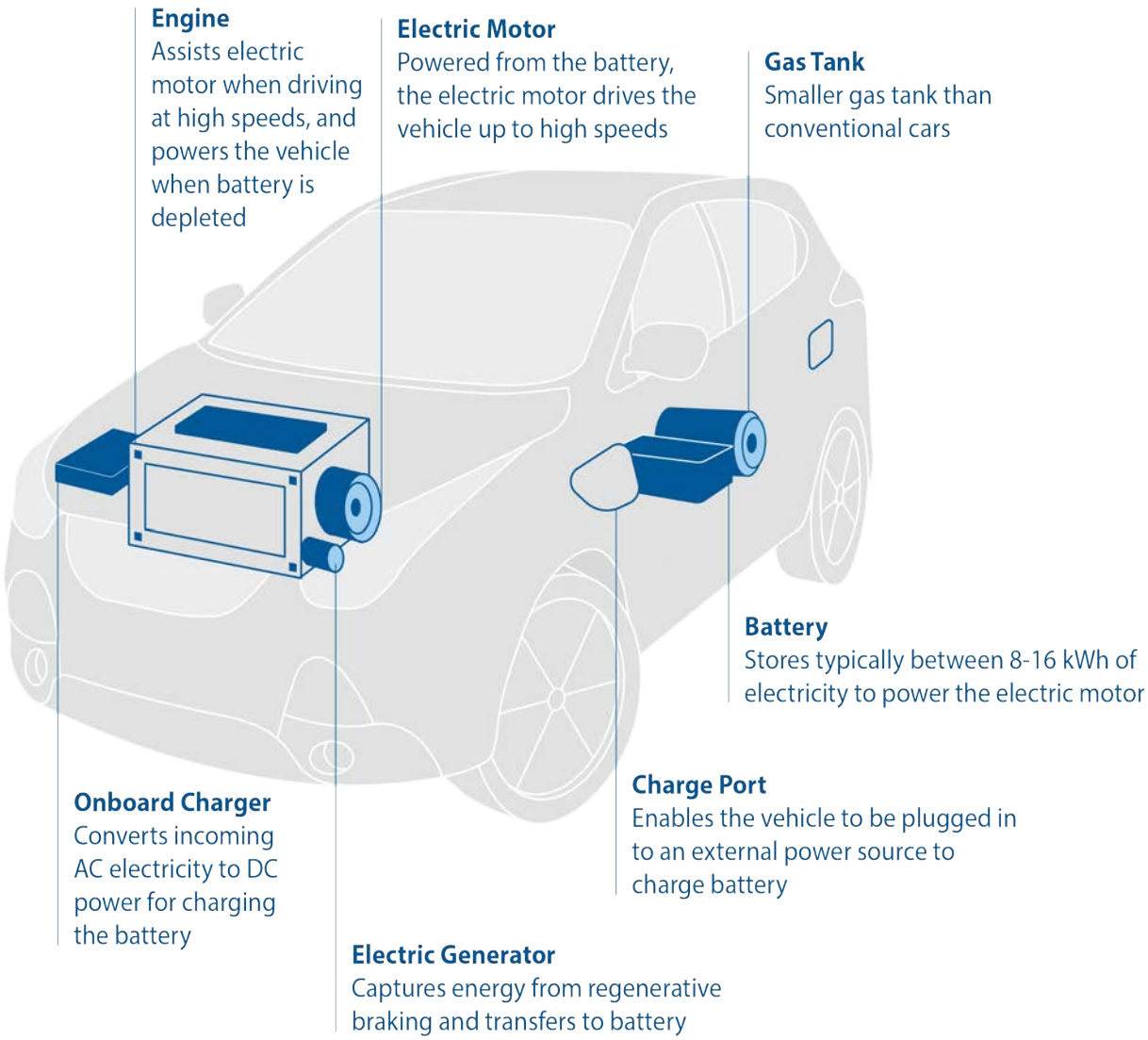
Plug-In Hybrid Electric Vehicle (PHEV)

A plug-in hybrid electric vehicle (PHEV) offers both gas and electric-only driving – even at relatively high speeds. PHEVs have smaller batteries than BEVs, but still enjoy many of the same benefits. Plug-in hybrid electric vehicles run on electricity and gasoline. The vehicle's onboard battery is charged using electricity from the grid, and when the battery is depleted, the gasoline engine is used.

PHEV


gasoline
electricity

PHEV


Engine
Assists electric motor when driving at high speeds, and powers the vehicle when battery is depleted
Electric Motor
Powered from the battery, the electric motor drives the vehicle up to high speeds
Gas Tank
Smaller gas tank than conventional cars
Battery
Stores typically between 8-16 kWh of electricity to power the electric motor
Charge Port
Enables the vehicle to be plugged in to an external power source to charge battery
Onboard Charger
Converts incoming AC electricity to DC power for charging the battery
Electric Generator
Captures energy from regenerative braking and transfers to battery

Fuel-Cell Electric Vehicles (FCEV)

A hydrogen fuel cell electric vehicle (FCEV) is a vehicle that is powered by hydrogen. Hydrogen is pumped into pressurized cylinders in the vehicle. The fuel cell converts the hydrogen into electrical energy to drive the motor. Hydrogen is found in organic matter and in water (H_2O). The majority of hydrogen for transportation is produced by extracting it from natural gas. Hydrogen can also be extracted from water; however, this is a more energy intensive method.

Fuel cell vehicles are zero-emission vehicles that emit water vapor and warm air as exhaust.

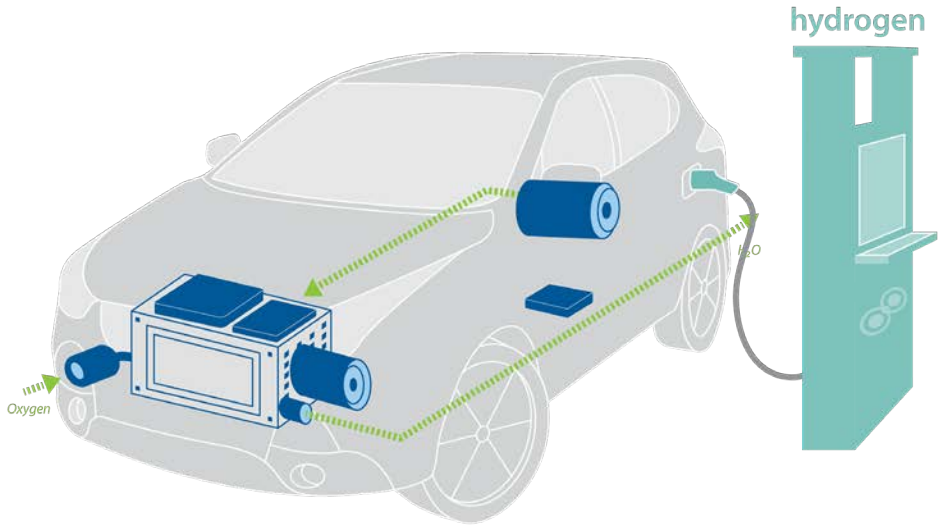
For drivers who want to combine the zero-emission driving of a battery electric car with the quick and easy refueling of hydrogen. Refueling takes less than ten minutes, and most manufacturers provide free fueling for the first three years.

According to the Department of Energy (DOE), a full tank of compressed hydrogen will cost around $50 (and provide a range of approximately 300 miles). The DOE also estimates that the future costs will fall to $30 to fill a tank of hydrogen. The target price for hydrogen is $4.00/gallon of gasoline equivalent.

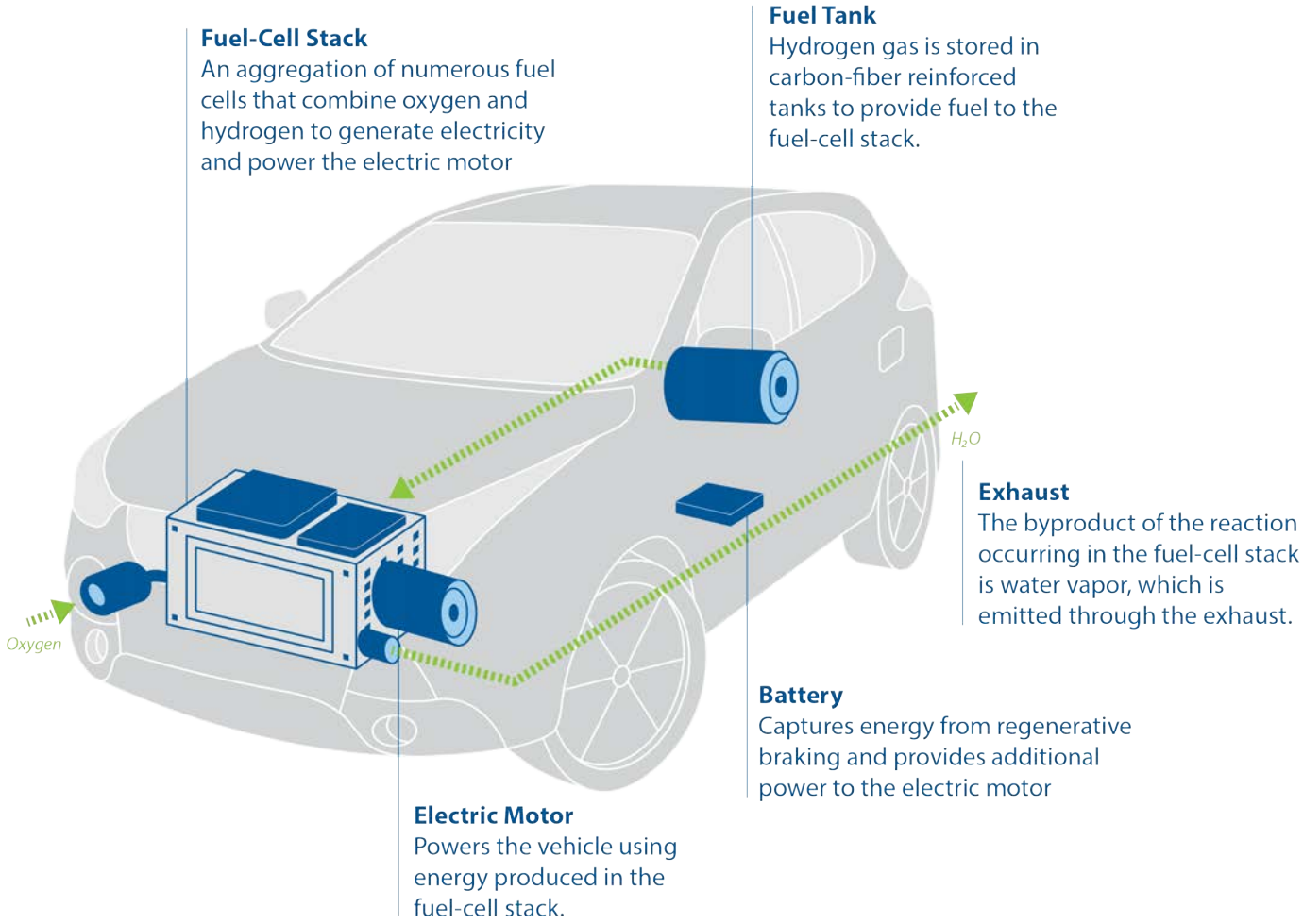
Though hydrogen fuel cells are a fairly new technology, there are still plenty of vehicles that can use this type of fuel:

- Passenger vehicles
- Shuttle buses
- Transit buses
- Forklifts

FCEV



FCEV


Fuel-Cell Stack
An aggregation of numerous fuel cells that combine oxygen and hydrogen to generate electricity and power the electric motor
Fuel Tank
Hydrogen gas is stored in carbon-fiber reinforced tanks to provide fuel to the fuel-cell stack.
H_2O
Exhaust
The byproduct of the reaction occurring in the fuel-cell stack is water vapor, which is emitted through the exhaust.
Oxygen
Battery
Captures energy from regenerative braking and provides additional power to the electric motor
Electric Motor
Powers the vehicle using energy produced in the fuel-cell stack.

Additional Alternative Fuel Technology

Biodiesel

Biodiesel is a non-petroleum-based diesel that is made from vegetable oil, recycled restaurant grease, or animal fats. Pure biodiesel is renewable and clean-burning form of diesel.

Typically, biodiesel can be blended with petroleum diesel. Biodiesel blends range from B2 (2% biodiesel, 98% petroleum diesel) to B99 (99% biodiesel, 1% petroleum diesel). B20 is the most common biodiesel blend in the United States. B20 provides similar fuel economy, horsepower, and torque as diesel fuel.

Renewable diesel has been growing in popularity. Renewable diesel is also made from biomass feedstocks, but is processed in a different way that makes it more chemically similar to diesel than biodiesel.

Any vehicle that runs on diesel can also use biodiesel, including, but not limited to:

- Passenger vehicle
- Vanpool – shuttle
- School bus
- Refuse hauler
- Sweeper
- Construction equipment

Ethanol (E85/Flex Fuel)

Ethanol is a renewable fuel made from various plant materials ("biomass") including corn, sugar cane, barley, and wheat.

There are several blends of ethanol: E10 (10% ethanol, 90% gasoline), which is universal in California gasoline, E15 (15% ethanol), and E85 85% ethanol). E85 can be used in flex-fuel vehicles.

Flex-fuel vehicles account for one out of three vehicles in the entire federal fleet. Flex-fuel vehicles can use regular gasoline and E85 interchangeably:

- Passenger vehicles
- Pick-up trucks
- Police vehicles
- Vans
- Medium-duty trucks

Natural Gas (CNG)

Natural gas used as a transportation fuel is used as compressed natural gas (CNG) or liquefied natural gas (LNG). Natural gas is a mixture of hydrocarbons, predominantly methane (CH4).

CNG is natural gas that has been compressed and stored as a gas in high pressure tanks up to 3,600 pounds per square inch (psi). LNG is natural gas that is cooled to a temperature below -260˚F.

Nearly 87% of U.S. natural gas is domestically produced and boasts 20-40% less carbon monoxide

and 80% particulate matter than gasoline. According to the Natural Gas Vehicle Coalition, there are about 112,000 natural gas vehicles on U.S. roads.

Taking into account fuel refining, transportation, and combustion, natural gas vehicles (NGVs) produce 22% less greenhouse gas (GHG) than comparable diesel vehicles and 29% less than gasoline vehicles.

Several types of vehicles can use natural gas. It is a versatile fuel.

- Vans
- Pick-up trucks
- Refuse haulers
- Low-speed vehicles
- Med- and heavy-duty
- Heavy-duty trucks
- Transit buses
- Light-duty vehicle

Types of natural gas vehicles

- Dedicated: These vehicles are designed to run only on natural gas.
- Bi-fuel: These vehicles have two separate fueling systems that enable them to run on either natural gas or gasoline.
- Dual-fuel: These vehicles are traditionally limited to heavy-duty applications, have fuel systems that run on natural gas and use diesel fuel for ignition assistance.

Propane

Propane is also known as liquefied petroleum gas (LPG). Propane is the third most common transportation fuel in the world. Nearly all U.S. propane is produced domestically and over half of it is a by-product from natural gas purification. Propane is a clean burning fossil fuel with lower greenhouse gas emissions than gasoline.

The following vehicle types use propane:

- Forklifts
- Low-Speed Vehicles
- Buses
- School Buses
- Lawn equipment
- Trucks
- Shuttles
- Delivery services

ZEV Technology in the Central Sierra Region

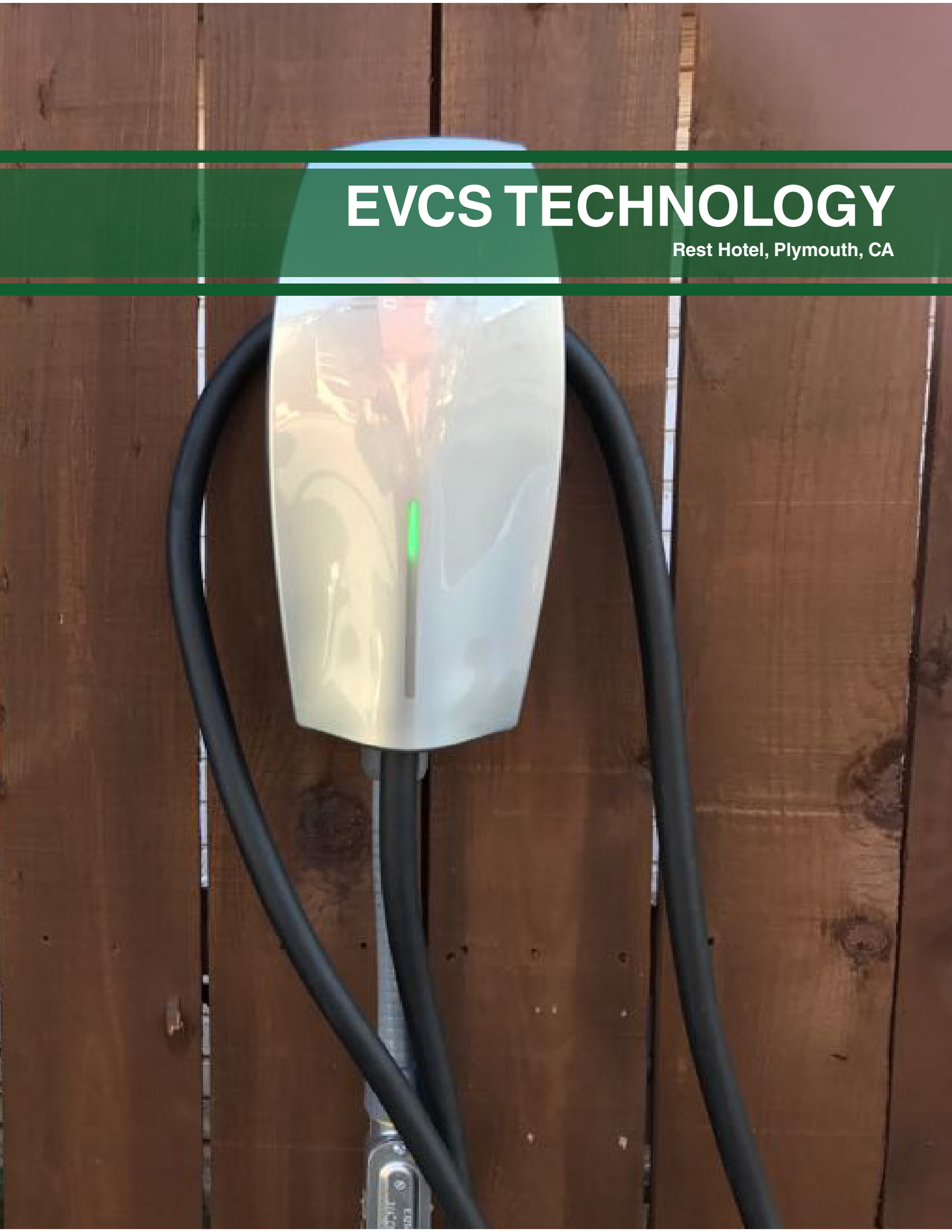
Alternative fuel technology in the State of California is quickly moving towards the electrification of vehicles. The adoption of the California Air Resource Board's Innovative Clean Transit regulation, to electrify transit fleets throughout the State, supports this trend. Building a network of electric vehicle infrastructure will continue to support the draw to the Region as a center for visitor attractions as well as support the continued adoption of electric vehicles among Central Sierra residents.

This report recommends exclusively battery-electric and plug-in hybrid vehicles (BEVS, PHEVS) rather than hydrogen fuel-cell electric vehicles (FCEVs). While FCEVs offer similar benefits as BEVs, including silent operation and a lack of tailpipe emissions (though FCEVs technically exhaust water vapor), FCEV fueling infrastructure has a significantly higher upfront cost compared to EVCS. Additionally, at the time of writing, hydrogen infrastructure is much less common to find within the state than EV charging, and thus can be less geographically convenient for drivers that live far from infrastructure. FCEVs do replicate the rapid refueling process characteristic of gasoline vehicles, but the lack of plans to further develop hydrogen fueling infrastructure within the Central Sierra region discouraged its exploration within this report.

Power
Charging
Power Fault
Charging Fault
ClipperCreek
Electric Vehicle
Charge Station
High Power

EVCS TECHNOLOGY

Rest Hotel, Plymouth, CA



EVCS Technologies

Electric vehicle charging stations (EVCS) are typically classified by three "levels" of power delivery: Level 1, Level 2 and direct current (DC) fast charging. The primary distinction between these levels is the input voltage – Level 1 uses a household 110/120 volts, Level 2 uses the same 208/240 volts as a clothes dryer, and DC fast chargers (DCFC) use between 208 and 480 volts, and usually requires three-phase power input. Various manufacturers produce each level of EVCS, with a variety of products with varying prices, applications and functionality. Figure 15 illustrates the differing characteristics of each of the charging levels.

Figure 15: Key Differences Between Level 1, Level 2, and DC Fast Chargers

LEVEL 1	LEVEL 2	DCFC
• Standand current • 8-12 hours to fully charge, although larger batteries could take 1-2 days • Standard outlets and standard J1772 coupler • In-vehicle power conversion	• Requires installation of charging equipment and may require utility upgrades • 4-8 hours to fully charge • Inside or outside locations • Public use, often requiring payment and provider network interfaces	• Requires installation of charging equipment and may require utility upgrades • 80% charge in as little as 30 minutes • Relatively high-cost compared to Level 2 chargers • Requires utility upgrades and dedicated circuits

Level 1 Charging

In general, Level 1 charging is cost efficient when an existing 110V/120V outlet is present. In this case, an EV driver can use their original equipment manufacturer (OEM) branded Level 1 charging cord set that comes with most EVs. The power output of Level 1 charging varies slightly, but typically is between 12 amps and 16 amps of continuous power output. At these levels of power output, a Level 1 charger will deliver between 3.5 and 7 miles of range per hour of charging. These charging rates can be satisfactory for drivers who do not drive more than 30-40 miles daily and who charge overnight.

Currently, there are only a few third-party manufacturers of Level 1 EVCS designed for commercial use. However, hosts can offer charging by offering easily accessible 110V or 120V outlets that drivers can use with the cord sets that came with their vehicles.

Level 2 Charging

Level 2 EVCS offer higher power output than Level 1 EVCS and have additional functionality that is not available with Level 1 EVCS. Level 2 EVCS may be designed for indoor or outdoor use (e.g., NEMA 3R, NEMA 6P, NEMA 4x rated) and typically produce between 16 and 40 amps of power output, which will deliver between 14 and 35 miles of electric range per hour of charging. In general, Level 2 EVCS are distinguished between non-networked EVCS (colloquially referred to as "dumb" EVCS) and networked EVCS (referred to as "smart" EVCS).

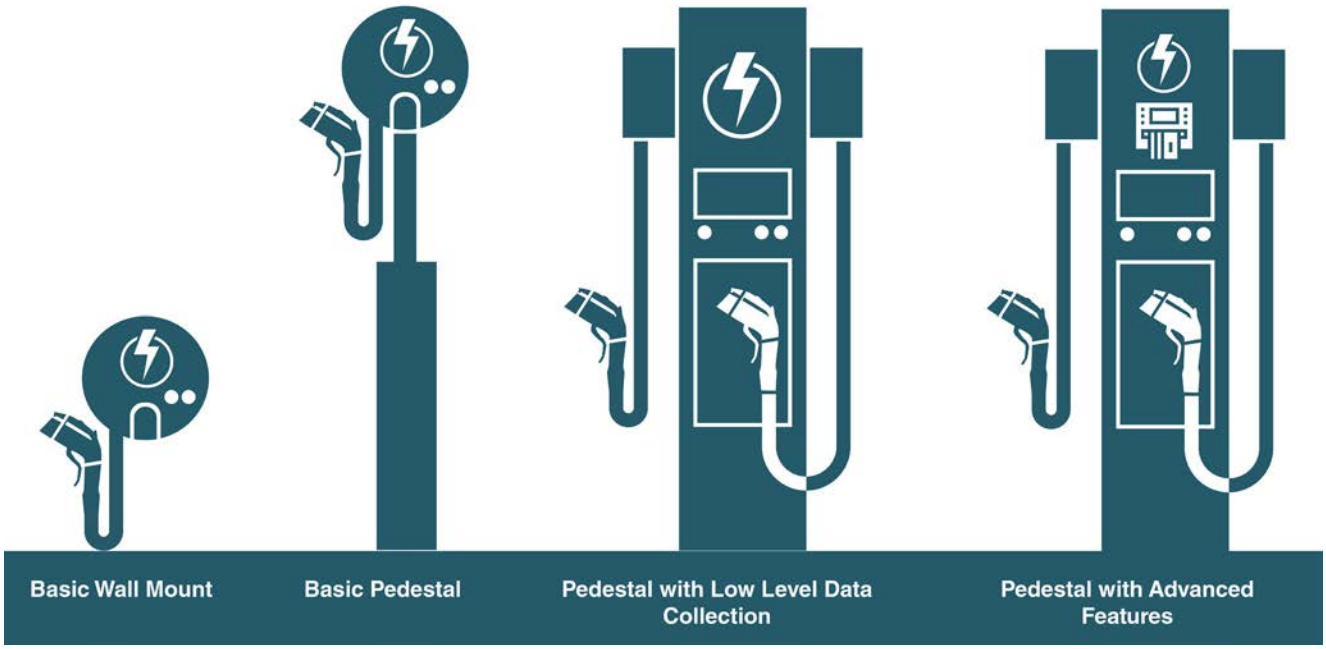
Non-networked (Dumb) Level 2 EVCS

Non-networked Level 2 EVCS serve a similar function as Level 1 EVCS, however, if an electrical permit is going to be obtained to install a dedicated circuit for EV charging, it is most often a better value to have a 240-volt circuit installed for Level 2 charging. Nonnetworked EVCS are typically available at slightly lower cost than networked/smart EVCS, but typically do not offer data monitoring.

Networked (Smart) EVCS

Networked EVCS are commonly used in workplace/public settings where payments are required or at multi-unit dwelling sites (MUDs) where the property's electricity bill is shared by multiple tenants. These include apartment buildings, condominiums, and townhouse complexes. Some of the "smart" features include remote access/control via Wi-Fi or cellular connection, access control/ability to accept multiple forms of payment, and load balancing across multiple EVCS.

Networked EVCS are useful for owners that need to monitor electricity usage across multiple EVCS, have multiple drivers sharing a single EVCS, require payment for use of EVCS, or in situations where electricity capacity is constrained or requires load balancing. Some models of smart EVCS participate in demand response programs which limit charging to certain hours and allows the operator to maximize a time-of-use (TOU) electricity rate structure and only allow charging when electricity is the cheapest. While the initial capital investment for a networked EVCS is higher than non-networked EVCS, they provide valuable data to the owner that can result in long-term cost savings through better management or by applying innovative charging solutions.



DC Fast Charging

DC fast chargers (DCFC) are the highest-powered EVCS on the market. They are commonly used as range extenders along major travel corridors for long-distance trips, as well as in urban environments to support drivers without home charging or very high-mileage drivers. At present charging speeds, these chargers are ideal for places at which a person would spend 30 minutes to an hour, such as short-dwell destinations (e.g. restaurants and retail locations).

Current DCFC stations typically require three-phase, 480V input at 100+ amps (50-60 kW) and can produce a full charge for an EV with a 100-mile range battery in slightly more than 30 minutes (averaging 178 miles of electric drive per hour of charging). Most DCFC-compatible vehicles currently on the market can only accept a maximum power delivery of 50kW, though this is rapidly increasing. To future-proof infrastructure against further improvements in power acceptance rates, the newest generation of DC fast chargers, such as those being installed by Volkswagen's Electrify America program, can output 150-350 kW of power. Tesla's Superchargers are capable of charging at speeds of 120-135kW with upgrades to existing electrical infrastructure.

It is important to note not every EV model is capable of DC fast charging, and therefore these stations cannot be utilized by every EV driver. Furthermore, there are multiple standards for connectors for DC fast charging, whereas there is only one common standard for Level 1 and 2 charging (SAE J1772). There are three types of DC fast charging connectors: CHAdeMO (typically used by Japanese-manufactured vehicles), Tesla (proprietary connector), and CCS (all other vehicles). As of March 2019, Tesla connectors are the most common connector type in the United States, totaling 5,659 ports; followed by CHAdeMO and CCS with 2,752 and 2402, respectively. These numbers are rapidly changing with many vendors making major investments in fast charging across the US.

EVCS Hardware, Software and Networking Capabilities

Software packages deployed in networked EVCS provide technological capabilities, such as tracking usage, billing customers, demand management, demand response and load balancing. Non-networked EVCS are simple in design, with features limited to a start/stop mechanism and status indicators.

Depending on the owner or operator arrangement, EVCS networking functional requirements will vary depending on user demands and equipment needs. Table 8 lists hardware and software specifications and capabilities that should be considered.

Table 7: Typical Hardware, Software and Networking Capability Requirements

Level 1 EVCS	
Hardware	• Supply an output current of at least 8 amps per port minimum at 120 VAC • Charge connector compliant in SAE J1772 • Outdoor rated NEMA 3R or better and an operating temperature range of 0 to 122 degrees Fahrenheit • Compliant with NEC article 625 • User interface - start/stop mechanism, status indicators
Software	• Operate and fault detect/diagnose (networked only) • Power Surge Protection
Level 2 EVCS	
Hardware	• Commercial-grade UL Listed • Supply an output current of at least 15 amps per port minimum at 208/240 volts • Charge connector compliant in SAE J1772 • User interface - start/stop mechanism, status indicators • Compliant with NEC article 625 • Outdoor rated NEMA 3R or better and an operating temperature range of 0 to 122 degrees Fahrenheit • Network ready – able to communicate with a network management system (NMS) (networked only) • ADA compliant
Software	• Control, operate, communicate, diagnose and capture data (networked only) • Power surge protection • Track usage data, billing customers and manage electrical loads (networked only) • Meter/display of energy consumption - 3% accuracy or better (networked only) • Load sharing capable • Use Open Charge Point Protocol (OCPP 1.6 or later) (networked only) • Certified to receive an OpenADR 2.0b signal (networked only) • ADA Compliant
DCFC EVCS	
Hardware	• CHAdeMO and SAE CCS connectors • Commercial-grade UL Listed • DC fast less than 50 kW: Supply an output current of up to 100 amps per port minimum at 200-480 VDC • DC fast greater than 50 kW: Supply an output current of up to 400 amps per port minimum at 200-600 VDC • ADA compliant
Software	• Control, operate, communicate, diagnose and capture data • Ability to “remote start” • Point-of-sale methods: pay-per-use, subscriptions, RFID or smart cards • Track usage, collect data, billing customers and managing electrical loads • Meter/display of energy consumption - 3% accuracy or better • Load sharing capable • Use Open Charge Point Protocol (OCPP 1.6 or later) • Certified to receive an OpenADR 2.0b signal

EVCS Installation, Operation, & Maintenance

Permitting

Recognizing the important role of permitting in the deployment of charging infrastructure, California legislators passed a law in 2015 requiring local governments to streamline the permitting process. AB 1236 required all communities under 200,000 people to adopt an ordinance that expedites the permitting process for PEV charging stations by September 30, 2017.

The required ordinance must include several streamlining elements. Local governments must provide a permitting checklist for which installation projects that meet all requirements must be eligible for expedited review. Cities and Counties can use the latest version of the "Plug-In Electric Vehicle Infrastructure Permitting Checklist" from the Zero-Emission Vehicles in California: Community Readiness Guidebook published by the Governor's Office of Planning and Research.

Permit Streamlining Considerations

Jurisdictions must balance efforts to simplify permitting and inspection while maintaining quality and safety standards. The following practices can help jurisdictions increase efficiency while meeting standards and state requirements:

- Prepare combined informational materials providing all guidance on the permitting and inspection processes specific for residential, multi-family dwelling, and non-residential charging equipment installations.
- Prepare all guidance, including a permitting and inspection checklist and application materials allowing for online submission to meet local and state requirements per AB 1236 as described on page 16.
- Work with other local governments to make permitting and inspection procedures consistent between jurisdictions by using consistent guidelines and other shared standards.
- Consider streamlining permitting for installations in single-family residences by reducing application material requirements; for example, eliminate site plan requirements and require installer to provide manufacturer specifications and approved equipment testing certification at the time of inspection, limit to one inspection, and set a fixed fee.
- Work with local utilities to create a notification protocol for new charging equipment through the permitting process.
- Train permitting and inspection officials in EV charging equipment installation.
- To provide permitting consistency between jurisdictions in the Region, it is also recommended that guidelines are developed for local governments on PEV charging systems for single-family and multi-family residences and commercial properties.

ADA/California Building Code Compliance

Under the California Building Code, a portion of all chargers at multi-family buildings and non-residential developments are required to be accesible to the disabled. It is important to take these requirements into account when planning to install chargers because they impact the spatial needs, and potentially the cost, of installations. The first new charger constructed is required to be ADA-accessible and this is significantly wider than a typical parking space and includes more space for adjacent access aisles. Property owners may have to sacrifice multiple standard parking spaces to build the first charging space.

When EVCS are installed in public parking garages and lots, it is important to note that under CBC Chapter 11B, Divisions 2 and 8:

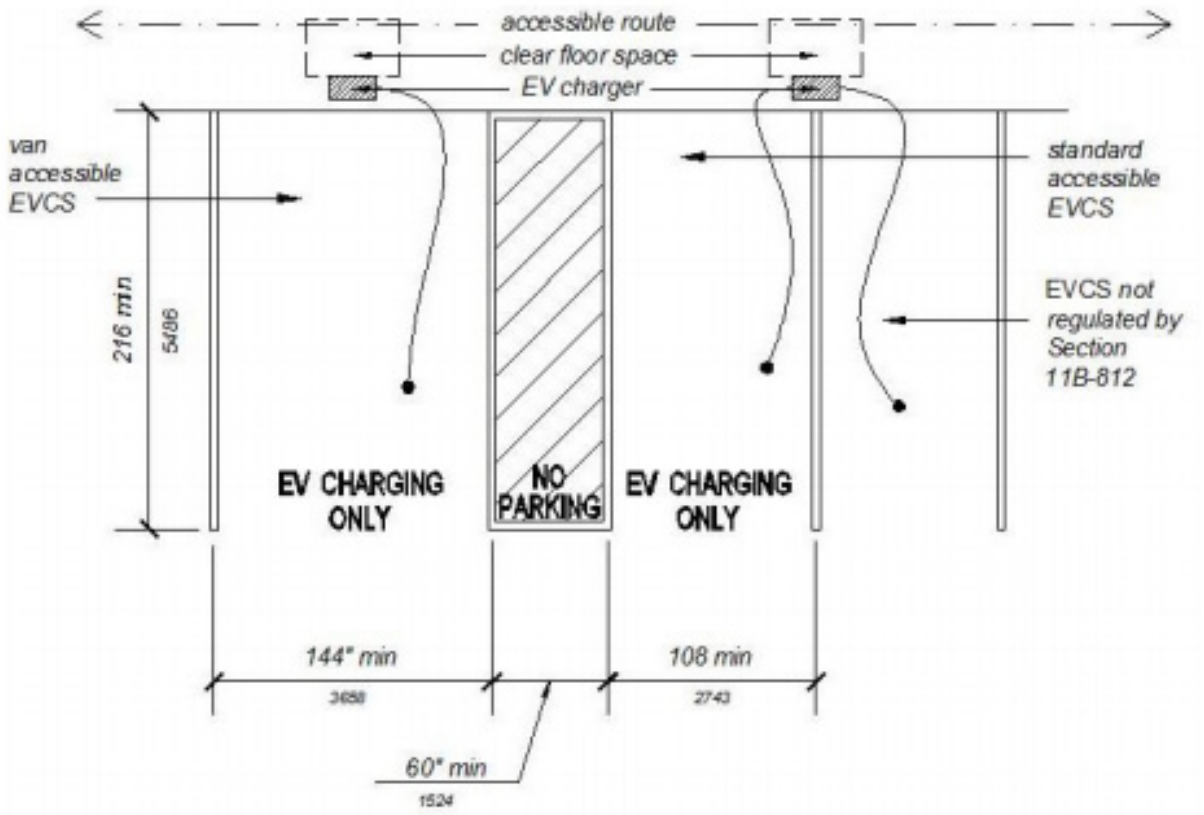
- Installing EVCS changes the use of the space from parking to charging.
- Depending on the number of EVCS to be installed, a certain number and type of accessible EV spaces needs to accompany the EVCS installation (see Table 9 below).
- Accessible spaces need to be on an accessible path of travel to the main entrance of the facility
- which the EVCS serves.

ADA Requirements for New Public Charger Installations

The California Building Code requires roughly one of every 15 newly-installed chargers at public locations to be ADA-accessible, as shown in Table 9. Three design standards for Americans with Disabilities Act (ADA)-accessible parking spaces are as follows:

- Ambulatory parking spaces designed for people with disabilities who do not require wheelchairs but may use other mobility aids.
- Standard ADA-accessible spaces designed for people who use wheelchairs but can operate vehicles.
- Van-accessible spaces for vehicles carrying people who use wheelchairs who cannot operate vehicles.

Figure 16: ADA Accessible Space Site Plan and Surface Markings



Source: California Building Standards Commission, 2016 California Building Standards Code Section 11B-812.9

Table 8: ADA-Accessible Chargers Required at Installations of New Public Charging Spaces

Total Chargers	Minimum Required Van Accessible Chargers	Minimum Required Standard Accessible Chargers	Minimum Required Ambulatory Chargers
1 – 4	1	0	0
5 – 25	1*	1	0
26 – 50	1*	1*	**1**
51 – 75	1*	**2***	**2**
76 – 100	1*	**3***	**3**
101+	1, plus 1 for each additional 300 spaces	3, plus 1 for each additional 60 spaces	3, plus 1 for each additional 50 spaces

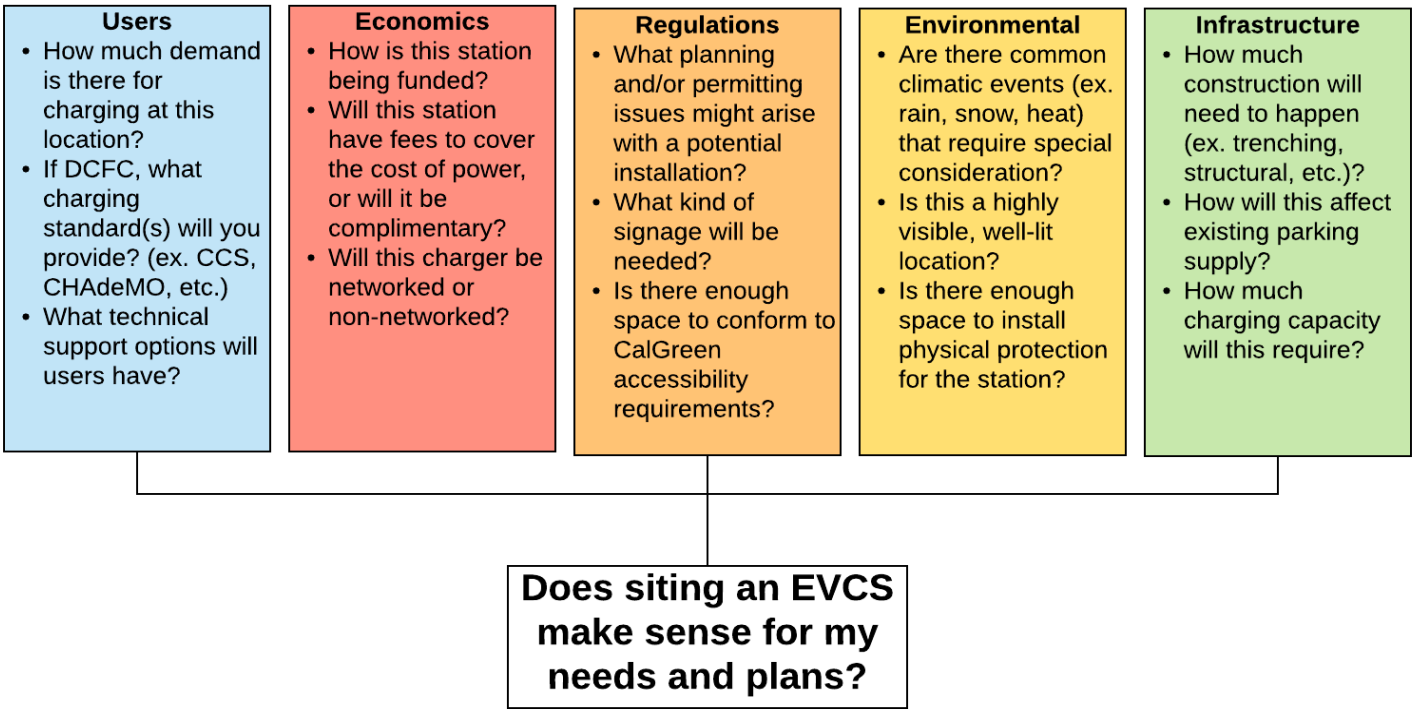
** Must have at least one accessible space*

Source: California Building Standards Commission, 2016 California Building Standards Code, Section 11B-812

The EVCS Decision Process

There are a wide range of initial considerations a potential site host should take into consideration before deciding to install a charging station. Figure 17 illustrates some representative questions - however, each individual installation is unique, and may be subject to additional considerations. For a more comprehensive list of considerations, please see the Department of Energy's Plug-In Electric Vehicle Handbook for Public Charging Station Hosts.

Figure 17: Common Considerations for EVCS Planning and Siting



Source: Adapted from the Dept. of Energy Plug-In Electric Vehicle Handbook for Public Charging Station Hosts

Demand Assessment

The first step a decision-maker should take is to determine the overall need/demand for EV charging. While there are multiple ways of doing this, a common methodology is to distribute a survey to relevant stakeholders/potential station users. This methodology is easily utilized in workplaces, multi-unit dwellings (MUDs), and commercial/retail locations where the building/project owner has direct communication with the potential station users; public agencies can also reach their constituencies through established communication outlets. When applicable, administering a survey should have a goal of determining the exact amount of power needed to supply charging for EV drivers' needs. Table 9 lists potential survey questions.

Table 9: EVCS Potential Survey Questions

Survey Question	Resulting Information	Explanation
Do you own an EV/ would like to own one in the next year?	Number of EV drivers that will be on the property one year from now.	This helps determine the short- and medium-term demand for EV charging.
How long is your vehicle typically parked overnight?	Minimum number of hours available for EV charging.	If a load balancing system is used, this will help determine how the system will be designed.
Are you willing to pay for the cost of installing EV charging?	The budget for the project.	If some residents are unwilling or unable to bear the costs of installing EV charging, the building owner/HOA can make the determine on whether it will help finance the costs, pay for the costs outright or not pay for any of the costs and therefore not provide charging for that resident.

Capacity Assessment

Once the EV charging demand is known, the electrical capacity calculations should be run to determine how much EV charging is required. To do this most effectively, a project owner should consult their facilities or maintenance personnel who are typically familiar with the building/property's electrical system. Load calculations following the California Electrical Code, Article 220 can identify the maximum expected load, with appropriate safety factors. An alternative is to do a load study to determine the actual maximum load on a panel or service.

To determine whether the electrical capacity is adequate, the following items must be estimated:

1. The number of EV drivers on the property (current and forecasted)
2. The daily commute distance for each driver

In general, the project owner should plan on one charging port per driver. The daily commute can determine the minimal type of charging needed. If an EV driver drives fewer than 25 miles daily, Level 1 charging can suffice. Therefore, Level 1 outlets could be utilized if available for anyone who drives fewer than 25 miles/day. If Level 1 outlets do not exist, Level 2 charging should be installed.

EVCS Costs

Installation Costs of EVCS

The cost to install EVCS is highly variable and dependent on several factors, including but not limited to the following:

- Electrical contractor's hourly rate
- Distance of conduit run from EVCS to electrical panel
- Potential trenching across hardscape for conduit run
- Potential service panel upgrade/sub panel installation
- Number of chargers being installed on the site

Table 10, below, outlines the range of costs for the first EVCS port (plug) installed at a given site. Table 11 outlines some specific installation variables that are incorporated into the figures shown in Table 12: the construction and excavation portions, which can vary significantly between installations.

Table 10: Approximate Costs for Non-Residential Single-Port EVCS

Cost Element	Level 1		Level 2		DC Fast Charge	
	Low	High	Low	High	Low	High
Hardware	$300	$1,500	$400	$6,500	$10,000	$40,000
Permitting	$100	$500	$100	$1,000	$500	$1,000
Installation	$0*	$3,000	$600	$12,700	$8,500	$51,000
Total	$400	$5,000	$1,100	$20,200	$19,000	$92,200

Source: Cost data from the Department of Energy, 2015

Table 11: Specific Installation Cost Considerations

Cost Element	Cost
Conduit	$1.50-$2.50/ft
Trenching	$25-$100/ft
Concrete Patch	$14-$15/sq.ft
Asphalt Patch	$10-$11/sq.ft

Source: Cost data from the San Diego Association of Governments (SANDAG), 2016

Curbside EVCS

Placing EVCS along curbsides in the public right-of-way has unique challenges and considerations that are not present in other EVCS installation scenarios. Depending on the location of the EVCS there may be competing current or future uses for the curb space. Furthermore, the EVCS might need to be wired into a nearby building panel or be powered from a nearby utility transformer. Since ownership and operation of multiple EVCS can be expensive and time consuming, it is an important consideration to make before installing an EVCS.

While there are unique challenges and considerations for curbside EVCS, it can provide a substantial benefit to residents. Curbside EVCS have high visibility, and their availability might help a resident decide to purchase or lease an EV. Furthermore, curbside EVCS can be an effective deployment strategy to support residents without access to off-street parking. Charging integrated into streetlight poles and utilizing existing streetlight circuits can potentially be an effective option.

Technology Specification

The following shows the minimum specification requirements that could be needed for a curbside EVCS to be permitted by a jurisdiction in the Region. The specifications defined below are derived from Seattle's EV Charging in the Right of Way (EVCROW) Program.

Table 12: Curbside EVCS Requirements

Publicly Accessible Curbside EVCS	
Power Requirement	Minimum AC Level 2 (208/220/240 V and 12 amps of continuous output)
Ownership	Public agency, private resident, business/organization, electric vehicle service provider (EVSP), utility
Networking/Payment	If in a metered space, must have an integrated payment system that allows for one-time payment for both EVCS use and parking meter
Parking	Parking shall only be allowed for EVs that use the EVCS. Non-EVs are prohibited from parking in designated EV spaces and EVs are prohibited from parking in these spaces if they are not charging

Municipal Challenges

Implementing vehicle charging at the curb (in the public right-of-way) has the potential to increase access to charging for residents who do not have access to off-street parking or charging. However, local governments have been hesitant to enact curbside charging programs because they lacked the authority to assess parking fines or towing vehicles illegally parked in spaces on public streets designated for charging EVs. Assembly Bill 1452, approved in October 2017, gives local governments this authority. Municipalities also need to consider changes in curbside parking payments systems and additional user fees, as well as data management, capital costs for subscription services if units are networked, public works operations and maintenance protocol, and the addition/creation of new signage and engineering standards for city staff/code.

Mobile Charging

If infrastructure installation proves too inconvenient or costly, mobile battery-based charging can also expand charging to a parking area with no fixed infrastructure required. Mobile charging units can be charged from an existing EVCS or other source of power and then wheeled through a parking lot to charge the desired vehicles. Integrated software helps managed the amount of charge each vehicle gets before the battery is depleted. Like autonomous solar charging, no permit would be required to deploy a mobile charger to an existing site. Additionally, the storage component of the onboard battery allows these chargers to continue operating even in the event of a power outage, and can help to avoid demand charges if necessary, as these typically charge from the grid at a Level 2 rate and discharge from the battery reservoir at 50+kW, rather than dispensing 50+kW straight from the grid.

Figure 18: Freewire Mobi

Source: Mobi, 2018

Operation & Maintenance Costs

There are several ongoing operational and maintenance (O&M) costs associated with EV charging stations: the cost of electricity, any network subscription fees, and station maintenance costs. Each of these costs can be reduced or recouped in several ways.

Cost Saving Opportunities

Demand Response/Time-of-Use Rates

In general, demand response refers to a dynamic communication network between the electricity grid and buildings that draw power from it that controls the amount of power being delivered to buildings, usually based on changes in electricity prices. This is a way of shifting electricity demand from end-users to off-peak times and away from peak-demand hours. Many electric utilities in California will implement time-of-use (TOU) rates, which refer to rate plans with variable costs for electricity that are dependent on the time of day at which the charging occurs.

TOU rates have at least two different time periods: on-peak, where the price of electricity is highest, and off-peak, when the price of electricity is lowest. Some rates have additional periods, such as partial-peak and super off-peak. Customers can utilize TOU programs paired with scheduling EV charging during off-peak periods to lower the cost of electricity required to meet their charging demand. The TOU off-peak price of electricity is lower than peak periods, so charging only during off-peak hours will have a significant impact on monthly utility costs. Utilities offer TOU rates specifically for EV owners and the EV charging station itself. This is a way of incentivizing end-users to use less electricity during peak-demand which helps avoid the need for increased distribution capacity and alleviate constraints on the electrical grid.

Cost Recovery

Fees

Charging station owners can contract with electric vehicle service providers (EVSP) or third-party operators who install, operate, and set the fees on charging equipment. However, if owners can set fees—either explicitly or implicitly through their choice of operator—goals may conflict. Owners often need to recoup the costs of installing, maintaining, and operating chargers, and may also wish to price vehicle charging to encourage turnover so chargers are available to more drivers. On the other hand, pricing EVCS charging so driving an EV is cheaper on a per-mile basis than a gasoline-powered vehicle creates an incentive for people to purchase electric vehicles or charge plug-in hybrids and use electricity instead of gasoline. Lower charging costs at commercial centers can also create incentives for drivers to shop at those locations.

- **Fixed fee:** Each charging connection has a set cost, regardless of energy use or length of charging time. For example, the fixed fee may be assessed by an employer at a workplace or when charging is provided as part of a parking lot fee. It may be expected that the driver will be parked for a significant period in this location.
- **Fixed rate:** Fees may be charged per hour or other intervals for AC Level 2 charging and a per minute basis for DC fast charging. This rate is useful if high utilization and turnover of vehicles is desired.
- **Pay per energy consumed:** Fees are based on the cost of electricity to the host and they require measuring the energy delivered. A multiplier on this cost may be applied to recover other operational costs.
- **Subscription:** A fixed rate may be charged to the driver monthly for an unlimited number of

connections or time connected at publicly available EVCS. Discounts on the fixed rate may be provided by membership program for a tiered membership fee. In most cases, a pay per use option is generally available although restrictions may apply based on the specific program.

When charging fees for usage, vehicles are less likely to remain parked after their charge is complete and other drivers are drawn to spaces that they know are more likely to be available. Over the long term, infrastructure owners should pilot innovative agreements with utilities to make charging cost-competitive with the price of gasoline. For the short term, infrastructure owners may need to establish higher fees to recuperate costs and encourage high levels of turnover. Various regional infrastructure owners should consider adopting the same fee schedules, particularly in high-demand locations, to create consistency throughout the region. Local governments looking to adopt a PEV charging fee may want to conduct a study to demonstrate the fee is necessary to cover costs and/or create a revenue-sharing agreement with private infrastructure operators.

Enforcement

The California Vehicle Code (CVC Section 2251) allows the owner of a space to remove a vehicle if it occupies that space in violation of posted regulations, including signs designating spaces for charging vehicles or time limits. For signs to be enforceable, governments must specify time limits, penalties, hours and other restrictions, and provide the necessary definitions. For example, the City of Sacramento posts a time limit of four hours for continuous charging in a parking space. Enforcement is key to making sure chargers are available for drivers who need them, but it can be challenging, potentially requiring increased funding for parking agents. The City of Los Angeles has adopted municipal code changes to enforce EV only charging. Instead of devoting resources to effective enforcement of time limits, it may be more effective to charge fees that escalate steeply after a certain time to encourage turnover at stations.

GHG Considerations

Greenhouse Gas Considerations

Electricity generation accounts for 10% of California's GHG emissions, while vehicle transportation accounts for roughly 41%. Electrifying transportation when the electricity is supplied by clean resources offers an opportunity to significantly reduce the sector's GHG emissions. In this section, we further discuss the implications GHG emissions associated with electricity generation and offer general guidelines on charging strategies to reduce GHG emissions with EVs.

Greenhouse gases (GHGs) emissions associated with vehicle travel are created by fossil fuel combustion during electricity generation (upstream or Scope 2) or fossil fuel combustion by vehicle internal combustion engines (tailpipe or Scope 1/3). Electric vehicles do have attributable GHG emissions. BEVs do not have tailpipe emissions but do have lifecycle emissions associated with upstream electricity generation. BEV emissions are entirely dependent upon the mix of electricity sources employed and the efficiency of electricity transmission, charging, and end use. Plug-in hybrid electric vehicles (PHEV) do not produce tailpipe GHG emissions when the vehicle utilizes only the battery for propulsion but does emit tailpipe emissions when the internal combustion engine is engaged, resulting in both upstream and tailpipe emissions.

In 2018, natural gas was the primary electricity-generating fossil fuel in California and is accountable for most GHG emissions in the electricity sector. To minimize GHG emissions stemming from charging EVs, it is desirable to incentivize charging during periods of time when the electric grid is supplied

by as much non-GHG-intensive power as possible, such as hydropower, geothermal, wind, solar, and other biomass derived sources.

GHG emissions from electricity generation vary as generators with differing efficiencies ramp up or down to meet electricity demand. Therefore, the timing of electric vehicle (EV) charging (i.e. charging at 9 AM or at 6 PM) influences the amount of GHG emissions generated by EV charging. The amount of GHG emissions created during energy production depends on numerous factors, including the energy mix (e.g., % renewable vs. non-renewable), electricity demand, and demand timing. As a result, the GHG emissions potential is continually changing from day to day and potentially between 15-minute cycles. While the impact of EV charging may not seem significant on a single vehicle scale, in aggregate, EVs accounted for 3.9% of total vehicle market share in California.

The following are guidelines for charging EVs at times when the electricity demand is likely to create the least amount of GHG emissions per kWh drawn from the grid. They provide general guidance for EV drivers and fleet managers to balance charging needs and GHG emissions; specific strategies should be verified with specific utility or energy provider data.

Ideal EV Charging Times (Low GHG emissions):

- Night time to early morning (about midnight to 6 AM)
    - Electricity demand is lowest at night, and therefore the most efficient natural gas generators can be used to meet demand. Additionally, wind turbines generate the most energy at night, providing GHG-free electricity.
- Late morning to early afternoon (about 9 AM to 4 PM)
    - Based on December 2018 data, the California Energy Commission (CEC) estimates that 34 percent of California's retail electricity sales are provided by Renewable Portfolio Standard (RPS)-eligible renewable resources. Most of this production is attributable to solar photovoltaics (PV), which have the highest average generation potential during this period. During peak PV generation (typically in summer and fall), solar PV can provide most or all the midday generation, allowing EVs to potentially charge from GHG-free electricity.

Non-Ideal EV Charging Times (Higher GHG emissions):

- 4 PM to 9 PM is typically when GHG emissions from electricity generation are highest. This is due to solar PV production ramping down as the sun sets and demand for electricity increasing as residential customers return home.

Time of Use Rates

- TOU rates are typically lowest during off-peak hours (e.g., 12 midnight to 6AM) night and early afternoon and a highest cost during evening hours (peak).

Table 13: Per-kWh Electricity Generation Carbon Intensities, 2016

Time of Day	Intensities
Midnight – 6 AM	0.37 kg CO2/kWh
9 AM – 4 PM	0.39 kg CO2/kWh
4 PM – 9 PM	0.43 kg CO2/kWh

- Both Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) have TOU programs for EV charging.

Table 13 provides average marginal carbon dioxide (CO2) emissions per kWh of electricity generation in California in 2016.

Advanced Charging Technologies

Charging from Distributed Renewable Resources

On an individual site level EV charging may be combined with electricity generated from distributed renewable energy resources, primarily solar. Distributed energy resources can be separate from the grid's centrally managed electricity generation and can add resiliency to charging during power outages. Renewable energy and energy storage systems combined with charging can lower the overall cost and carbon intensity of electricity for charging.

In the event of widespread power outages vehicle charging could be interrupted or halted entirely. Distributed resources such as microgrids, large-scale battery storage and solar energy generation add resiliency to operations. At small scales, this already has been demonstrated in real world settings—particularly on the East Coast following hurricane events. Grid independent solar powered charging also may be necessary in areas where trenching for conduit is not practical.

Figure 19: Envision Solar EV-Arc

Source: http://www.envisionsolar.com/ev-arc/ev-arc-4/

Load Management Technologies

The standard for an EV-ready parking space is a dedicated, 40-amp circuit that can provide up to 200 miles of charging over eight hours or 300 miles of charging over 12 hours for a passenger vehicle. With most drivers requiring less than 40 miles per day, this opens a variety of technology options to allow multiple vehicles to charge from a single point.

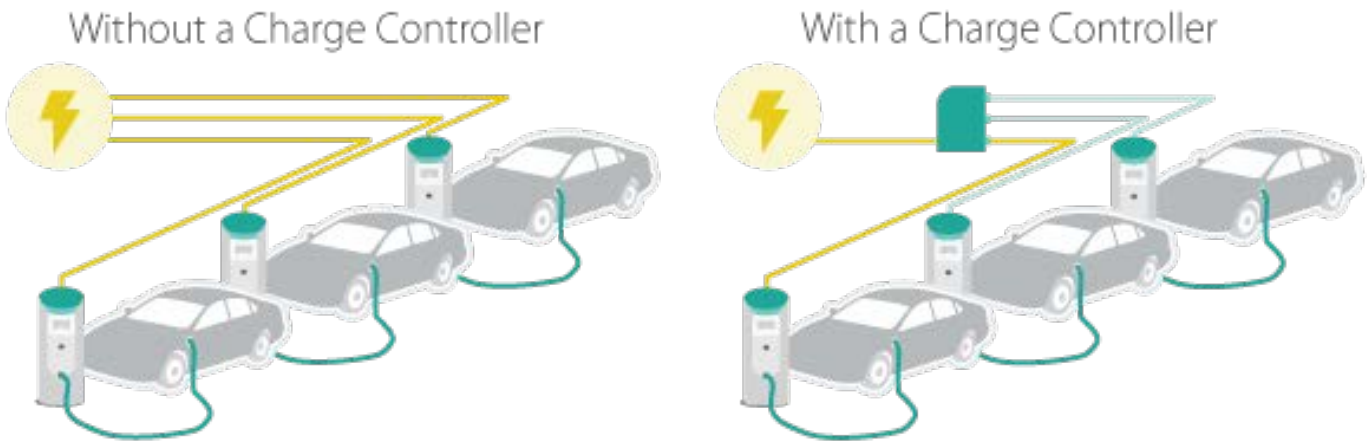
Load Balancing

In general, load balancing in the context of EV charging involves efficiently utilizing available electrical and physical capacity to deliver variable amounts of power to multiple EVCS. Without load balancing, power is delivered to each charging station at the maximum available charging rate. Where electric capacity is limited, delivering full power to one charging station may mean that there is no available capacity to install charging for additional EVCS without potentially expensive service upgrades. Where capacity exists for multiple full-power EVCS, using the full capacity can result in high electricity bills, particularly when it raises a building's peak demand. Therefore, load balancing is a smart way to allow for multiple EVCS to be utilized either simultaneously or on the same property without hitting demand charges or needing to install additional service capacity.

Power Sharing

The most basic load balancing systems are dual-port EVCS that can share a single circuit. For example, a station on a 40-amp circuit can provide full power to one plug when a single vehicle is plugged in or provide 50 percent power to each plug when two vehicles are connected. If one vehicle finishes charging, the remaining vehicle returns to 100 percent.

Figure 20: Rotational Charging



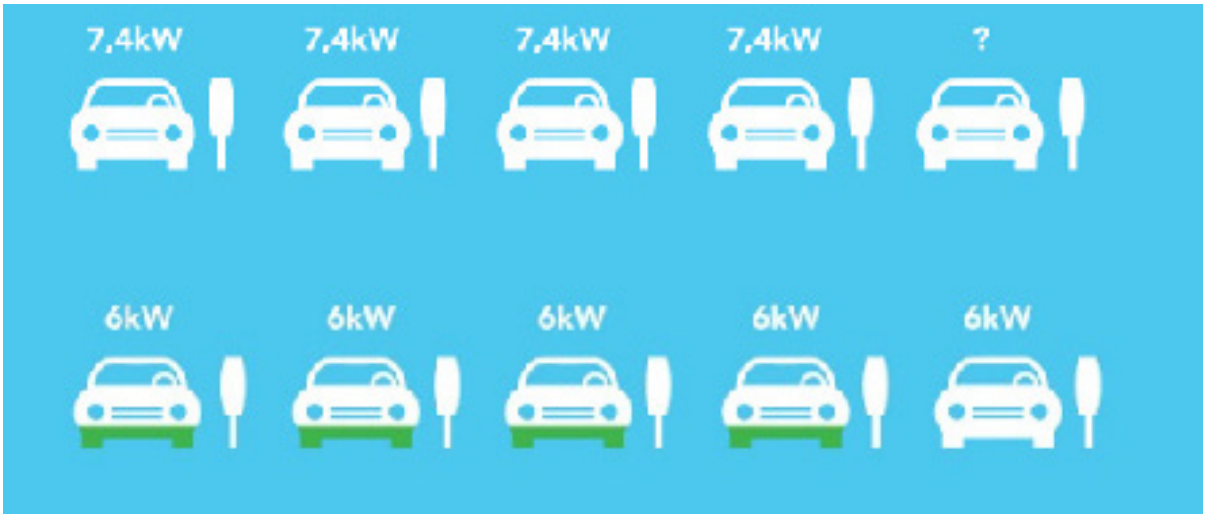
Rotational Charging

Another form of power sharing is rotational charging, where a single 40-amp circuit can be rotated among multiple EVCS. For example, an installation could be set up with five EVCS with each station getting full use of the circuit for one hour at a time. Within 10 hours (overnight or through a workday), each vehicle would get a minimum of two hours of full power charging, or up to 55 miles of range. For vehicles needing less than two hours of charging, the system would continue to rotate to a vehicle still needing charging. Both kinds of power management techniques can be applied to existing installations to meet growing vehicle demand.

Conventional and Dynamic Load Balancing

Conventional load balancing splits the amount of power between multiple EVCS equally based on the amount of available capacity. For instance, if a panel has 30 kW of available capacity and five EVCS installed, all of which can deliver up to 7.4 kW, it will typically only be able to support charging for four EV drivers (4 EVCS at 7.4 kW each = 29.6 kW). If a fifth driver wants to charge, they would only be able to use the remaining capacity of 0.4 kW. However, if this load was balanced across all five EVCS, each station would deliver 6 kW to each vehicle and thus every driver could charge at a sufficient rate, as shown in Figure 21.

Figure 21: Conventional Load Balancing System



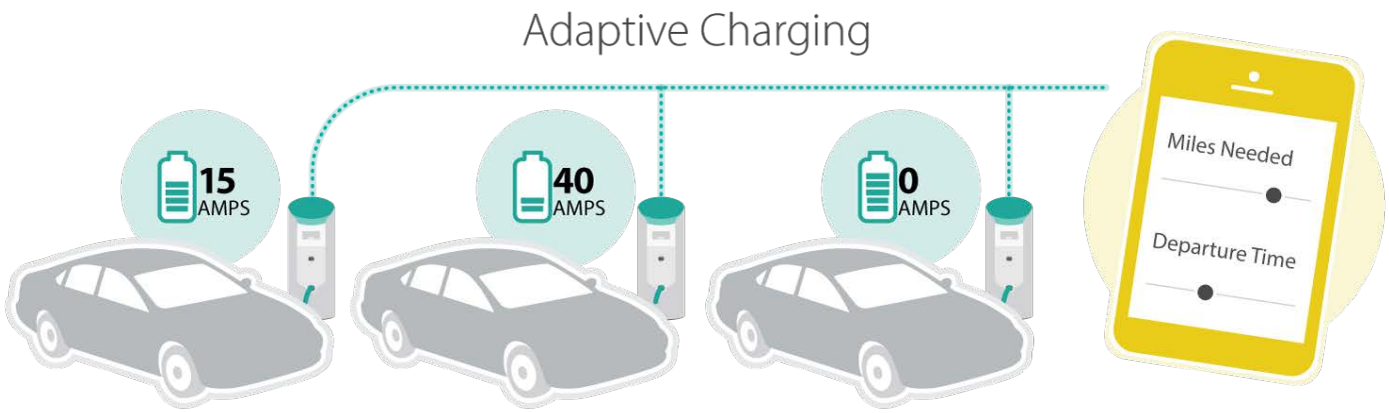
Source: http://www.evbox.com/learn/faq/difference-priority-load-balancing

This type of load balancing is useful when total charging demand only slightly exceeds available electrical capacity, as shown in the above example. However, using this example, if there was only 10 kW of available capacity instead of 30 kW, each vehicle would only receive 2 kW of charging power, which would not be a sufficient charge for most workdays. In this situation, dynamic load balancing would be a better fit.

Dynamic load balancing delivers variable amounts of power to each EVCS depending on many factors, including the state of charge (SOC) of each vehicle's battery and the demand capacity of the building/facility's electrical system. In short, a dynamic load balancing system will deliver the most power to the vehicle with the lowest battery SOC and, in aggregate, will never deliver over a fixed amount of power at one time. This has two advantages: it delivers power to vehicles based on need (vehicles that drive the farthest daily get the most power because they have the lowest SOC) and it ensures that the building/facility will not exceed demand thresholds that result in demand charges.

Figure 22 illustrates how a smart load balancing system operates using a smartphone application.

Figure 22: A Dynamic or Adaptive Load Balancing System



Load balancing systems ensure that the amount of EV charging is maximized with a fixed amount of capacity, however, where very little capacity exists in the first place, load balancing systems may only delay the need for a service upgrade.

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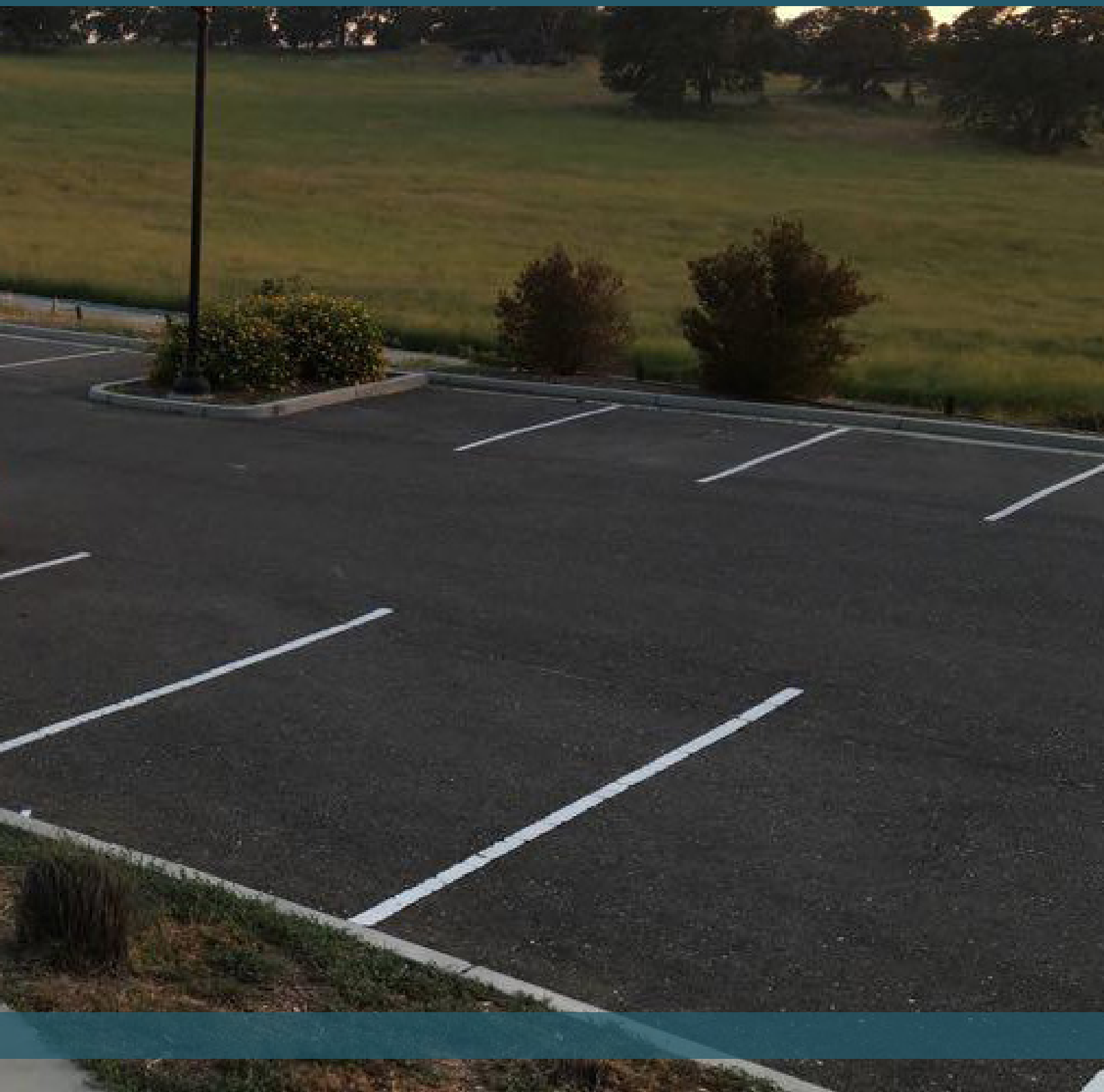
EXISTING CONDITIONS

Sutter Creek Transit Center, Sutter Creek, CA



PEV Registrations

The Central Sierra Region has EV drivers, EV infrastructure and numerous existing conditions that support wider EV adoption. Vehicle registration statistics and charging station data are primary indicators of the existing EV market size. Department of Motor Vehicles (DMV) registration data identifies general PEV market attributes but does not readily provide information on the types of vehicles deployed.

There are currently 203 plug-in hybrid electric vehicles (PHEVs) and 196 battery electric vehicles (BEVs) in the Region according to 2018 vehicle registration data from the State of California. This accounts for just 0.16% of total vehicle registrations in the four-county Region.

The Clean Vehicle Rebate Program (CVRP) was initiated in March 2010. CVRP offers incentives to purchasers of PEVs in California; however, the program is elective and participation rates can be impacted by vehicle eligibility and applicant income caps.

As of May 31, 2018, CVRP had issued 247,084 PEV rebates. Less than 1% (184) of those rebates were issued in the Region. PEV drivers in Calaveras and Amador counties have redeemed the most rebates in the Region, accounting for approximately 71% of rebates in the Region. Table 14 shows the number of rebates by vehicle type per county.

Figure 23 shows that the monthly number of rebates issued in the Region has increased over time. Central Sierra PEV drivers redeemed an average of 3.2 rebates per month in 2017, an increase from 2.4 rebates in 2016. In the first five months of 2018, the Region redeemed about 5.2 rebates per month. Table 17 shows how the annual number of rebates issued has increased since the beginning of the program.

Table 14: California PEV Registrations, 2018

Fuel Type	Number of Registrations	% of Total Registrations
PHEV	163,317	0.53%
BEV	178,348	0.58%
Total	**341,665**	**1.12%**

Source: California Department of Motor Vehicles

Table 15: CVRP Rebates for the Region

County	PHEV	BEV	PHEV%	BEV%
Alpine	0	2	0%	100%
Amador	27	37	42%	58%
Calaveras	28	38	42%	58%
Tuolumne	31	21	60%	40%
Total	**86**	**98**	**47%**	**53%**

Table 16: Central Sierra Region PEV Registrations, 2018

Fuel Type	Number of Registrations	% of Total Registrations
PHEV	203	0.08%
BEV	196	0.08%
Total	**399**	**0.16%**

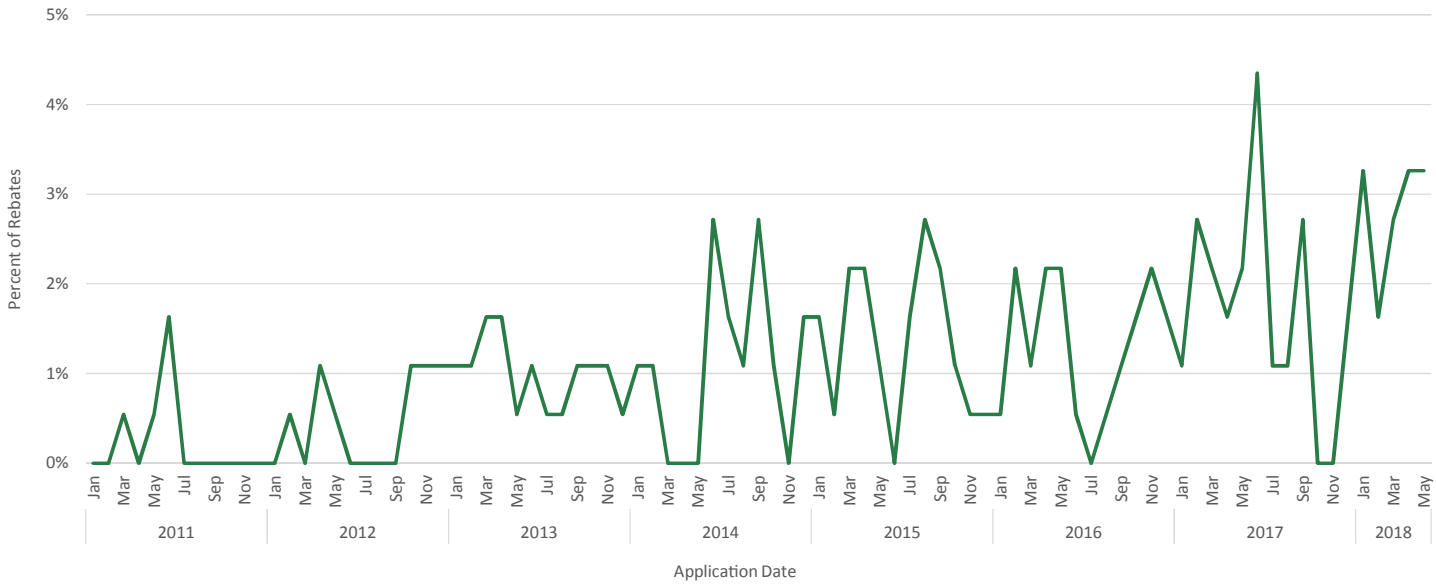
Source: California Department of Motor Vehicles

Table 17: CVRP Rebates per Year by County

Year	Alpine	Amador	Calaveras	Tuolumne	Total Region	Total State
2011	0	2	2	1	5	4,424
2012	0	3	4	3	10	11,117
2013	1	5	13	3	22	29,004
2014	0	9	8	7	24	43,552
2015	1	11	9	9	30	46,383
2016	0	10	11	8	29	43,432
2017	0	13	10	15	38	45,575
2018	0	11	9	6	26	23,530
Total	**2**	**64**	**66**	**52**	**184**	**247,017**

Source: Center for Sustainable Energy, 2018

Figure 23: CVRP Rebates per Month for the Region



Source: Center for Sustainable Energy, 2018

EV Infrastructure

Alternative Fuels Data Center (AFDC) Data

The U.S. Department of Energy's AFDC provides an alternative fueling station locater using data for existing and planned stations. Data is provided by trade media, Clean Cities coordinators, infrastructure equipment and fuel providers, original equipment manufacturers, and regular station users. The station locater provides details about the station location, power level, plug, connector, and network type for alternative fueling stations. Table 18 shows the locations of charging stations in the Region that are listed in the AFDC database.

As of September 30, 2018, there were at least 29 locations in the Region with public Level 2 and DC fast charging stations. Only three locations host DC fast charging - a public lot in Groveland, Yosemite Gateway Museum, and Rush Creek Lodge, all in Tuolumne County. Most of the charging stations are sited at lodges, inns, wineries, and resorts.

Table 18: Department of Energy AFDC Station Counts

County	Location Name	City	Charger and Connector Type	Station Plugs	Nearest State Route
Alpine	Bear Valley Lodge	Bear Valley	Level 2, Tesla	2	4
	Sorensen's Resort	Hope Valley	Level 2, Tesla	1	88
	Kirkwood Mountain Resort	Kirkwood	Level 2, Tesla	6	88
Amador	REST Hotel	Plymouth	Level 2, Tesla	1	49
	Jackson Civic Center	Jackson	Level 2	2	49
	Municipal Center	Jackson	Level 2	2	49
	Taste Restaurant and Wine Bar	Plymouth	Level 2, Tesla	1	49
	Shenandoah Vineyards Winery	Plymouth	Level 2, Tesla	1	49
	Andis Wines	Plymouth	Level 2, J-1772, and Tesla	3	49
	Karmere Vineyards	Plymouth	Level 2, Tesla	3	49
	Amador Regional Transit	Sutter Creek	Level 2, J-1772	2	49
	Gold Quartz Inn Senior Retirement Home	Sutter Creek	Level 2, J-1772	2	49
	Avio Vineyards	Sutter Creek	Level 2, Tesla	2	88
Calaveras	Courtwood Inn	Murphys	Level 2, J-1772, and Tesla	2	4
	Dunbar House 1880 Bed & Breakfast Inn	Murphys	Level 2, Tesla	1	4
	New Melones - Glory Hole Recreational Area	Angels Camp	Level 2	1	49
	Victoria Inn	Murphys	Level 2, Tesla	1	4

County	Location Name	City	Charger and Connector Type	Station Plugs	Nearest State Route
Tuolumne	Groveland Hotel	Groveland	Level 2, Tesla	1	120
	Groveland Supercharger	Groveland	DC Fast Charger, Tesla	7	120
	Evergreen Lodge	Groveland	Level 2, J-1772, and Tesla	2	120
	Jamestown Hotel	Jamestown	Level 2, Tesla	1	49
	Chicken Ranch Casino	Jamestown	Level 2, Tesla	3	49
	Adventist Health Hospital	Sonora	Level 2	10	49/108
	Black Oak Casino	Tuolumne	Level 2, Tesla	5	108
	McCaffrey House Bed & Breakfast Inn	Twain Harte	Level 2, J-1772, and Tesla	2	108
	Columbia College	Columbia	Level 2, J-1772	2	49
	Tuttletown Recreational Area	Tuttletown	Level 2, J-1772	1	49
	Groveland Yosemite Gateway Museum*	Groveland	DC Fast Charger, J1772	3	120
	Rush Creek Lodge*	Groveland	DC Fast Charger, J1772	3	120

Source: Alternative Fuels Data Center, 2018 **under construction*

PlugShare Data

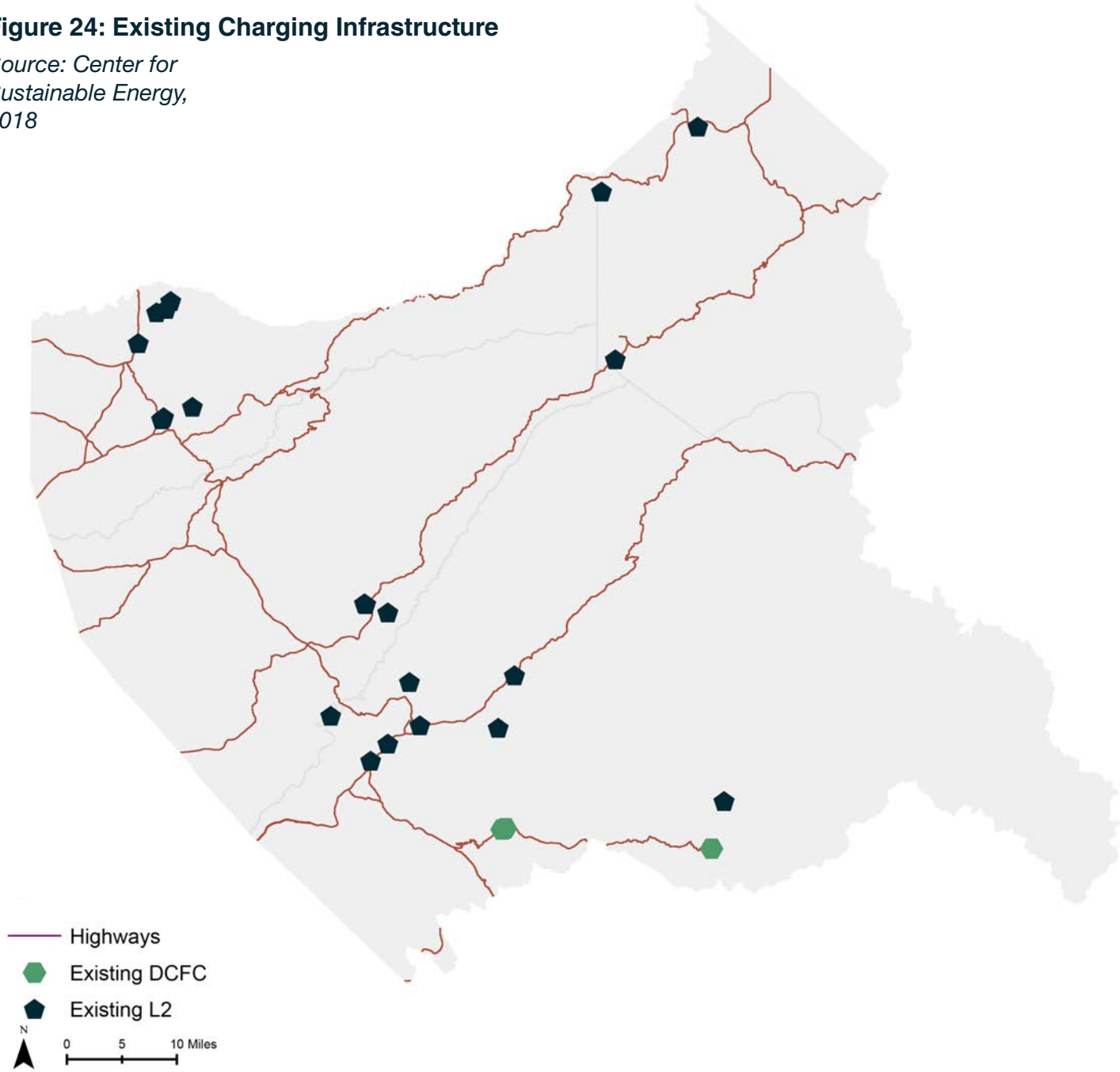
The PlugShare database provides the location of over 90,000 stations in the U.S. and Canada and allows homeowners to register their charging stations, providing insight on the number of residential charging stations. PlugShare data is different than AFDC data therefore, utilizing both datasets results in an increased understanding of the public PEV charging station count. The AFDC station locater provides plug counts for Tesla chargers in the Region but does not provide plug counts for J-plugs (also known as J-1772) co-located with Tesla stations at five locations. As a free app and webtool, PlugShare allows users to find charging stations, leave reviews and photos, and connect with other PEV owners worldwide. The Central Sierra ZEV Readiness Plan Team verified AFDC station counts with manual queries in the PlugShare map to check the accuracy; the number of stations identified using PlugShare are mapped in Figure 24. Please visit https://www.plugshare.com/ to learn more about the station locator.

Level 1 Charging

It is important to note that this list does not include locations of Level 1 charging, however, Level 1 charging can play an important role in providing short-term and readily-available infrastructure. Specifically, Level 1 charging at RV parks, campgrounds, and natural areas can be a cost-effective means of ensuring PEV drivers can access remote areas of the Region while having ample state of charge to return home. Level 1 charging at these sites could be installed in various ways, but one short-term solution could be to provide gas-powered generators that power electrical outlets for Level 1 charging. In the longer term, solar and battery storage could be installed to power Level 1 charging outlets at these sites, and this would provide additional greenhouse-gas reduction benefits compared to the use of generators.

Figure 24: Existing Charging Infrastructure

Source: Center for Sustainable Energy, 2018



Targeted Areas for Charging

When installing electric vehicle charging stations, there are several factors that must be considered to install appropriate charging infrastructure for the site's expected or observed demand. As a general rule of thumb, the longer the expected "dwell time" of the average driver, the lower the rate of power delivery (expressed as kilowatts, or kW) can be. Any site can install EV charging; however, the most effective sites will follow some commonly observed criteria:

a) Sites will be obvious destinations for reasons other than the presence of EV charging.

b) For DC Fast chargers, the average dwell time should be short - typically under 30 minutes, facilicating quick turnover.

c) For Level 2 chargers, the average dwell time should be 30 minutes or longer, requiring a greater number of chargers to ensure availability.

Popular destinations for visitors and tourists, such as historic main streets, parking lots serving outdoor recreation facilities, regional museums, and hotels may be ideally sited for Level 2 charging. Additional long-dwell sites where vehicles are typically stationary for extended periods of time, such as fleet yards and transit sites, may also be well-suited for Level 2 charging. Mixed-dwell time sites, such as shopping centers, grocery stores, and parks and recreation district lots may benefit from a mixture of both Level 2 and DC Fast charging to serve both those who will be at the site for an extended period of time and visitors simply passing through. Highway rest stops and other areas where charging speed is more important than immediate availability may be better suited for DCFC installation.

Charging Behavior

Recent analysis from the Electric Power Research Institute (EPRI) and published by the American Public Power Association (Wood, 2018) indicates that the concern of "range anxiety" (not having enough charge to get between charging stations) is beginning to be replaced by "charge anxiety". Rather than not having enough range to get between stations, the concern underlying charge anxiety deals with whether a driver will be able to charge at their next destination.

Reasons for charge anxiety include uncertainty over:

- Pricing (Whether the rate structure is attractive or prohibitive for their charging needs)
- Operations (Whether the station is broken)
- Network (Whether a payment network, e.g. Chargepoint, EVgo, is compatible with the station)
- Demand (How long of a wait there will be for a station)

Fueling Habits

Research conducted by Elk River Municipal Utilities (ERMU) and supplemented by various other studies indicated that EV drivers tend to fuel in a very different manner than conventional gasoline fueling. While gasoline refueling typically involves either completely filling a tank or leapfrogging between gas stations, EV drivers typically left home with a full charge and attempted to "top off" their batteries at their destinations, even those with short dwell times (Quiros-Tortos, Ochoa, & Lees, 2015). EV drivers would then fully replenish their battery overnight at home.

Data from the EV Project, as published by the Idaho National Laboratory (Francfort, 2016), suggests that while this "top off" behavior appears to holds true across aggregated Level 2 and DC Fast Charge stations, behavior changes somewhat when examining only DC Fast Charge stations. Across both

Level 2 and DCFC stations, roughly 57% of sessions were initiated by vehicles at 50% state-of-charge or higher; that is, the vehicle's battery had more than half of its full charge capacity remaining.

With DCFC sessions examined in isolation, though, more than 25% of examined DCFC charging sessions were initiated by vehicles at between 20-30% state-of-charge. Approximately 52% of DCFC sessions were started by vehicles between 20 and 40% state-of-charge. Less than 20% of sessions were started by vehicles with more than 50% state-of-charge.

This reflects a fundamental difference between the services offered by the two distinct charging speeds. DCFCs provide the security, high turnover, and short charge times that help to incentivize drivers to feel confident in using more of their battery capacity. Meanwhile, less-expensive Level 2 chargers offer the ability to provide service over a larger geographic area at much slower speeds, allowing for the "top off" behavior observed by ERMU and others.

Pricing

Initially, ERMU levied both a flat connection fee and a per-kWh fee on their chargers, which proved unpopular and discouraged charging among drivers who only needed to charge for a short amount of time. Connection fees, while effective to recover the cost of installing stations and/or maintenance, must be carefully considered to avoid reducing station utilization.

Over three separate studies conducted by EPRI, Arizona's Salt River Power (SRP), and the EV Project, time-of-use pricing has shown to be effective at shifting EV charging to times of excess grid capacity provided that drivers are aware of the time-of-use rates being offered by local utilities. This suggests that EV charging demand can be moved in order to minimize impacts on the grid.

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EV
CHARGING
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chargepoint
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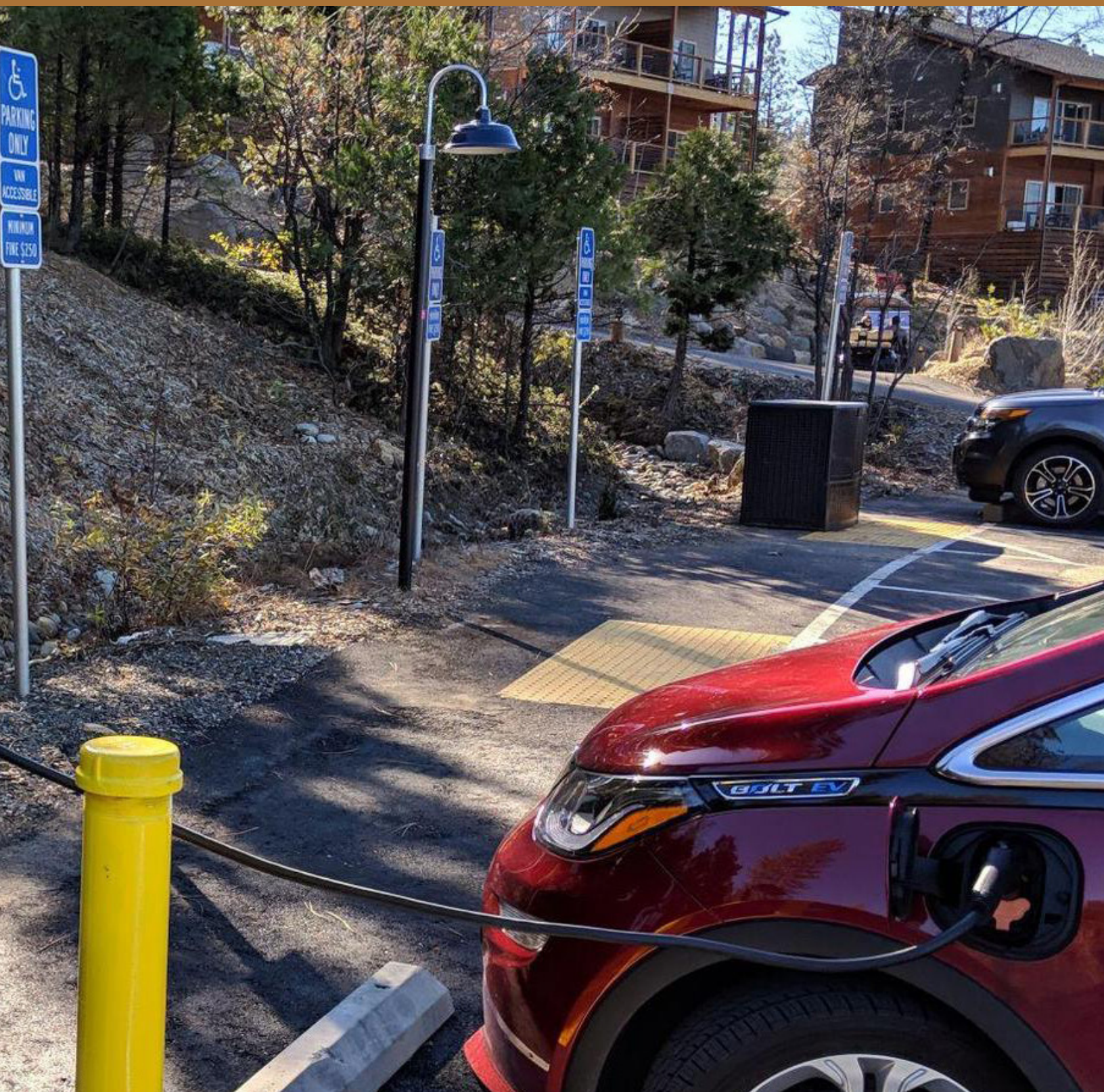
ELECTRIC
VEHICLE
PARKING
ONLY

GAPS ANALYSIS

Rush Creek Lodge, Groveland CA



Electric Vehicle Deployment

According to the Alliance of Automobile Manufacturers, there were 49,765 battery electric vehicles (BEV) and 45,107 plug-in hybrid electric vehicles (PHEV) sold in California in 2017, an increase from 38,861 and 34,933 in 2016, respectively. Overall, the deployment of PEVs in the State of California has steadily increased since 2011 and is expected to grow at an even faster rate from 2018 to 2025. As more models become available and as the deployment of charging infrastructure increases, California residents will have more incentive to purchase PEVs. These factors, along with others, heavily influenced the growth of the PEV market from 2011 to 2017. Table 19 shows the growth of the PEV market.

Table 19: Statewide PEV Deployment by Year

Year	PHEV	PHEV%	BEV	BEV%	Total Annual PEV Sales	PHEV:PEV ratio
2011	1,656	1%	5,062	3%	6,718	0.25
2012	13,971	8%	5,160	3%	19,131	0.73
2013	17,512	10%	20,943	11%	38,455	0.46
2014	29,797	17%	28,749	16%	58,546	0.51
2015	27,645	16%	33,945	19%	61,590	0.45
2016	34,993	21%	38,861	21%	73,854	0.47
2017	45,107	26%	49,765	27%	94,872	0.48
Total	170,681	100%	182,485	100%	353,166	0.48

Source: Alliance of Automobile Manufacturers, 2018

Statewide Projections

Table 20: State of California EVI Projections (Number of Charging Ports)

EVCS Type	Average Scenario	Low Scenario	High Scenario
Work L2	54,556	51,737	57,375
Public L2	61,746	47,596	75,895
Public DCFC	17,016	9,064	24,967

Source: EVI-Pro, 2019

Table 21: State of California PEV Projections (Number of PEVs)

	2025
State of California	1,321,368

Source: EVI-Pro, 2019

Regional PEV Projections

Similar to the rest of the state, the Region expects to see a substantial growth in PEVs over the next seven years leading into 2025 benchmarks. While the rate of EV rebate deployment has been stagnant over the last four years, the availability of all-wheel drive electric vehicles and EV charging infrastructure in the region is likely to increase over the next seven years.

Scenario Analysis

To estimate EV charging needs for the Region by 2020 and 2025, the authors utilized a high and low PEV scenarios. Fleet in this reference describes all electric vehicles on the road.

Scenario A: High PEV Projection

Scenario A uses county and statewide PEV estimates calculated by the CEC in its 2017-2025 infrastructure projections report. By 2025, the CEC estimated that there would be 2,233 PEVs in the Region, representing 0.17% of the estimated statewide PEV fleet.

Scenario B: Low PEV Projection

Scenario B uses the 2017 EMFAC model from the California Air Resources Board to estimate the PEVs in the region by 2020 and 2025. The EMFAC model is CARB's mobile source emissions inventory for assessing emissions through 2050. By 2025, EMFAC estimated that there would be 1,548 PEVs in the Region, representing 0.12% of the estimated statewide PEV fleet.

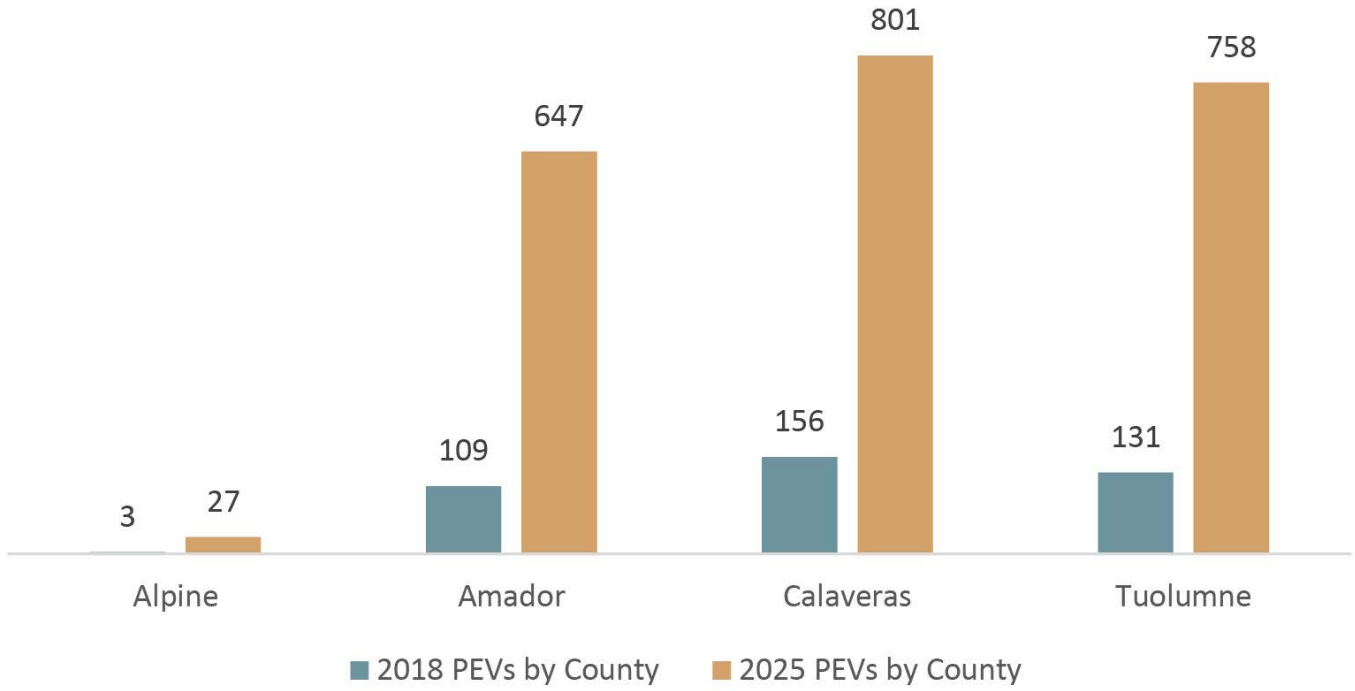
Table 22: State of California EVI Projections (Vehicles)

	2020	2025
Fleet Scenarios	**Total PEVs**	**Total PEVs**
Scenario A: High	1,090	2,233
Scenario B: Low	483	1,548

Source: EVI-Pro, 2019

Figure 25 identifies the existing and projected PEVs by County in 2018 and 2025 using Scenario A: High PEV Projection.

Figure 25: Existing and Projected PEVs by County, 2018 & 2025



Source: California Energy Commission, 2018; California Motor Vehicle Fuel Types by County, 2018

EVI Growth Projections

EV infrastructure projections help transportation planners anticipate future EV charging demand and deploy adequate infrastructure. The CEC and National Renewable Energy Laboratory (NREL) developed the Electric Vehicle Infrastructure Projection tool (EVI-Pro) to quantify the types of PEV charging infrastructure required to meet PEV drivers' needs. In 2017, the CEC and NREL used the EVI-Pro tool to project infrastructure needs to meet California's 1.5 million ZEV goal by 2025. To generate projections, the EVI-Pro model utilizes four primary inputs: PEV attributes such as electric range and efficiency; infrastructure attributes for residential, workplace, and public charging; travel data from regional models or transportation surveys; and county-level sales projections by technology type. The EVI-Pro model generates low and high estimates. The low estimate is based on peak vehicle quantity calculations and reflects the minimum quantity of chargers that must be available to meet drivers' simultaneous need to charge. The high estimate utilizes the total number of vehicle charging events over a 24-hour period assuming chargers are shared with at least one other vehicle. The Regional EVI-Pro analysis estimates between 230 and 320 total charging ports are needed by 2025 (CEC, 2018).

Tables 23 – 29 identify the total projected PEV chargers needed in 2025 to serve the projected future demand of residents in the Region. The tables also include an estimate for addtional EV plug investment in each County to meet demand from EV driving visitors in 2025. Visitor calculations are discussed in the next section of this report.

Table 23: Alpine County EVI Projections (Number of Charging Ports)

EVCS Type	Average Scenario	Low Scenario	High Scenario
Work L2	0	0	0
Public L2	(3) Residents + (2) Visitor	1	4
Public DCFC	(2) Residents + (1) Visitor	1	3

Table 24: Amador County EVI Projections (Number of Charging Ports)

EVCS Type	Average Scenario	Low Scenario	High Scenario
Work L2	25	20	30
Public L2	(46) Residents + (28)Visitor	39	52
Public DCFC	(22) Residents + (9) Visitor	14	29

Table 25: Calaveras County EVI Projections (Number of Charging Ports)

EVCS Type	Average Scenario	Low Scenario	High Scenario
Work L2	23	21	25
Public L2	(45) Residents + (28)Visitor	45	45
Public DCFC	(18) Residents + (8) Visitor	16	20

Table 26: Tuolumne County EVI Projections (Number of Charging Ports)

EVCS Type	Average Scenario	Low Scenario	High Scenario
Work L2	34	32	35
Public L2	(46) Residents + (28)Visitor	33	58
Public DCFC	(14) Residents + (6) Visitor	8	19

Table 27: Average Estimate Totals for PEV Charging Ports in 2025 by County

County EVI Estimates		
Alpine Totals Average: 8	**Calaveras Totals** Average: 122	**Region Totals** **Average: 388**
Amador Totals Average: 130	**Tuolumne Totals** Average: 128	

Source: California Energy Commission, 2018

Table 28: County Progress toward 2025 Scenario Goals.

	Level 2 "Low"	DCFC "Low"	Level 2 "Average"	DCFC "Average"	Level 2 "High"	DCFC "High"
Alpine County	450%	0%	**300% / 180%**	**0% / 0%**	225%	0%
Amador County	32%	0%	**27% / 19%**	**0% / 0%**	23%	0%
Calaveras County	8%	0%	**7% / 5%**	**0% / 0%**	7%	0%
Tuolumne County	42%	163%	**34% / 25%**	**93% / 65%**	29%	68%

*Second number in "Average" columns reflects progress toward the additional chargers needed to meet visitor demand.

Visitor PEV & EVI Projections

Although the Central Sierra Region has a relatively low population in comparison to other parts of the State, the Region attracts significant visitors to numerous regional destinations as noted in Section IV: Existing Conditions. EVI-Pro projections paint a partial picture but do not account for EV infrastructure demand generated by this visitor travel. The California Statewide Regional Travel Model estimates that 23,299 daily trips originated outside and ended within Central Sierra in 2010; that count is projected to increase by 89% to 44,068 daily trips in 2040 (California Department of Transportation, 2014). Table 29 shows the Visitor projections through 2040 and estimates the number of PEVs visiting the Region per day using the EVI-Pro EV market share assumptions and the State of California's EV registration split (PHEV: 48%, BEV: 52%), which are expected to remain similar through 2025.

Visitor EVI demand was calculated for the average planning scenario (EVI-Pro "Average" forecast) only because it is the most reasonable target for planning. The calculation assumes that workplace L2 ports are not available to visitors and that the ratio of Public L2 and Public DCFC charging plugs needed to meet visitor and resident demand are the same. On average, daily EV visitors to each County in 2025 is expected to be: Alpine County 27, Amador 647, Calaveras 801, Tuolumne 758. Assuming these average daily EV visitor counts the demand for each County was calculated by...

1. Determining the overall number of PEVs visiting the region each day (839) by multiplying 33,684 total daily visitors by the expected PEV adoption rate (2.5%).

2. Based on existing driver-to-charger ratios for residents within the region (# drivers/# of projected plugs), determining the number of Level 2 (86) and DCFC (24) ports required across the Region to meet expected additional demand from visitor PEVs.

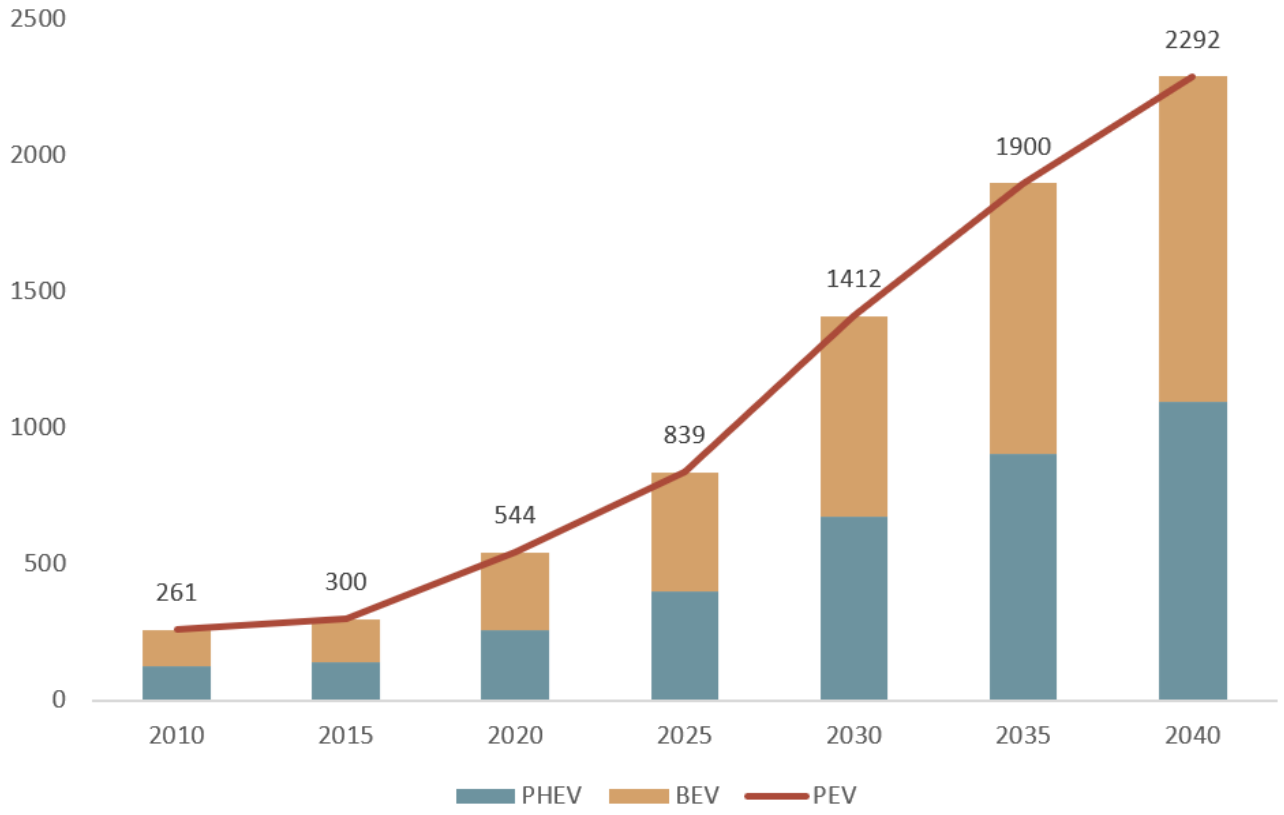
3. Distributing ports across all 4 counties based on existing proportions of Level 2 and DCFC plugs.

Table 29: Regional Visitor Projections through 2040 (per day)

	2020	2025	2030	2035	2040
Visitors per Day	30,222	33,684	37,145	40,607	44,068
PEV	544	839	1,412	1,900	2,292
PHEV	260	401	675	908	1,095
BEV	284	438	737	992	1,196

Source: California Department of Motor Vehicles, 2019
California Statewide Regional Travel Model, California Department of Transportation, 2014
EMFAC, 2017

Figure 26: Projected Visitors to the Region through 2040



Source: California Department of Motor Vehicles, 2019
California Statewide Regional Travel Model, California Department of Transportation, 2014
EMFAC, 2017

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BEAR VALLEY LODGE ENTRY
RESERVED
PARKING FOR
Check In - Out
ONLY

RECOMMENDATIONS

Bear Valley Lodge, Bear Valley CA

Destination Siting

Tourism & Recreation

Tourist and recreation destinations within the Region are also prime examples of charging infrastructure opportunities since they draw large numbers of regional visitors who generally stay at the destination for extended periods of time.

Schools

Schools are good locations for charging infrastructure for both public charging and workplace charging and include fleet transition opportunities for school bus fleets.

Airports

Airports in the Region may provide opportunities for longer dwell times and are destinations for visitors and residents alike.

Lakes

Parking lots at regional lakes offer opportunities for destination and corridor charging along the highway network.

Figure 27: Tourism & Recreation

Source: Center for Sustainable Energy, 2018

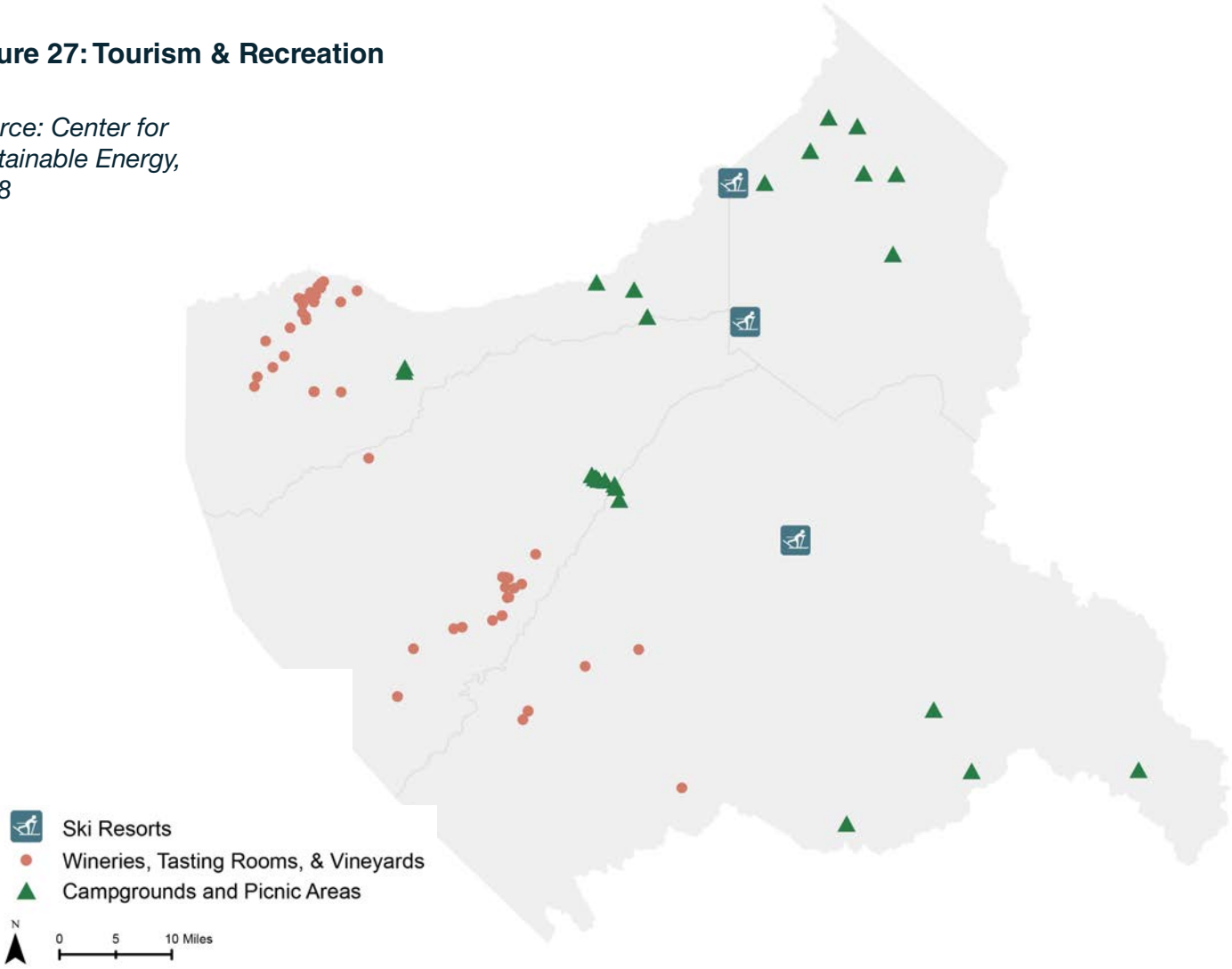


Figure 28: Schools

Source: Center for Sustainable Energy, 2018

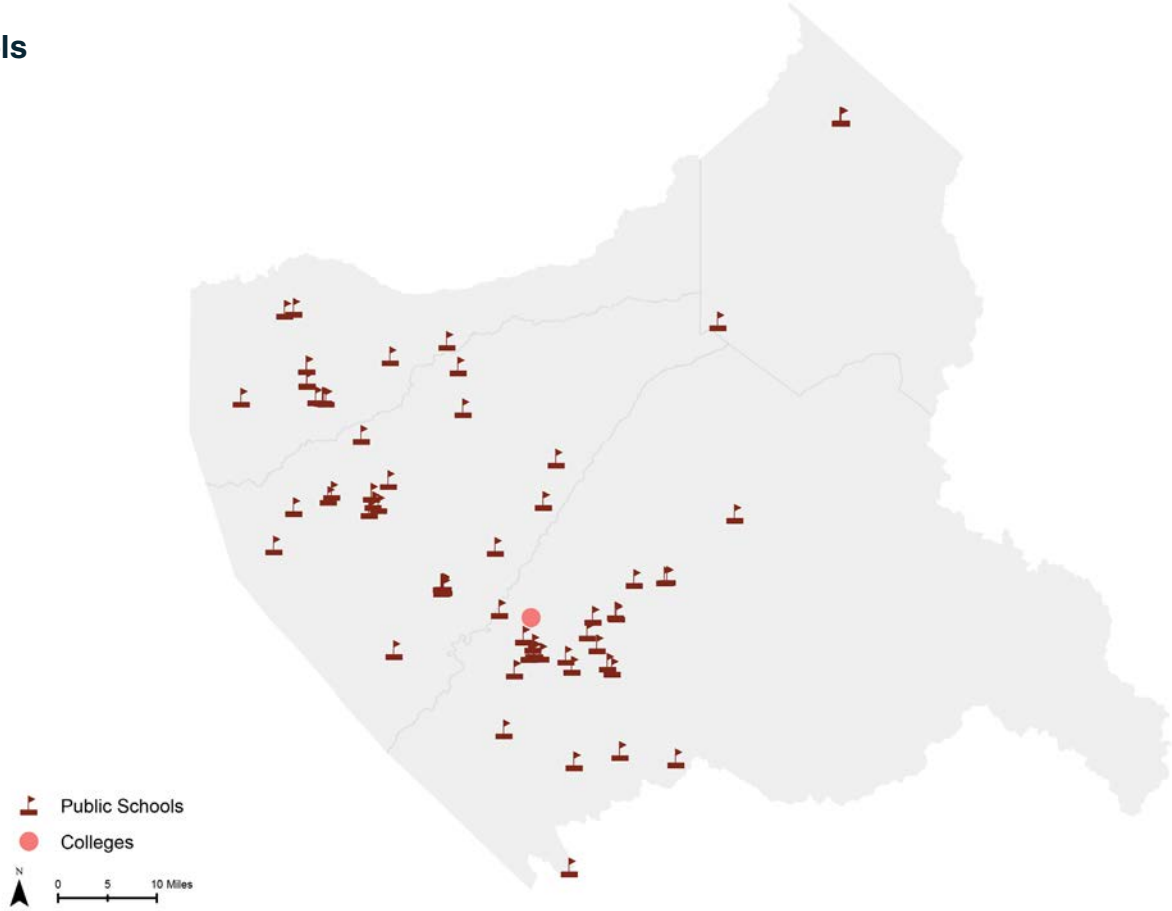


Figure 29: Airports

Source: Center for Sustainable Energy, 2018

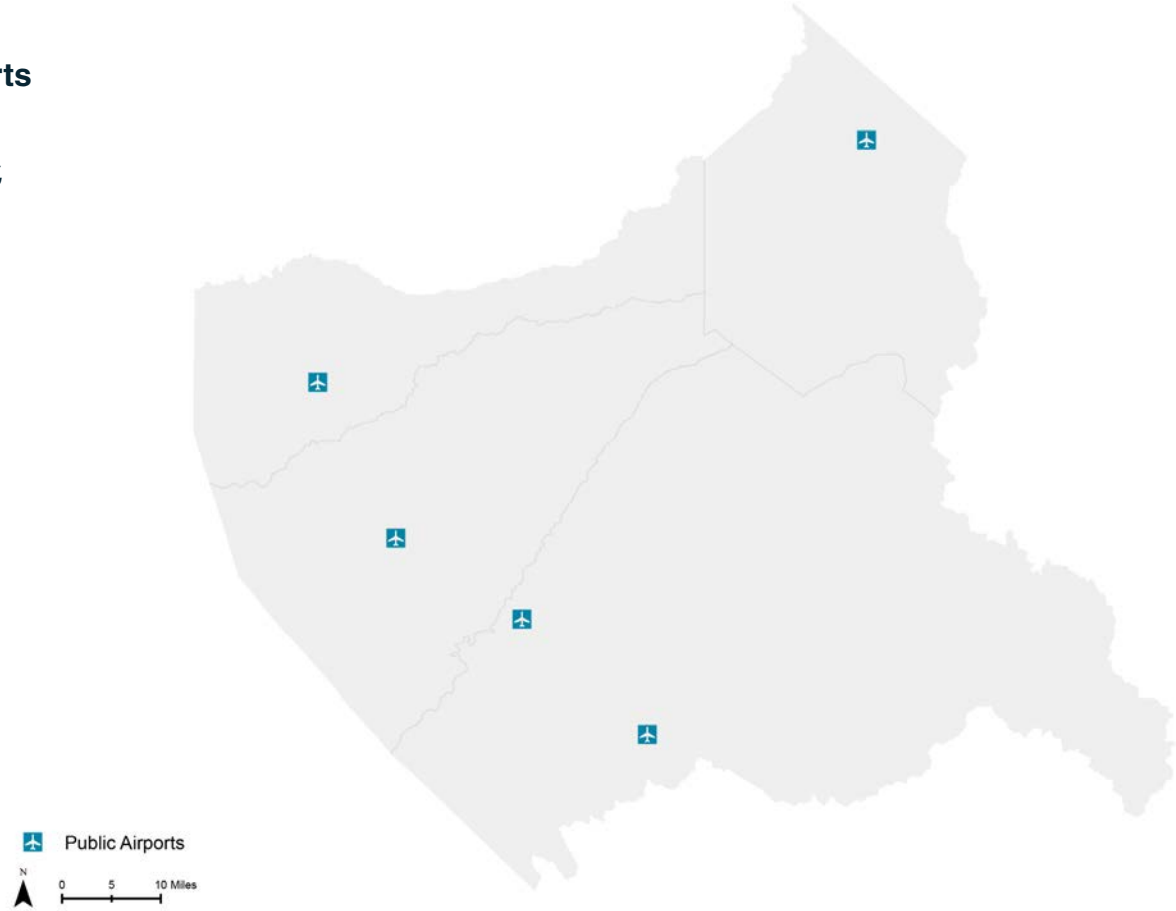
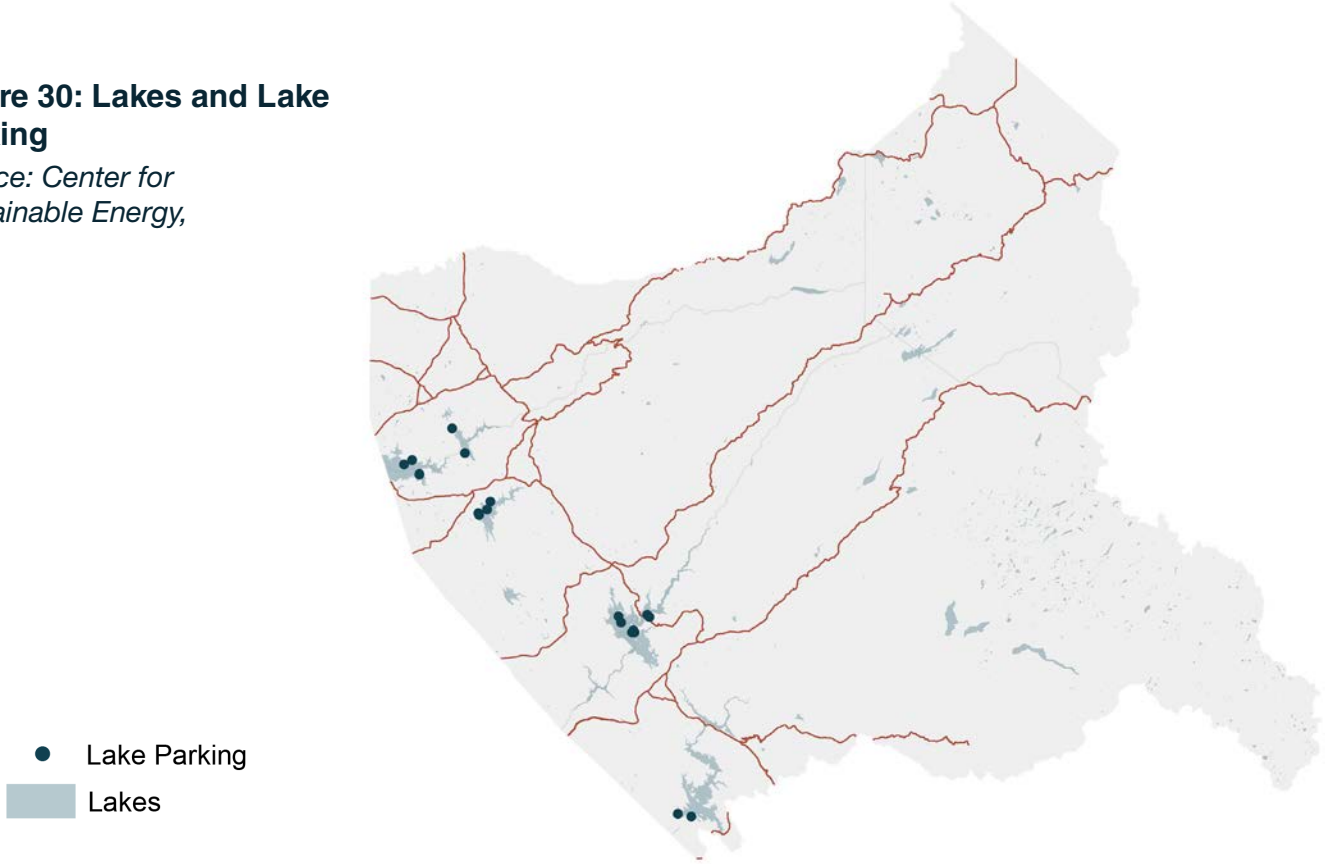


Figure 30: Lakes and Lake Parking

Source: Center for Sustainable Energy, 2018



YARTS Stops & State Park Entrances

Opportunities for charging infrastructure also exist along YARTS stops and at State Park entrances. Visitors to the Region utilize the YARTS system to visit Yosemite and surrounding destinations and provide opportunities for EVCS at park and ride locations.

Stops along the Sonora – Highway 120 YARTS route are also potential opportunities for EVCS in the Region. These include the following 12 stops listed in Table 30.

Table 30: Stops on The Sonora – Highway 120 Route

Stop	Sonora to Yosemite National Park Stops
1	Black Oak Hotel and Resort
2	Sonora Best Western
3	Inns of California/Downtown Sonora
4	Rocca Park/ Jamestown Main Street
5	Mary Laveroni Park
6	Yosemite Pines RV Park
7	Buck Meadows Restaurant
8	Yosemite Lakes Campgrounds
9	Rush Creek Lodge
10	Big Oak Flat/ Park Entrance Gate
11	Crane Flat Gas Station
12	Yosemite Valley Visitor Center

Source: Yosemite Area Regional Transportation System, 2018

Source: The Fresno Bee, 2018

Regional Destination Siting

Districts

The plan recommends that charging be included in commercial and residential planning through parking lots, garages, and on-street parking. As a regional tourist destination that attracts PEV drivers from across the state, regional districts are well positioned to provide charging infrastructure to visitors and residents alike. The planning team identified the following areas within each City or Census Designated Place as districts for further analysis. These include the following areas within each of the following Cities and CDPs:

- Alpine: Markleeville
- Amador: Amador City, Ione, Jackson, Sutter Creek
- Calaveras: Angels Camp
- Tuolumne: Sonora

These areas are significant in the Region for implementing EV infrastructure for one or more of the following factors: size, Regional historic district, proximity to major travel corridors, Main Street designation, and parking infrastructure. The following maps identify the districts while the subsequent tables identify the parking lots within each district.

Amador City District

Figure 31: Amador City District, Amador

Source: Center for Sustainable Energy, 2018

Number	Site Name
1	Downtown Amador City Parking
2	Jensen's Antiques
3	Andrae's Bakery
4	Keystone Mine Parking
5	Imperial Hotel parking

Angels Camp District

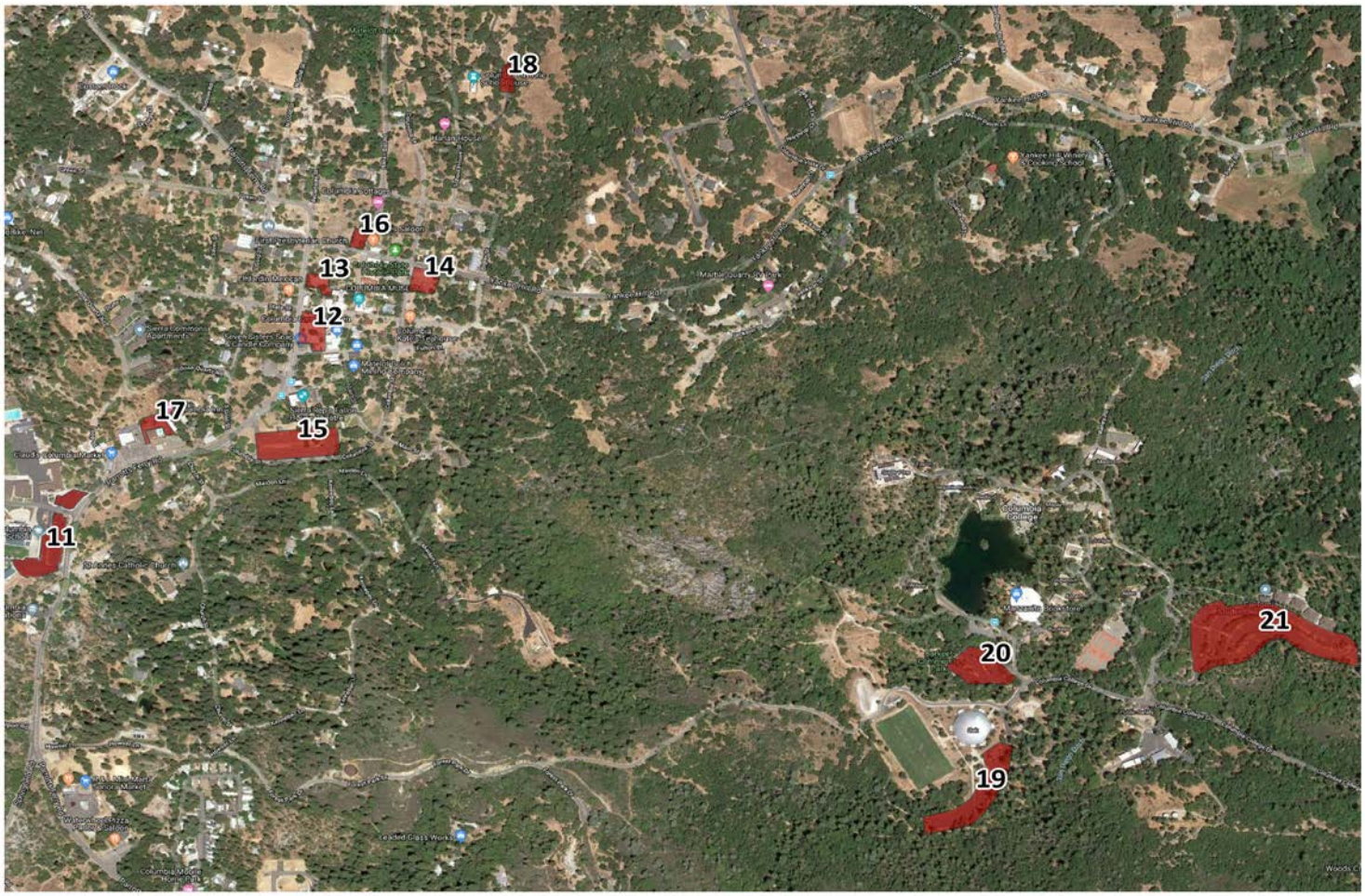
Figure 32: Angels Camp District, Calaveras

Source: Center for Sustainable Energy, 2018

Number	Site Name
6	Calaveras Visitors Bureau
7	Downtown Angels Camp Public Parking
8	Angels Camp Public Parking
9	Village Realty Parking
10	Public parking

Columbia District

Figure 33: Columbia District, Tuolumne



Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
11	Columbia Elementary
12	Public parking
13	City Hotel Parking
14	Public parking
15	Public parking
16	Public parking
17	Columbia Inn parking
18	Columbia Historic Schoolhouse Parking
19	Columbia College Parking
20	Carkeet Community Park/Columbia College Parking
21	Columbia College Parking

East Sonora District

Figure 34: East Sonora District, Tuolumne

Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
22	Best Western Plus Sonora Oaks
23	Sonora East Shopping Center
24	Aladdin Inn/My Garden Cafe
25	USFS Regional Office
26	Job Connection Tuolumne
27	Junction Shopping Center
28	Sonora Sports and Fitness
29	Granite Hill Plaza
30	The Peppery Restaurant

Number	Parking Spaces
31	Tuolumne County Public Health/ Social Services
32	Sonora Plaza Shopping Center
33	Indian Rock Center
34	Sierra Plaza Shopping Center
35	Oak Valley Community Bank
36	Standard Center Shopping Center
37	Sonora Medical Complex

Groveland District

Figure 35: Groveland District, Tuolumne

Source: Center for Sustainable Energy, 2018

Number	Site Description
38	Groveland Library/Laveroni Community Park
39	Public parking with Supercharger
40	USPS Parking
41	Yosemite Hwy 120 Chamber of Commerce
42	USPS Parking and Subway
43	PML Hardware
44	Groveland Pharmacy
45	Our Lady of Mt Carmel Church

Ione District

Figure 36: Ione District, Amador

Source: Center for Sustainable Energy, 2018

Number	Site Description
46	Police Station/Shopping parking
47	Ione Police Department
48	Ione Cafe parking
49	USPS/Corner Cafe and Bistro
50	Pizza Factory/Wine a Little
51	The Edge Strength and Training
52	Unmarked public angle-in parking
53	Ione Fire Station parking lot
54	Cornerstone Church of Ione Parking

Jackson District

Figure 37: Jackson District, Amador

Source: Center for Sustainable Energy, 2018

Number	Site Description
55	Kennedy Flat Storage
56	Western Land Title Co. Building
57	Foothill Conservancy
58	Sutter Health Medical Foundation Parking
59	Public Angle-In Parking (3 hour)
60	Public parking (angle-in)
61	Public parking (terrace)
62	Hein and Co. Bookstore Parking
63	Ledger Dispatch
64	Jackson City Offices/Police Dept.

Number	Site Description
65	Wells Fargo Lot
66	National Hotel parking
67	Crucible Jewelry
68	El Dorado Savings Bank Parking Lot
69	El Dorado Savings Parking Lot
70	Public parking (4 hour)
71	Public Park-and-Ride Parking
72	Public parking (3 hour)
73	Public parking

Jamestown District

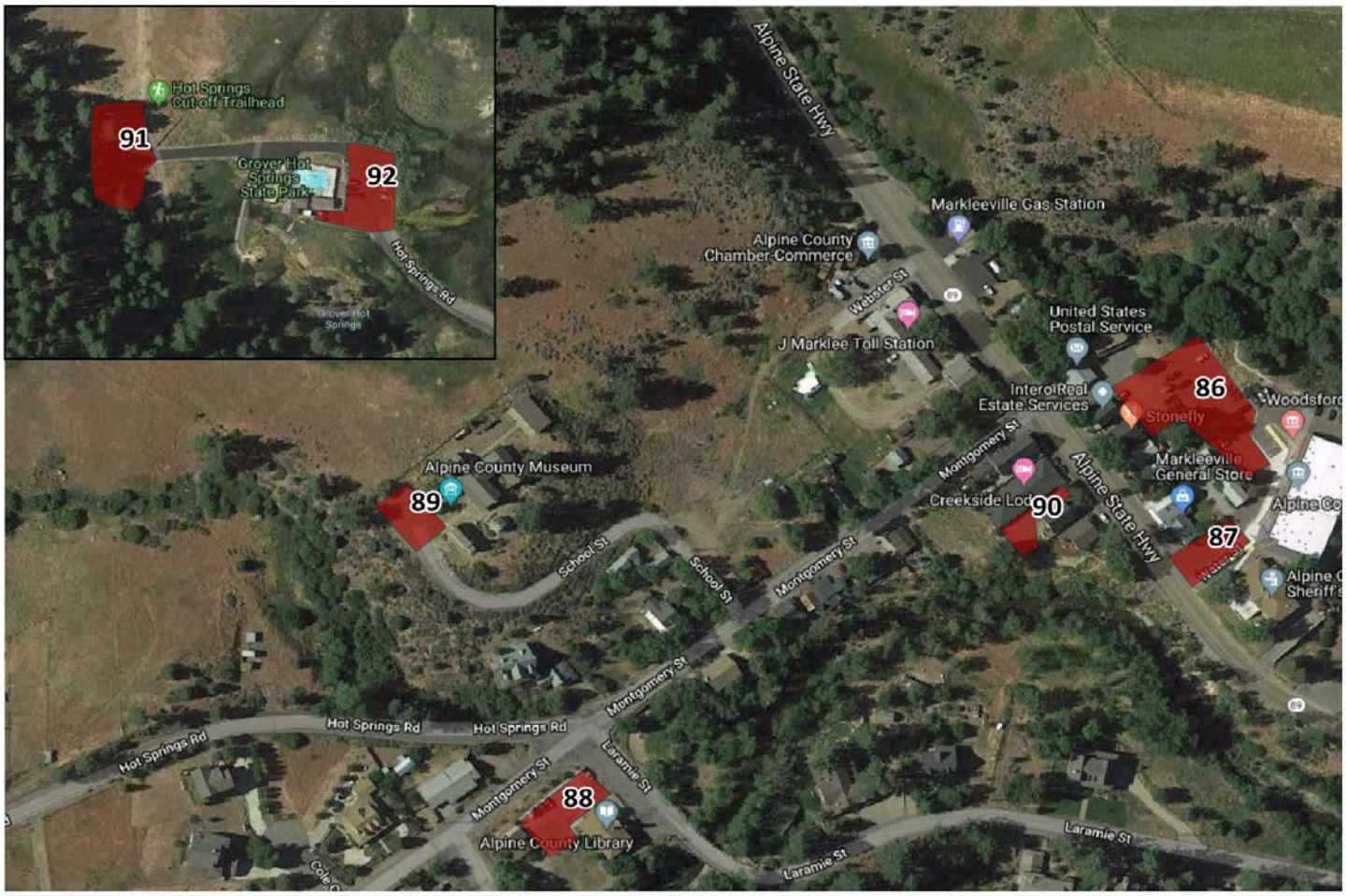
Figure 38: Jamestown District, Tuolumne

Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
74	Jamestown Historic Jail Parking
75	Downtown Jamestown public parking
76	National Hotel/Jamestown Hotel
77	Jamestown Railtown Hotel
78	USPS Parking
79	Railtown Parking
80	Public parking
81	Railtown Parking
82	Mathiesen Memorial Health Clinic
83	Mall Center Parking
84	Public parking
85	Country Inn Sonora parking

Markleeville District

Figure 39: Markleeville District, Alpine



Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
86	Alpine County Administrative Bldg.
87	Markleeville General Store
88	Alpine County Library
89	Alpine County Museum
90	Creekside Lodge Parking
91	Hot Springs Trailhead
92	Hot Springs Trailhead Overflow

Murphys District

Figure 40: Murphys District, Calaveras

Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
93	Victoria Inn Parking
94	Murphys Hotel Parking
95	Black Sheep Winery Parking
96	Taylor Plaza Parking
97	Sierra Hills Center Parking
98	Feeney Park Parking
99	Murphys Inn
100	Murphys Suites
101	Murphys Library
102	Public Parking

Plymouth District

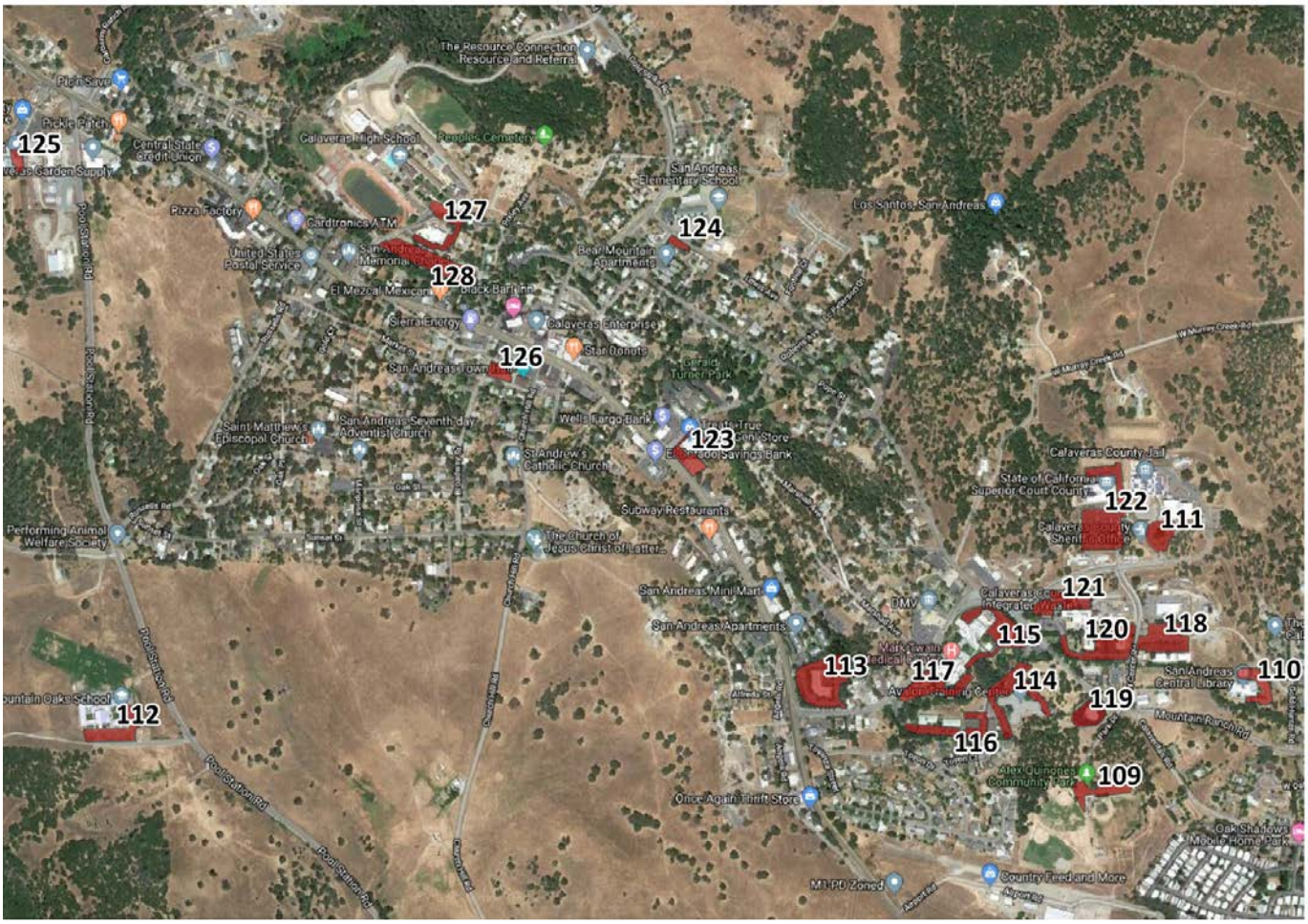
Figure 41: Plymouth District, Amador

Source: Center for Sustainable Energy, 2018

Number	Site Name
103	USPS Parking
104	Main St. Park Paved lot
105	Main St. Park
106	Rest Hotel Parking
107	Local Boutique Parking
108	Plymouth Library/Main St. Park

San Andreas District

Figure 42: San Andreas District, Calaveras



Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
109	Quinones Community Park
110	San Andreas Library Parking
111	Calaveras County Sheriff's Office Parking
112	Mountain Oaks School
113	Calaveras County Health and Human Services
114	Avalon Training Center Parking
115	Mark Twain Hospital Foundation Parking
116	Calaveras County Public Health Parking
117	Mark Twain Medical Center
118	Calaveras County Parking C

Number	Parking Spaces
119	Calaveras Senior Center
120	Calaveras County Parking B
121	Calaveras County Parking A
122	State of CA Superior Court
123	Treats True Value General Store Parking
124	San Andreas Elem. School Staff Parking
125	Calaveras Transit Yard
126	San Andreas Town Hall/Pub Parking
127	Calaveras Performing Arts Center/High School Parking
128	Calaveras High Student Parking

Sonora District

Figure 43: Sonora District, Tuolumne

Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
129	Fire Lounge Parking
130	Tuolumne County Veterans Hall
131	Sonora Public Parking
132	Mother Lode Answering Service
133	Public parking, closed every Saturday 5A-1P
134	Public parking
135	Angle-in Public Parking
136	Public parking
137	Public Parking
138	NorCal Glass
139	Rodeway Inn parking
140	Bank of America parking
141	The Sportsman Parking
142	Sonora Police Department

Number	Parking Spaces
143	Public parking (3 hour)
144	Sonora Area Foundation
145	Simply Delish/Day-O Espresso
146	Sonora Down Town Plaza
147	Community Pharmacy
148	Public Parking
149	Amador Tuolumne Community Action Agency
150	Fire Department Parking
151	Woods Creek Park (N)
152	Mother Lode Fairgrounds Parking
153	Woods Creek Park (S)
154	City of Sonora Parking Garage
155	Sonora High School Parking
156	Tuolumne County CRA Garage

Sutter Creek District

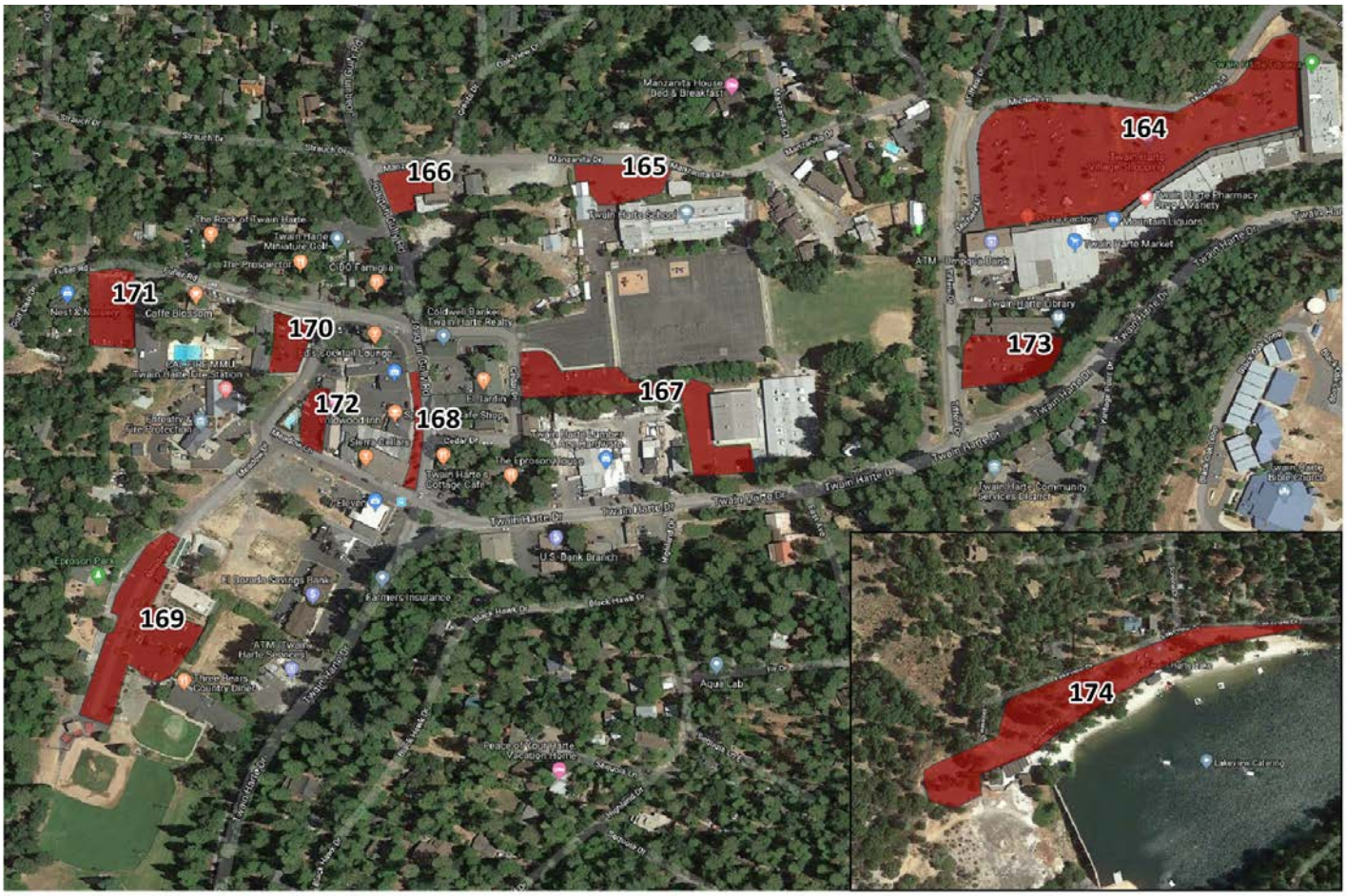
Figure 44: Sutter Creek District, Amador

Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
157	Public Parking
158	Sutter Creek Primary School
159	USPS Parking
160	Sutter Creek Church Parking
161	Sutter Creek City Hall
162	Gold Dust Pizza Sutter Creek
163	Baiocchi Wines Tasting Room

Twain Harte District

Figure 45: Twain Harte District, Tuolumne



Source: Center for Sustainable Energy, 2018

Number	Site Description
164	Twain Harte Shopping Center Parking
165	Twain Harte School
166	Twain Harte Carwash + Laundry
167	Twain Harte School (S)
168	Downtown Sonora Public Parking
169	Eproson Park
170	Twain Harte Chamber of Commerce

Number	Site Description
171	USPS Parking
172	Wildwood Inn
173	Twain Harte Library
174	Twain Harte Lake Parking

Valley Springs District

Figure 46: Valley Springs District, Calaveras

Source: Center for Sustainable Energy, 2018

Number	Parking Spaces
175	Jenny Lind Elementary Parking
176	Foothills Drugstore Parking
177	Pizza Factory Parking
178	La Contenta Golf Club Parking
179	Jenny Lind Veterans Memorial Park
180	Valley Springs Library Parking B
181	Valley Springs Library Parking
182	Sender's Market and Village Center Parking
183	Brewgers Parking
184	Valley Oaks Shopping

Tourism & Recreation Siting Recommendations

Destination Chargers

Destination charging is beneficial to both residents of the Region and tourists alike. Visitors to the region do not have the capability to charge their PEV at home, and therefore an extensive charging network at regional destinations is both beneficial to the visitor and will encourage travel throughout the region. Destination charging is also a revenue generation and cost saving method, a good branding opportunity, and beneficial to the environment.

Revenue Generation and Cost Saving:

- Revenue can be collected from charging activity and potentialy through generating Low Carbon Fuel Standard credits.
- Charging equipment can persuade customers to visit regularly.
- Your own PEV-fleet can save money by charging on-site rather than at other locations.

Good Branding Opportunity:

- Hosting a charging station symbolizes your organization's environmental values, attracting like-minded customers, new and old.

Helping the Environment:

- Contributes to pollution-reduction achieved by PEVs.
- Indirectly improves public health by encouraging public PEV charging and, therefore, PEV-use.

The following table identifies the ideal type of charging infrastructure by the hours to charge (Long or Short Stopover) and the destination type.

Table 31: EVCS Type by Destination Type

EVCS	Hours to Charge	Destination Types
Level 2	Long Stopover: Parked for 2-4 hours	Dining Historic Attraction Lodging Parks Recreation Regional Destination Resorts Shopping Tourism Destination
DC Fast Charge	Short Stopover: Quick stop for 5-30 minutes	Dining Highways Corridors Regional Destination Shopping Tourism Destination

The following destinations have been identified throughout the region as potential locations for new or added charging infrastructure. These locations are identified as tourist or regional destinations and geographically diverse. Located along the highway network, these destinations will also encourage EV drivers to visit multiple stops along the route to their destination.

Figure 47: Destinations for EVCS

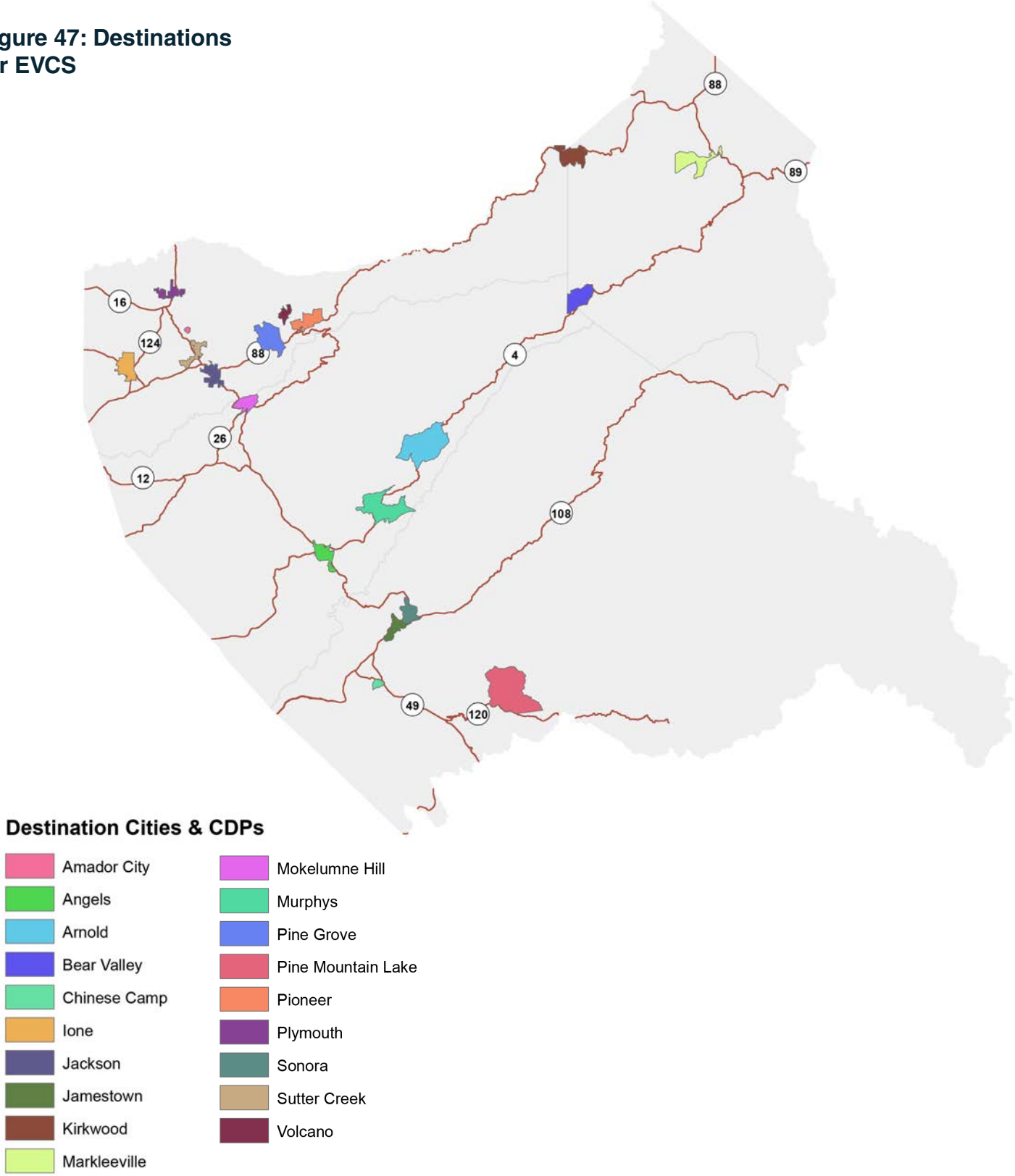


Table 32: Destinations for EVCS

Number	City/Municipality	Site Description	Category
1	Amador City	Downtown Amador City Parking	Parking
2	Amador City	Jensen's Antiques	Commercial
3	Amador City	Andrae's Bakery	Commercial
4	Amador City	Keystone Mine Parking	Parking
5	Amador City	Imperial Hotel parking	Lodging
6	Angels Camp	Calaveras Visitors Bureau	Public Institution
7	Angels Camp	Downtown Angels Camp Public Parking	Parking
8	Angels Camp	Angels Camp Public Parking	Parking
9	Angels Camp	Village Realty Parking	Commercial
10	Angels Camp	Public parking	Parking
11	Columbia	Columbia Elementary	School
12	Columbia	Public parking	Parking
13	Columbia	City Hotel Parking	Lodging
14	Columbia	Public parking	Parking
15	Columbia	Public parking	Parking
16	Columbia	Public parking	Parking
17	Columbia	Columbia Inn parking	Lodging
18	Columbia	Columbia Historic Schoolhouse Parking	Public Institution
19	Columbia	Columbia College Parking	Parking
20	Columbia	Carkeet Community Park/Columbia College Parking	Parking
21	Columbia	Columbia College Parking	Parking
22	East Sonora	Best Western Plus Sonora Oaks	Lodging
23	East Sonora	Sonora East Shopping Center	Commercial
24	East Sonora	Aladdin Inn/My Garden Cafe	Commercial
25	East Sonora	USFS Regional Office	Public Institution
26	East Sonora	Job Connection Tuolumne	Public Institution
27	East Sonora	Junction Shopping Center	Commercial
28	East Sonora	Sonora Sports and Fitness	Commercial
29	East Sonora	Granite Hill Plaza	Commercial
30	East Sonora	The Peppery Restaurant	Commercial
31	East Sonora	Tuolumne County Public Health/Social Services	Public Institution
32	East Sonora	Sonora Plaza Shopping Center	Commercial
33	East Sonora	Indian Rock Center	Commercial
34	East Sonora	Sierra Plaza Shopping Center	Commercial
35	East Sonora	Oak Valley Community Bank	Commercial
36	East Sonora	Standard Center Shopping Center	Commercial
37	East Sonora	Sonora Medical Complex	Commercial

Number	City/Municipality	Site Description	Category
38	Groveland	Groveland Library/Laveroni Community Park	Public Institution
39	Groveland	Public parking with Supercharger	Parking
40	Groveland	USPS Parking	Parking
41	Groveland	Yosemite Hwy 120 Chamber of Commerce	Public Institution
42	Groveland	USPS Parking and Subway	Parking
43	Groveland	PML Hardware	Commercial
44	Groveland	Groveland Pharmacy	Commercial
45	Groveland	Our Lady of Mt Carmel Church	Community Center
46	Ione	Police Station/Shopping parking	Public Institution
47	Ione	Ione Police Department	Public Institution
48	Ione	Ione Cafe parking	Parking
49	Ione	USPS/Corner Cafe and Bistro	Public Institution
50	Ione	Pizza Factory/Wine a Little	Commercial
51	Ione	The Edge Strength and Training	Commercial
52	Ione	Unmarked public angle-in parking	Parking
53	Ione	Ione Fire Station parking lot	Public Institution
54	Ione	Cornerstone Church of Ione Parking	Parking
55	Jackson	Kennedy Flat Storage	Commercial
56	Jackson	Western Land Title Co. Building	Commercial
57	Jackson	Foothill Conservancy	Commercial
58	Jackson	Sutter Health Medical Foundation Parking	Commercial
59	Jackson	Public Angle-In Parking (3 hour)	Parking
60	Jackson	Public parking (angle-in)	Parking
61	Jackson	Public parking (terrace)	Parking
62	Jackson	Hein and Co. Bookstore Parking	Commercial
63	Jackson	Ledger Dispatch	Commercial
64	Jackson	Jackson City Offices/Police Dept.	Public Institution
65	Jackson	Wells Fargo Lot	Commercial
66	Jackson	National Hotel parking	Lodging
67	Jackson	Crucible Jewelry/Luka's Restaurant	Commercial
68	Jackson	El Dorado Savings Bank Parking Lot	Commercial
69	Jackson	El Dorado Savings Parking Lot (secondary)	Commercial
70	Jackson	Public parking (4 hour)	Parking
71	Jackson	Public Park-and-Ride Parking	Parking
72	Jackson	Public parking (3 hour)	Parking

Number	City/Municipality	Site Description	Category
73	Jackson	Public parking	Parking
74	Jamestown	Jamestown Historic Jail Parking	Commercial
75	Jamestown	Downtown Jamestown public parking	Parking
76	Jamestown	National Hotel/Jamestown Hotel	Lodging
77	Jamestown	Jamestown Railtown Hotel	Lodging
78	Jamestown	USPS Parking	Public Institution
79	Jamestown	Railtown Parking	Public Institution
80	Jamestown	Public parking	Parking
81	Jamestown	Railtown Parking	Public Institution
82	Jamestown	Mathiesen Memorial Health Clinic	Commercial
83	Jamestown	Mall Center Parking	Commercial
84	Jamestown	Public parking	Parking
85	Jamestown	Country Inn Sonora parking	Lodging
86	Markleeville	Alpine County Administrative Bldg.	Parking
87	Markleeville	Markleeville General Store	Commercial
88	Markleeville	Alpine County Library	Public Institution
89	Markleeville	Alpine County Museum	Public Institution
90	Markleeville	Creekside Lodge Parking	Lodging
91	Markleeville	Hot Springs Trailhead	Public Institution
92	Markleeville	Hot Springs Trailhead Overflow	Public Institution
93	Murphys	Victoria Inn Parking	Lodging
94	Murphys	Murphys Hotel Parking	Lodging
95	Murphys	Black Sheep Winery Parking	Commercial
96	Murphys	Taylor Plaza Parking	Commercial
97	Murphys	Sierra Hills Center Parking	Commercial
98	Murphys	Feeney Park Parking	Public Institution
99	Murphys	Murphys Inn	Lodging
100	Murphys	Murphys Suites	Lodging
101	Murphys	Murphys Library	Public Institution
102	Murphys	Public Parking	Parking
103	Plymouth	USPS Parking	Public Institution
104	Plymouth	Main St. Park Paved lot	Parking
105	Plymouth	Main St. Park	Public Institution
106	Plymouth	Rest Hotel Parking	Lodging
107	Plymouth	Local Boutique Parking	Commercial
108	Plymouth	Plymouth Library/Main St. Park	Public Institution
109	San Andreas	Quinones Community Park	Public Institution
110	San Andreas	San Andreas Library Parking	Public Institution
111	San Andreas	Calaveras County Sheriff's Office Parking	Public Institution
112	San Andreas	Mountain Oaks School	School

Number	City/Municipality	Site Description	Category
113	San Andreas	Calaveras County Health and Human Services	Commercial
114	San Andreas	Avalon Training Center Parking	Commercial
116	San Andreas	Calaveras County Public Health Parking	Commercial
117	San Andreas	Mark Twain Medical Center	Commercial
118	San Andreas	Calaveras County Parking C	Parking
119	San Andreas	Calaveras Senior Center	Public Institution
120	San Andreas	Calaveras County Parking B	Parking
121	San Andreas	Calaveras County Parking A	Parking
122	San Andreas	State of CA Superior Court	Public Institution
123	San Andreas	Treats True Value General Store Parking	Commercial
124	San Andreas	San Andreas Elem. School Staff Parking	School
125	San Andreas	Calaveras Transit Yard	Public Institution
126	San Andreas	San Andreas Town Hall/Pub Parking	Public Institution
127	San Andreas	Calaveras Performing Arts Center/High School Parking	School
128	San Andreas	Calaveras High Student Parking	School
129	Sonora	Fire Lounge Parking	Commercial
130	Sonora	Tuolumne County Veterans Hall	Public Institution
131	Sonora	Sonora Public Parking	Parking
132	Sonora	Mother Lode Answering Service	Commercial
133	Sonora	Public parking, closed every Saturday 5A-1P	Parking
134	Sonora	Public parking	Parking
135	Sonora	Angle-in Public Parking	Parking
136	Sonora	Public parking	Parking
137	Sonora	Public Parking	Parking
138	Sonora	NorCal Glass	Commercial
139	Sonora	Rodeway Inn parking	Parking
140	Sonora	Bank of America parking	Parking
141	Sonora	The Sportsman Parking	Parking
142	Sonora	Sonora Police Department	Public Institution
143	Sonora	Public parking (3 hour)	Parking
144	Sonora	Sonora Area Foundation only	Public Institution
145	Sonora	Simply Delish/Day-O Espresso	Commercial
146	Sonora	Sonora Down Town Plaza	Commercial
147	Sonora	Community Pharmacy	Commercial
148	Sonora	Public parking	Parking

Number	City/Municipality	Site Description	Category
149	Sonora	Amador-Tuolumne Community Action Agency	Public Institution
150	Sonora	Fire department parking	Public Institution
151	Sonora	Woods Creek Park (N)	Public Institution
152	Sonora	Mother Lode Fairgrounds Parking	Public Institution
153	Sonora	Woods Creek Park (S)	Public Institution
154	Sonora	City of Sonora Parking Garage	Parking
155	Sonora	Sonora High School Parking	School
156	Sonora	Tuolumne County CRA Garage	Parking
157	Sutter Creek	Public Parking	Parking
158	Sutter Creek	Sutter Creek Primary School	School
159	Sutter Creek	USPS Parking	Public Institution
160	Sutter Creek	Sutter Creek Church Parking	Public Institution
161	Sutter Creek	Sutter Creek City Hall	Public Institution
162	Sutter Creek	Gold Dust Pizza Sutter Creek	Commercial
163	Sutter Creek	Baiocchi Wines Tasting Room	Commercial
164	Twain Harte	Twain Harte Shopping Center Parking	Commercial
165	Twain Harte	Twain Harte School	School
166	Twain Harte	Twain Harte Carwash + Laundry	Commercial
167	Twain Harte	Twain Harte School (S)	School
168	Twain Harte	Downtown Sonora Public Parking	Parking
169	Twain Harte	Eproson Park	Public Institution
170	Twain Harte	Twain Harte Chamber of Commerce	Public Institution
171	Twain Harte	USPS Parking	Public Institution
172	Twain Harte	Wildwood Inn	Lodging
173	Twain Harte	Twain Hart Library	Public Institution
174	Twain Harte	Twain Harte Lake Parking	Parking
175	Valley Springs	Jenny Lind Elementary Parking	School
176	Valley Springs	Foothills Drugstore Parking	Commercial
177	Valley Springs	Pizza Factory Parking	Commercial
178	Valley Springs	La Contenta Golf Club Parking	Commercial
179	Valley Springs	Jenny Lind Veterans Memorial Park	Public Institution
180	Valley Springs	Valley Springs Library Parking B	Parking
181	Valley Springs	Valley Springs Library Parking	Parking
182	Valley Springs	Sender's Market and Village Center Parking	Commercial
183	Valley Springs	Brewgers Parking	Commercial
184	Valley Springs	Valley Oaks Shopping	Commercial

Lodging

The following regional resorts and lodges provide the opportunity for new or increased charging infrastructure at their locations. These sites were chosen due to the highest amount of online activity from visitors as well as their geographic distribution.

Table 33: Recommendations for Charging at Regional Resorts and Lodging

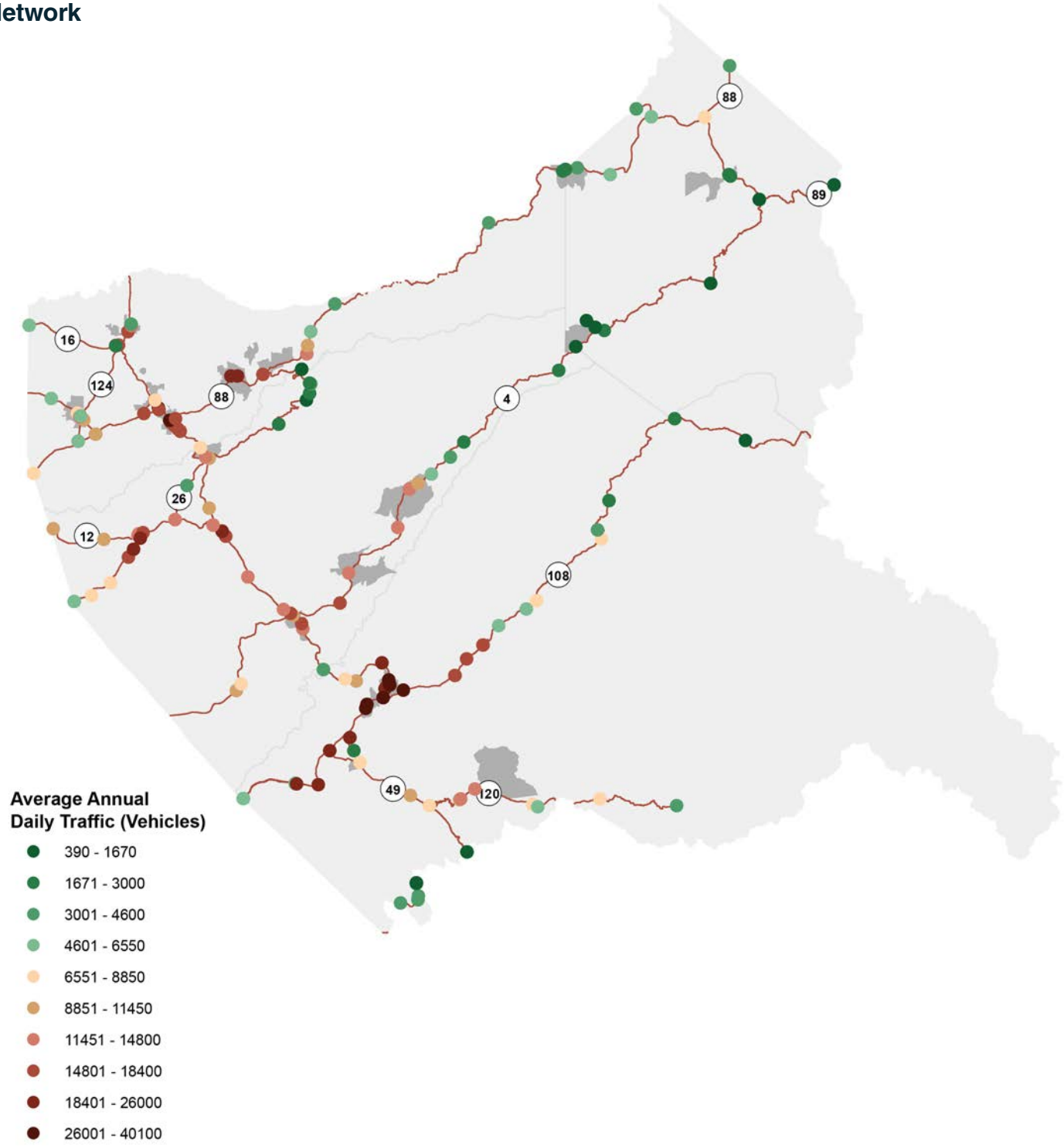
	Lodging	Location
Alpine	Kirkwood Mountain Resort*	Kirkwood
	Sorensen's Resort*	Hope Valley
	Skyline Bear Valley*	Bear Valley
	Creekside Lodge	Markleeville
	Woodfords Inn	Markleeville
Amador	Best Western Amador Inn	Jackson
	Jackson Rancheria Casino-Resort	Jackson
	Grey Gables Inn	Sutter Creek
	Shenandoah Inn	Plymouth
	Lake Amador Resort	Ione
Calaveras	Best Western Cedar Inn and Suites	Angels Camp
	Travelodge	Angels Camp
	WorldMark Resort	Angels Camp
	Mountain Retreat Resort	Arnold
	Murphys Suites	Murphys
	Victoria Inn*	Murphys
	Murphys Inn	Murphys
	Hotel Leger	Mokelumne Hill
Tuolumne	Pinecrest Lake Resort	Pinecrest
	Long Barn Lodge	Long Barn
	Pinecrest Chalet	Pinecrest
	Camp Mather	Groveland
	Kennedy Meadows Resort	Sonora

**Has existing charging*

Transportation Demand

The following section identifies ideal locations for DCFC infrastructure. The map below identifies the highly traversed highway corridors throughout the Region. The table on the next page identifies potential charging locations spaced approximately every 20 miles along the highway network. This does not identify the number of chargers recommended at each location, but would recommend increased chargers based on corridor demand and utilization over time. Installation of DCFCs can be phased in as data report high utilization of the infrastructure.

Figure 48: State Highway Network



Corridor Charging

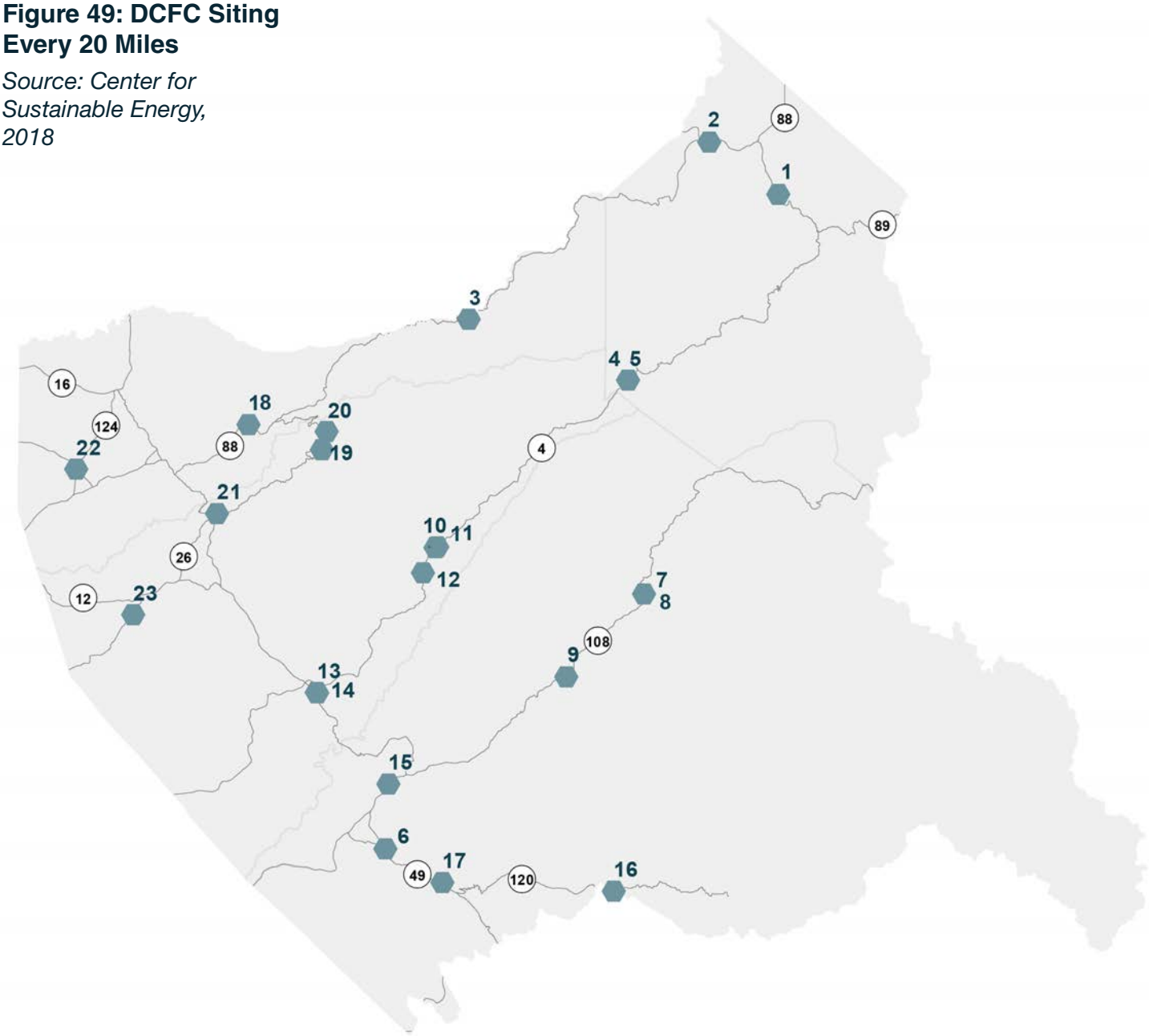
Highway corridors represent the primary conduit for interregional charging and past CEC funding opportunities through the state have funded fast charging along highway corridors with locations every 20 miles. This provides range assurance for drivers traveling along these highway routes since the spacing ensures that electric vehicle drivers with different range capabilities will have multiple chances to stop to charge. Table 34 identifies the closest location for EVCS at these recommended points. Traffic counts and other information can also inform which routes are higher priorities. Figure 46 displays a hypothetical DC fast charger location placed approximately every 20 miles along the primary state routes in the Region.

Table 34: Locations Near DCFC Siting Every 20 Miles

Number	Location	Spaces
1	Alpine County Chamber of Commerce	15
2	Sorensen's Resort	15
3	Ham's Station	15
4	Bear Valley General Store	15
5	Bear Valley Parking Lot C	70
6	Tuolumne County Fire Station - Chinese Camp	10
7	Strawberry Store	30
8	Pinecrest Lake	50
9	Long Barn Lodge	35
10	Ebbetts Pass Visitors Center	4
11	Big Trees Market	50
12	Arnold Plaza Shopping	30
13/14	Angels Camp Public Parking	38
15	Jamestown Public Parking	35
16	Buck Meadows Lodge and Restaurant	30
17	Don Pedro Lake Parking	60
18	Pine Grove Village	37
19	Sandy Gulch Baseball Park	10
20	Cozy Cabin Cafe	10
21	Mokelumne Hill Station	20
22	Ione Public Parking	26
23	The Terrace Plaza	50

Figure 49: DCFC Siting Every 20 Miles

Source: Center for Sustainable Energy, 2018



DCFC every 20 miles

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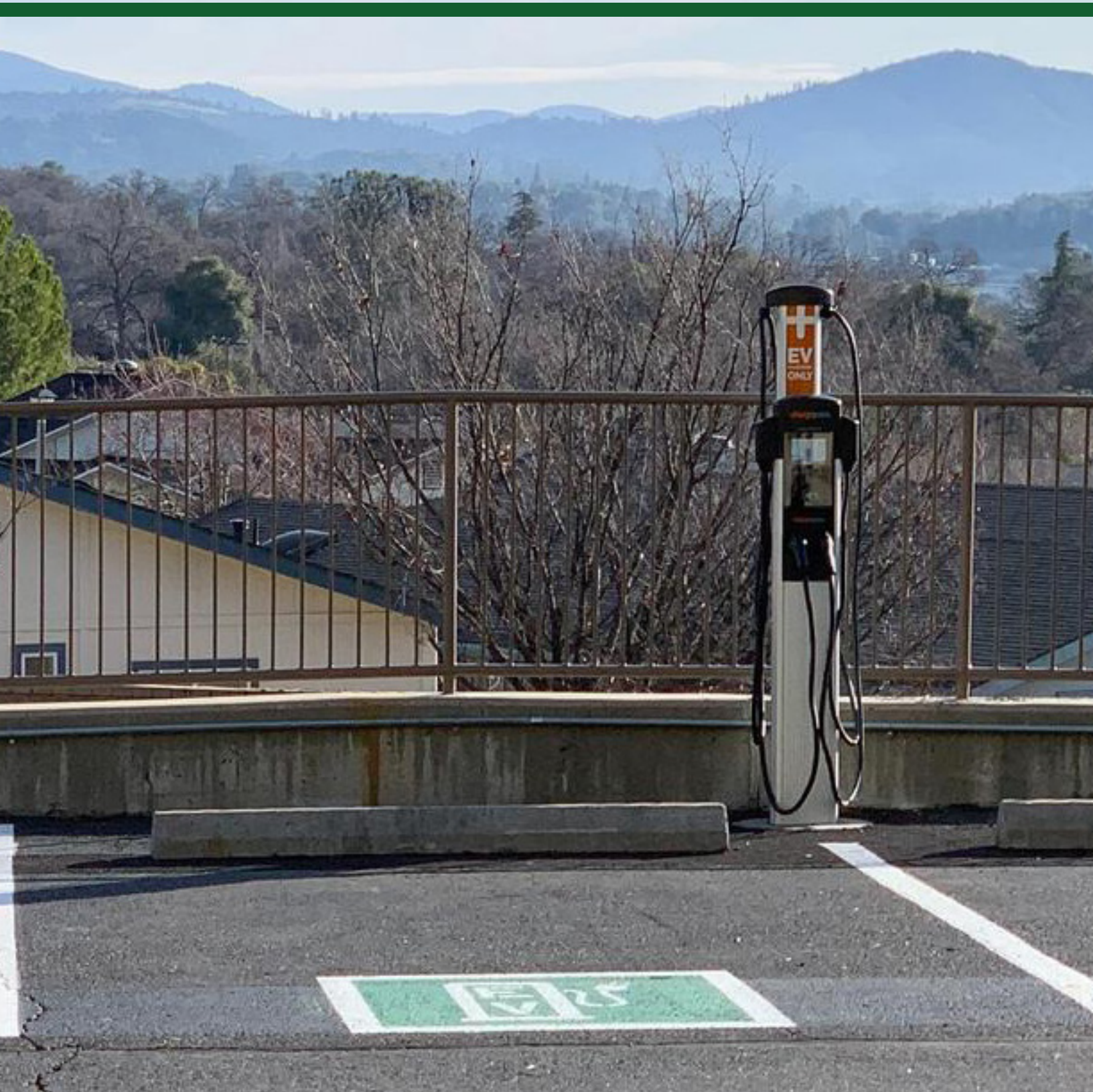
EV
ONLY

IMPLEMENTATION

Adventist Healthcare, Sonora, CA



Recommendations

Along with the deployment of Plan Toolkits and Guidebooks, the following are recommendations to support the implementation of the Plan and development of electric vehicle infrastructure throughout the Region.

Create and Maintain a Regional EVI Collaborative

The Region has numerous stakeholder groups, each with specific challenges, opportunities, and EV adoption profiles. Creating and sustaining a regional network of stakeholders that can share best practices, collaborate on deployment, and increase their buying/negotiation power would help strengthen regional EVI adoption and deployment. The regional transportation planning agency (RTPA) should create a regional EVI collaborative to facilitate deployment and encourage inter- and intra-County engagement.

Integrate Plan into Local Planning

Regional local governments, employers, CBOs and other stakeholders that develop strategic plans should integrate Plan goals, actions, and metrics into relevant documents and internal policies. The actions recommended here and provided in concept-specific toolkits provide the framework for stakeholders to navigate and participate in EVI deployment.

Utilize and Promote Funding Opportunities (Grants, Incentives, and LCFS)

The cost to deploy EVI is a critical factor that every stakeholder evaluates as part of the decision-making process. Identifying and securing funding opportunities can reduce capital investment costs and/or improve return on investment. Many federal, state, local and utility-subsidized programs are available. Regional and municipal partners should consider funding and hosting workshops and outreach events to promote available funding programs to regional stakeholder groups.

Blueprint Tracking & Reporting

RTPA members should utilize the CSZEV Plan website to function as a repository for all plan and Outreach resources, future EVI resources, and to track regional progress on EVCS deployment activities and the Region's progress towards the 2025 goals.

Prioritize Investments in DCFC at 20-mile radius

High-power public charging can mitigate two primary concerns potential EV drivers have: range anxiety and time to charge when traveling. Increasing the availability of DCFCs is a recommended pathway for improving BEV utility and accelerating market adoption. DCFCs sited on major travel corridors facilitate inter-county travel and extend the range of intra-county drivers, which increases annual eVMT miles driven. Utilizing a 20-mile charging radius, an additional 22+ DCFC stations are recommended in the Region to provide adequate range coverage to facilitate all inter/intra-county travel by PHEV/BEVs.

Regional EVI Expert & Technical Advisory Program

To help decision-makers with EVI deployment, Regional partners should create an EVI expert & technical advisory program. The program would offer services of a regional EV Expert for direct assistance to regional stakeholders (e.g., public agencies, workplaces, apartments and HOAs) through outreach, education and workshops; services would be provided at no cost to the recipient. San Diego Association of Governments (SANDAG) created a similar grant program as part of PEV readiness implementation and to date has conducted over 150 unique consultations providing guidance for EVCS installations.

Small Transit Agency ZEB Planning

Small transit agencies must develop a rollout plan to transition to 100% zero-emission bus fleets by 2040. Small transit agencies must have the rollout plan submitted to CARB in 2023.

Engage the Business Community

Based on results of the business survey, Regional businesses have interest in siting EVI. Many businesses in the Region rely on tourism and business travelers so planning for increased EV adoption in adjacent Regions is warranted. TCTC should use the Outreach Plan, toolkits, and existing communication channels/assets to deploy this Plan and relay the value of investing in EVI.

Prioritize Investing in Public and Destination Level 2 EVI

Siting Level 2 charging infrastructure at public locations is recommended because there is likely existing infrastructure that can be leveraged to reduce the amount of upfront capital investment needed. Public sites are typically located near businesses, downtowns, or near areas of interest which should ensure high utilization. Public sites offer access for many EV drivers to charge, and because they are typically sited throughout the Region, they will increase the overall charging potential for the Region.

Destinations in the Region (e.g. casinos, hotels, restaurants, wineries, ski mountains, parks) are heavily used by residents and visitors. These destinations are ideal for Level 2 charging because drivers typically will have a long dwell time (over 1 hour) and could be onsite over four hours or overnight. There is a compelling business case for certain businesses located at/near a Destination to install EVI infrastructure as an added ammenity and to support evolving driver/customer needs.

EVCS Costs, Funding, & Incentives

Cost Guidance

Installation Costs

Basic charging infrastructure costs include hardware, permitting, and installation. Total costs vary by charging level, site characteristics, and equipment features. In workplace charging, fleet charging, and opportunity charging, there may be significant costs for trenching, concrete, and provision for ADA-accessibility.

Table 35: Approximate Costs for Non-Residential Single-Port EVCS

	Level 1		Level 2		DC Fast Charge	
	Low	High	Low	High	Low	High
Hardware	$300	$1,500	$400	$6,500	$10,000	$40,000
Permitting	$100	$500	$100	$1,000	$500	$1,000
Installation	$0*	$3,000	$600	$12,700	$8,500	$51,000
Total	$400	$5,000	$1,100	$20,200	$19,000	$92,200

** Assumes site host is offering an outlet for PEV users to plug into for charging*
Source: DOE, 2015

Table 36: Specific Installation Cost Considerations

Cost Element	Cost
Conduit	$1.50-$2.50/ft
Trenching	$25-$100/ft
Concrete Patch	$14-$15/sq.ft
Asphalt Patch	$10-$11/sq.ft

Source: SANDAG, 2016

The values presented in Table 35 are based on the first charge port at each location. The marginal cost of the next charger installation for each level of charging infrastructure is lower. The charging equipment hardware is the only cost element that does decrease with greater number of installations. This is particularly relevant because the hardware represents a small fraction of the overall cost for Level 1 and Level 2 equipment. Even for DC Fast Charging equipment, there is potentially significant savings with more locations, with about 25-60 percent of the installed cost represented by the hardware.

Factors that affect the cost of electric vehicle charging infrastructure include:

- **Type of mounting:** Charging hardware is available as a wall-mounted or pedestal- mounted unit. Pedestal-mounted units typically cost $500-$700 more than wall-mounted due to material, manufacturing, and install construction costs.
- **Technological features:** The simplest units (non-networked) provide a charging port and electricity, but many amenities and features can be included in hardware and subscriptions such as data collection, usage monitoring, user communication, and billing options.
- **Location:** The further away the charging station is from the electrical panel, the more it costs to

install, as it becomes necessary to trench or bore long distances to lay electrical supply conduit from electrical panel to the charging location. A 2013 Electric Power Research Institute (EPRI) study found that Level 2 sites that required special work such as trenching or boring were about 25 percent more costly than sites that did not need such work.

- **Electrical needs:** In most cases, charging stations need a dedicated circuit for each EVCS unit on the electrical panel, sufficient electrical capacity from the utility connection the electrical panel, and sufficient electrical capacity at the panel. If the selected site does not meet these three key electrical needs, then panel upgrades are required. The most common electrical upgrade for a Level 2 EV charging station is a re-organization of the panel to create space for a 40-amp circuit. More significant electrical work, such as a transformer upgrade, is more expensive.

Additional Costs

Network Fees

If a charging station has the ability to connect to a monitoring network, the station's operator will need to cover the cost of maintaining the cellular or internet network connection, as well as the network's technical support. These fees typically also provide for 24/7 customer service through the network provider, though each operator should consult with their network operator to ensure this is the case. The US Department of Energy (2015) estimates that these network fees can range from $100-$900 annually, depending on the particular station and connection type.

Credit Card Reader

To equip each of EVCS stations with a credit card reader carries an additional cost of approximately $5,000, though this will vary based on installation location, connection type, and network provider. This expense may be offset by the increased convenience and accessibility offered by a simplified charging experience, as the payment transaction is typically handled within the unit itself and no network account is required to utilize the chargers.

Operation and Maintenance

Ownership

There are three types of EVCS ownership and management. First, it can be owned, operated and maintained by the property owner. This includes EVCS installed at a private residence, private business or a multi-unit housing development. Secondly, it can be owned by the EVCS manufacturer and service provider. In this case, management is normally performed by a charging site host or other third party. The EVCS provider compensates the site host or third party for use but maintains responsibility for equipment operations and maintenance. Lastly, EVCS can be owned by a public agency or property manager. In this case, EVCS is managed by a site host or other third party. The host or third party determines fees and receives all revenue but must pay for equipment operations and maintenance.

Some charging infrastructure business models provide charging at no cost to the driver. Other business models charge access fees which generate revenue through the subscription method or pay-per-use (discussed in more detail below) and are expected to be imposed at most publicly available charging sites. In cases where the charging station provider owns the charging station, and therefore its revenue, two methods of dividing revenue are commonly used: the station provider may offer a percentage split with the host based upon negotiated terms with the charging station provider to encourage the host

to maximize the utilization of the equipment, or may provide a fixed rate to the host to compensate for the costs associated with hosting the charging infrastructure and/or the use of the parking space. The balance of any revenue would be retained by the charging station provider.

Fees

Charging station owners often contract with electric vehicle service providers (EVSP) or third-party operators who install, operate, and set the fees on charging equipment. However, if owners have the ability to set fees—either explicitly or implicitly through their choice of operator—goals may conflict. Owners often need to recoup the costs of installing, maintaining, and operating chargers, and may also wish to price vehicle charging to encourage turnover so chargers are available to more drivers. On the other hand, pricing vehicle charging so driving an electric vehicle is cheaper on a per-mile basis than a gasoline-powered vehicle creates an incentive for people to purchase electric vehicles or charge plug-in hybrids and use electricity instead of gasoline. Lower charging costs at commercial centers can also create incentives for drivers to shop at those locations.

- **Fixed fee:** Each charging connection has a set cost, regardless of energy use or length of charging time. For example, the fixed fee may be assessed by an employer at a workplace or when charging is provided as part of a parking lot fee. It may be expected that the driver will be parked for a significant period in this location.
- **Fixed rate:** Fees may be charged per hour or other intervals r AC Level 2 charging and a per minute basis for DC fast charging. This rate is useful if high utilization and turnover of vehicles is desired.
- **Pay per energy consumed:** Fees are based on the cost of electricity to the host and they require measuring the energy delivered. A multiplier on this cost may be applied to recover other operational costs.
- **Subscription:** A fixed rate may be charged to the driver on a monthly basis for an unlimited number of connections or time connected at publicly available EVCS. Discounts on the fixed rate may be provided by membership

When charging fees for usage, vehicles are less likely to remain parked after their charge is complete and other drivers are drawn to spaces that they know are more likely to be available. Over the long term, infrastructure owners should pilot innovative agreements with utilities to make charging cost-competitive with the price of gasoline. For the short term, infrastructure owners may need to establish higher fees to recuperate costs and encourage high levels of use. Various regional infrastructure owners should consider adopting the same fee schedules, particularly in high-demand locations, to create consistency throughout the region. Local governments looking to adopt a PEV charging fee may want to conduct a study to demonstrate the fee is necessary to cover costs and/or create a revenue-sharing agreement with private infrastructure operators.

Charging Time Limit

Time limits can help ensure turnover at chargers so they are available to more drivers. When setting time limits, charging station owners should consider how much time will be necessary to provide vehicles sufficient charge at a given location will likely need. For instance, in some downtowns, time limits apply mostly in commercial areas, as the trips that drivers take to these areas—for shopping, eating out, or socializing—tend to be relatively short. Most drivers traveling from home to the commercial center should be able to recharge from their trips in under two hours. Drivers running a series of errands over a larger area may need a more significant charge time.

Consistency with time limits for regular parking may also influence time limits on charging. Having longer time limits at charging spaces than at regular parking spaces may enable more EV drivers to achieve a significant charge and create incentives for PEV ownership, but it can also make enforcement challenging.

Enforcement

The California Vehicle Code (CVC Section 2251) allows the owner of a space to remove a vehicle if it occupies that space in violation of posted regulations, including signs designating spaces for charging vehicles or time limits. For signs to be enforceable, governments must specify time limits, penalties, hours and other restrictions, and provide the necessary definitions. For example, the City of Sacramento posts a time limit of four hours for continuous charging in a parking space. Enforcement is key to making sure chargers are available for drivers who need them, but it can be challenging, potentially requiring increased funding for parking agents. The City of Los Angeles has adopted municipal code changes to enforce EV only charging. Instead of devoting resources to effective enforcement of time limits, it may be more effective to charge fees that escalate steeply after a certain time to encourage turnover at stations.

Maintenance

Normally there are relatively few EVCS maintenance requirements. The charging cord should be stored securely so it is not damaged, and the accessible EVCS parts should be checked periodically for wear or vandalism. The system should be kept clean using a damp cloth and detergent to wipe surfaces. A qualified electrician should conduct periodic inspections, testing, and preventative maintenance. Annual maintenance costs range from $25 to $50 per EVCS unit. Manufacturers also provide extended warranties to help reduce long-term maintenance and repair costs. Warranties may also be available for the labor. Level 1 and 2 EVCS have an expected useful life of approximately ten years. See the EVCS manufacturer's guidelines for specific requirements. The Plug-In Electric Vehicle (PEV) Handbook for Public Charging Station Hosts offers details on maintenance requirements (US DOE Clean Cities Technical Response).

For Level 1 EVCS, the commercial grade electrical outlet may need to be replaced periodically. This should cost no more than $100 for equipment and professional installation. Level 2 EVCS are modular and components can be replaced, if necessary, without installing a whole new unit. Networked EVCS with communications systems for data or payment may need more frequent maintenance that a local electrician should be able to perform. Technical troubleshooting may be covered in network subscription fees. DC fast charging units require more maintenance due to cooling systems, filters, and other components not found in Level 1 and 2 chargers. The chosen warranty and service plan should reflect expected usage and site-specific needs.

Some charging station hosts purchase, install and operate stations themselves. They receive all revenue from the unit and can contract regular maintenance to a third party. In other ownership models, a third party pays for station equipment, installation and maintenance costs, and manages logistics in return for lease payments or a share of the station's revenue. This model minimizes a host's upfront costs and administrative responsibilities.

Funding & Incentives

EV charging stations face a variety of installation and operation costs that inhibit the development of a diverse EVCS network. Most single-family homes are equipped with the 110/120 volt outlets that can be used for Level 1 charging, but relying exclusively on Level 1 charging isn't feasible for most EV drivers. MUD, workplaces, and public spaces have the potential for electrical and physical barriers (e.g., lack of make-ready infrastructure, billing complexities, distance to/from building) that can increase the cost to install all types of charging (e.g., Level I, Level II, DCFC).

One method to reduce installation costs and burdens is to offer incentives and funding programs that help pay for the installation of EV charging. After determining suitable areas for potential EV charging investments, many PEV plans and assessments provide resources for stakeholders to begin targeting sites within these areas. These resources discuss solutions to EV charging barriers like installation and operation costs, station utilization strategies, and financial incentives that could minimize associated costs.

Local Funding Opportunities

Pacific Gas & Electric (PG&E)

PG&E administers three funding programs for electric vehicle infrastructure. These programs include the FleetReady Program, Fast Charge Program, and EV Charge Network Program.

- **EV Fleet Program** – Starting in May 2019, PG&E received $236 million in eligible funds from the California Public Utilities Commission (CPUC) for infrastructure supporting fleet vehicle charging. PG&E is working with fleet managers that request funding across Northern and Central California to install EVCS at 700 sites (EV Fleet Program, 2019)
- **Fast Charge Program** – Starting in Summer 2019, PG&E will fund and build infrastructure for public DCFCs, including 25% located within DACs. Furthermore, PG&E will offer rebates for customers in DACs who wish to purchase DCFCs (CPUC Approves New PG&E Projects to Help Accelerate Electric Vehicle Adoption in California, 2018).
- **EV Charge Network Program** - Starting in 2016, the CPUC approved the PG&E EV Charge Network Program to install 7,500 Level 2 EVCS at MUDs and workplaces. Within the service territory, PG&E will install the infrastructure at qualified locations with at least ten parking spaces available for charging (About the Program, 2018).

Carl Moyer Program

The Carl Moyer Memorial Air Quality Standards Attainment Program (Moyer Program) was implemented in 1998. The current program is authorized under Senate Bill 513 (SB 513). SB 513 provides funding for infrastructure projects such as alternative fueling stations for on-road and off-road vehicles and equipment (California Air Resources Board, 2017). Moyer Program project types include:

- Replacement: replacing a vehicle with a newer, lower-polluting or zero-emission vehicle.
- Repower: replacing a vehicle's motor with a newer, lower-polluting or zero-emission unit,
- Retrofit: replacing equipment on a vehicle's motor in order to reduce the motor's emissions.
- Vehicle Retirement: removing a vehicle from service
- Infrastructure: constructing fueling or charging infrastructure

The Program applies to on-road and off-road heavy-duty vehicles including school buses, heavy-duty trucks and buses, transit fleet vehicles, drayage trucks, solid waste vehicles, public agency/utility vehicles, and emergency vehicles.

The Moyer Program is implemented through local air districts and funding amounts vary. For example, the cap for a School Bus Zero-Emission Replacement is $400,000 through the State Funding Caps for Moyer School Bus Projects.

State Funding Opportunities

Alternative and Renewable Fuels and Vehicle Technology Program (ARFVTP)

The ARFVTP, a California Energy Commission program established under AB 118, provides annual investments for advanced transportation and fuel technologies (ARFVTP Overview, 2018), including EVCS. Available funding for the 2018-2019 investment cycle reached a total of $134.5 million, more than the average annual investment of $100 million. According to the 2018-2019 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program, policy goals for the investment include GHG Reduction, Petroleum Reduction, Low-Carbon Fuel Standard, Air Quality, and ZEV Regulations (2018). ARFVTP funded the three projects within the Region listed in Table 37. ClipperCreek, an EVCS manufacturer, was the recipient of these funds.

Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)

The California Legislature appropriated funds for the Low Carbon Transportation Program, which includes $125 million specifically allocated to the Hybrid and Zero-Emission Truck and Voucher Incentive Project (California Air Resources Board, 2018). HVIP provides clean truck and bus vouchers to help fleets reduce the initial costs of converting fleets to PHEVs and ZEVs and range from $8,000 to $45,000 per vehicle.

Table 37: ARFVTP Funded Projects in the Region

Project	Address	Amount	Description	Status
ARV-10-001-271 New Melones Lake - Glory Hole	86 Glory Hole Rd., Angels Camp, CA 95222 (Calaveras County)	$2,996.54	Update Existing EV infrastructure To SAE-J1772	Complete
ARV-10-001-11 Jackson Civic Center	33 Broadway, Jackson, CA 95642 (Amador County)	$2,996.54	Update Existing EV infrastructure To SAE-J1772	Complete
ARV-10-001-270 New Melones Lake - Tuttletown	7591 Reynolds Ferry Rd., Sonora, CA 95370 (Tuolumne County)	$2,996.54	Update Existing EV infrastructure To SAE-J1772	Complete

Source: ARFVTP Project Map, 2018

Federal Funding Opportunities

FAST Act - Congestion Mitigation and Air Quality Improvement (CMAQ) Program

The FAST Act authorizes funding of $2.3-2.5 billion to the CMAQ program for apportionment to the states. States, local governments, and transit agencies can use these funds to invest in transportation projects that support the Clean Air Act. Projects eligible for the funds include "alternative fuel vehicles and infrastructure. A project supported with CMAQ funds must demonstrate that the project reduces emissions, is located in or benefits an EPA designated nonattainment or maintenance area and is a transportation project (23 U.S.C. 149)" (Department of Energy, 2016).

According to the Environmental Protection Agency's (EPA) Clean Air Act National Ambient Air Quality Standards, Tuolumne, Calaveras, and Amador Counties are all designated nonattainment for at least 1 NAAQS Pollutant (2018).

- Tuolumne County is Designated Nonattainment for 2 NAAQS Pollutant (8-Hour Ozone 1997 & 2015) – Marginal
- Calaveras County is Designated Nonattainment for 2 NAAQS Pollutants (8-Hour Ozone 2008 & 2015) – Marginal
- Amador County is Designated Nonattainment for 2 NAAQS Pollutant (8-Hour Ozone 1997 & 2015) – Marginal

FAST Act - Low or No Emission Vehicle Program – 5339(c)

The FAST Act authorizes $55 million in funding per year through FY 2020 for capital projects involving low or zero-emission public transportation vehicles. The program may fund up to 85% of the cost, but requires a 15% non-federal cost share. The funding is apportioned to the State of California through the 5307 Urbanized Area Formula. Public information is available on the FAST Act website and FAST Act Section 5339 fact sheet (Department of Energy, 2016).

Title XVII Clean Energy Loan Guarantees

Loan guarantees are available through the U.S. Department of Energy for investment in alternative fuel vehicles. Loan guarantees may cover up to 100% of the eligible project cost and may include infrastructure and networking projects. More information is available on the Loan Guarantee Program website and the Alternative Fuel Infrastructure fact sheet (Department of Energy, 2016).

Incentives

General information on organizations that offer ZEV related funding is useful in both plans and toolkits. Understanding different incentives that can reduce the cost of EVCS installation will help reduce barriers to infrastructure deployment. The Butte County Area Governments (BCAG, 2018) developed a table of different incentive programs for EV charging and PEV purchase costs and sorted them by funder, these are shown, along with local funding opportunities, in Table 38.

Table 38: Available EVCS Funding & Incentive Programs (BCAG 2018)

Programs	Description	Amount	Eligibility
Federal Programs			
Plug-in Electric Vehicle Tax Credit	A tax credit for the purchase or lease of a new PEV, ZEV, PHEV, ZEM or NEV	$2,500 - $7,500 per vehicle	Individuals
Fuel Cell Vehicle Tax Credit	A tax credit for the purchase of a new light-duty FCEV; credits are based on vehicle weight	$4,000 - $40,000 per vehicle	Individuals
Low Speed, 2/3 Wheel PEVs Tax Credit	Tax credit for low speed and 2/3-wheel vehicles	10% of vehicle $2,500 limit	Individuals
Employee Corporate Incentives	Private companies and organizations offering employees assistance with purchasing new ZEVs	$1,000 - $5,000 per vehicle	Individuals
State Incentive Programs			
Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act			
Alternative Fuel Vehicle Refueling Property Credit	A 30% tax credit is allowed for any qualified alternative fuel vehicle refueling property	$1,000 - $30,000 per vehicle	Individuals/Property Owners
Clean Vehicle Rebate Project (CVRP)	Available rebate for ZEVs, PHEVs, NEVs and ZEMs	$900 - $2,500 per vehicle, with a limit of two rebates for vehicles purchased or leased after 2015	Individuals/Private Fleets/Public Fleets/ Nonprofit
California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project	Vouchers to help fleets reduce the initial costs of converting fleets to PHEVs and ZEVs	$8,000 - $110,000 per vehicle, including buses	Fleets
Hybrid Off-Road Equipment Pilot Project	Vouchers to integrate hybrid off-road construction vehicles into California	$28,500 - $75,000 per vehicle	Public/Private Fleets
Air Resources Board Grant Programs			
Enhanced Fleet Modernization Program	Voluntary retirement of passenger or cargo trucks with a vehicle weight rating of 10,000 pounds or less	$500 - $1,500 per vehicle	Individuals/Private Fleets

Programs	Description	Amount	Eligibility
Good Movements Emission Reduction Program	ARB working with Local Agencies to reduce air pollution and health risks associated with heavy freight movement	Up to $50 million	Local Agencies
PLACE Program	Loans for fleets that can be used for fleet modernization, e.g., retrofitting diesel engines with emission control systems	$1 million	Private Fleets Less Than 500
Local Programs			
Tuolumne County Air Pollution Control District	Carl Moyer Program - Limited funding opportunities for zero-emission on-road and off-road heavy-duty vehicles as well as infrastructure	$200,000 available each year; Grant amounts vary	Private Companies and Local Agencies
Calaveras County Air Pollution Control District	Carl Moyer Program - Limited funding opportunities for zero-emission on-road and off-road heavy-duty vehicles as well as infrastructure	Information not publicly available	Private Companies and Local Agencies
Amador Air District	Carl Moyer Program - Limited funding opportunities for zero-emission on-road and off-road heavy-duty vehicles as well as infrastructure	Information not publicly available	Private Companies and Local Agencies
Great Basin Unified Air Pollution Control District (Alpine)	Carl Moyer Program - Limited funding opportunities for zero-emission on-road and off-road heavy-duty vehicles as well as infrastructure	Information not publicly available	Private Companies and Local Agencies

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EV
EXCEPT FOR ELECTRIC
VEHICLE CHARGING
4 Hours Max.

EVCS PLANNING TOOLS

EVCS Deployment Planning Tools

This section reviews the planning tools to assist in the deployment and implementation of electric vehicle charging infrastructure. The tools include information on utility coordination, permitting, fleet implementation, and transit. The full resources can be found in the Appendix of this document.

Permitting and Codes

Permitting Process for Governments

A key step in the installation of PEV charging equipment is to obtain city or county permits and pass an inspection. Because regional infrastructure has been expanding rapidly, there are many opportunities to streamline permitting and inspection procedures and harmonize processes between jurisdictions. Making the permitting process easy, affordable, and less time consuming can help speed the roll out of charging infrastructure and make installations more straightforward.

Permit Streamlining Considerations

Jurisdictions must balance efforts to simplify permitting and inspection while maintaining quality and safety standards. The following practices can help jurisdictions increase efficiency while meeting standards and state requirements:

- Prepare combined informational materials providing all guidance on the permitting and inspection processes specific for residential, multi-family dwelling, and non-residential charging equipment installations
- Prepare all guidance, including a permitting and inspection checklist and application materials allowing for online submission to meet local and state requirements per AB 1236 as described on page 16.
- Work with other local governments to make permitting and inspection procedures consistent between jurisdictions by using consistent guidelines and other shared standards
- Consider streamlining permitting for installations in single-family residences by reducing application material requirements; for example, eliminate site plan requirements and require installer to provide manufacturer specifications and approved equipment testing certification at the time of inspection, limit to one inspection, and set a fixed fee
- Work with local utilities to create a notification protocol for new charging equipment through the permitting process
- Train permitting and inspection officials in EV charging equipment installation

To provide permitting consistency between jurisdictions in the Region, it is also recommended that guidelines are developed for local governments on PEV charging systems for single-family and multi-family residences and commercial properties.

Assembly Bill 1236: Electric Vehicle Charging Stations

Recognizing the important role of permitting in the deployment of charging infrastructure, California legislators passed a law in 2015 requiring local governments to streamline the permitting process. AB 1236 required all communities under 200,000 people to adopt an ordinance that expedites the permitting process for PEV charging stations by September 30, 2017.

The required ordinance must include several streamlining elements. Local governments must provide a permitting checklist for which installation projects that meet all requirements must be eligible for expedited review. Cities and Counties can use the latest version of the "Plug-In Electric Vehicle Infrastructure Permitting Checklist" from the Zero-Emission Vehicles in California: Community Readiness Guidebook published by the Governor's Office of Planning and Research. An example checklist is also provided in Appendix E. Local jurisdictions can modify standards based on "unique climactic, geological, seismological, or topographical conditions." In addition to developing streamlined procedures, permitting offices must provide the permitting materials on the government's website and must allow for electronic submittal of the application materials online.

ADA/California Building Code Compliance

Under the California Building Code, a portion of all chargers at multi-family buildings and non-residential developments are required to be ADA-accessible. It is important to take these requirements into account when planning to install chargers because they impact the spatial needs, and potentially the cost, of installations. The first new charger constructed is required to be ADA-accessible and this is significantly wider than a typical parking space, and includes more space for adjacent access aisles. Property owners may have to sacrifice multiple standard parking spaces to build the first charging space.

When EVCS are installed in public parking garages and lots, it is important to note that under CBC Chapter 11B, Divisions 2 and 8:

- Installing EVCS changes the use of the space from parking to charging.
- Depending on the number of EVCS to be installed, a certain number and type of accessible EV spaces needs to accompany the EVCS installation
- Accessible spaces need to be on an accessible path of travel to the main entrance of the facility which the EVCS serves.

ADA Requirements for Pre-Wired Charging Spaces at New Multi-Family Developments

CalGreen (California Green Building Code) requires that multi-family residential developments with 17 or more parking spaces to have three percent of parking spaces, but in no case less than one space, pre-wired for a level 2 charger. One in every 25 of these spaces, with a minimum of one space, is required to have an adjacent access aisle that is eight feet wide, though this can be reduced to five feet if the parking space is over 12 feet wide. These spaces are also required to be relatively flat.

ADA/California Building Code Compliance

The California Building Code requires roughly one of every 15 newly-installed chargers at public locations to be ADA-accessible, as shown in Appendix E. Three design standards for ADA-accessible parking spaces are as follows:

- Ambulatory parking spaces designed for people with disabilities who do not require wheelchairs, but may use other mobility aids.
- Standard ADA-accessible spaces designed for people who use wheelchairs but can operate vehicles.
- Van-accessible spaces for vehicles carrying people who use wheelchairs who cannot operate vehicles.

New Construction Guidance

The state of California has created requirements for pre-wiring charging spaces in new development and using signs to indicating chargers. Appendix E summarizes these requirements as they apply to charging spaces in new development and newly constructed charging stations.

Local EVCS Guidance

Under California Assembly Bill 1236, cities and counties were required to enact ordinances creating an expedited, streamlined permitting process for electric vehicle charging stations by September 30, 2017. A checklist of eligibility requirements for expedited review were required to be posted online, alongside the permitting documentation.

ZEV Readiness Scorecard

The Governor's Office of Business and Economic Development has established a ZEV readiness landing page (http://www.business.ca.gov/ZEVReadiness) that will be used to track station development streamlining, resulting in a shared resource of best practices, ordinances, and checklists. The site will initially focus on permit streamlining and voluntary building codes.

Permitting

The below "Permitting Electric Vehicle Charging Stations Scorecard" will serve as the foundation for assessing statewide compliance with California's electric vehicle charging station permit streamlining law (AB 1236, 2015).

Table 39: Permitting Electric Vehicle Charging Stations Scorecard:*

•	**Streamlining Ordinance** Ordinance creating an expedited, streamlined permitting process for electric vehicle charging stations (EVCS) including level 2 and direct current fast chargers (DCFC) has been adopted
•	**Permitting checklists covering L1, L2, and DCFC** Checklist of all requirements needed for expedited review posted on Authority Having Jurisdiction (usually a city or county) website
•	**Administrative approval of EVCS** EVCS projects that meet expedited checklist are administratively approved through building or similar non-discretionary permit
•	**Approval focused on Health and Safety Review** EVCS projects reviewed with the focus on health and safety
•	**EVCS are accessory features** EVCS projects do not trigger planning/zoning review
•	**One complete deficiency notice** AHJ commits to issuing one complete written correction notice detailing all deficiencies in an incomplete application and any additional information needed to be eligible for expedited permit issuance.
•	**Electric signatures accepted**. AHJ accepts electronic signatures on permit applications*
•	**EVCS not subject to association approval** EVCS permit approval not subject to approval of an association (as defined in Section 4080 of the Civil Code).

**Note –The requirements establish by AB 1236, 2015 is the foundation of this scorecard. See Part 3 – Permitting for more information.*

Cities and Counties that have met all the checklist parameters will be highlighted as "AB 1236 Compliant," and the Governor's Office of Business and Economoic Development ZEV Readiness website will point to the relevant ordinances and checklists for other jurisdictions to reference. Overall, jurisdictions will be scored using the following scale, with the objective creating a platform for collaboration to establish statewide compliance.

Permitting
Unknown
Not in Compliance with AB 1236
Compliance in Progress (or partial compliance)
AB 1236 Compliant

For more information on permitting see Appendix E: Permitting Guidebook.

Utility Coordination

EVCS & Utilities

As the number of PEVs on the road increases, so does the demand placed on electric utilities to supply them with the power they need. Vehicle charging can add substantial electrical load and changes how, when, and why electricity is used. Potential site hosts should coordinate with their utility on a number of different issues (Process identified in Figure 48). The following include:

- Participate in utility infrastructure program: Some utilities offer programs that include funding installations for charging infrastructure or rebates for charging stations. Contact utility provider to evaluate qualification for active programs.
- Upgrade service: Electrical service may need to be expanded to support EV charging. Utility service planners will determine the requirements for upgrading service or establishing new service to support EV charging.
- Change rate plan: The traditional tiered rate structure is helpful in promoting energy conservation, but it offers no incentive to charge during off-peak hours. Compare rate plans and select based on EV charging schedule. For example, Liberty Utilities and PG&E offer time-of-use plans for their EV charging customers to charge during off-hours at a lower cost (Figure 47).
- Explore smart grid opportunities: Utilities are piloting smart grid programs that may offer incentives for managing charging to reduce grid impacts.

Figure 50: PG&E Time of Use

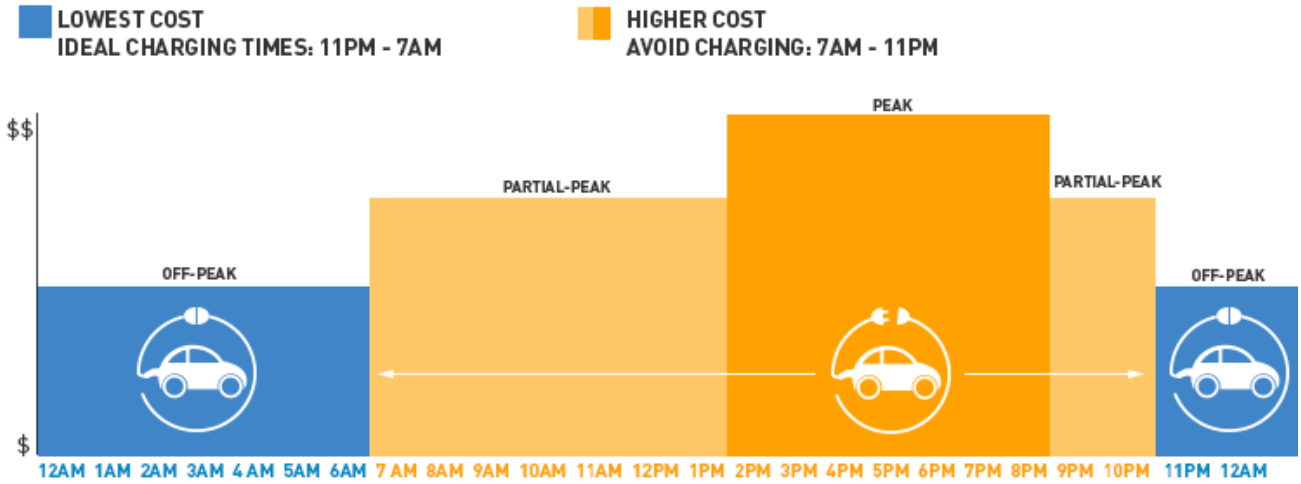
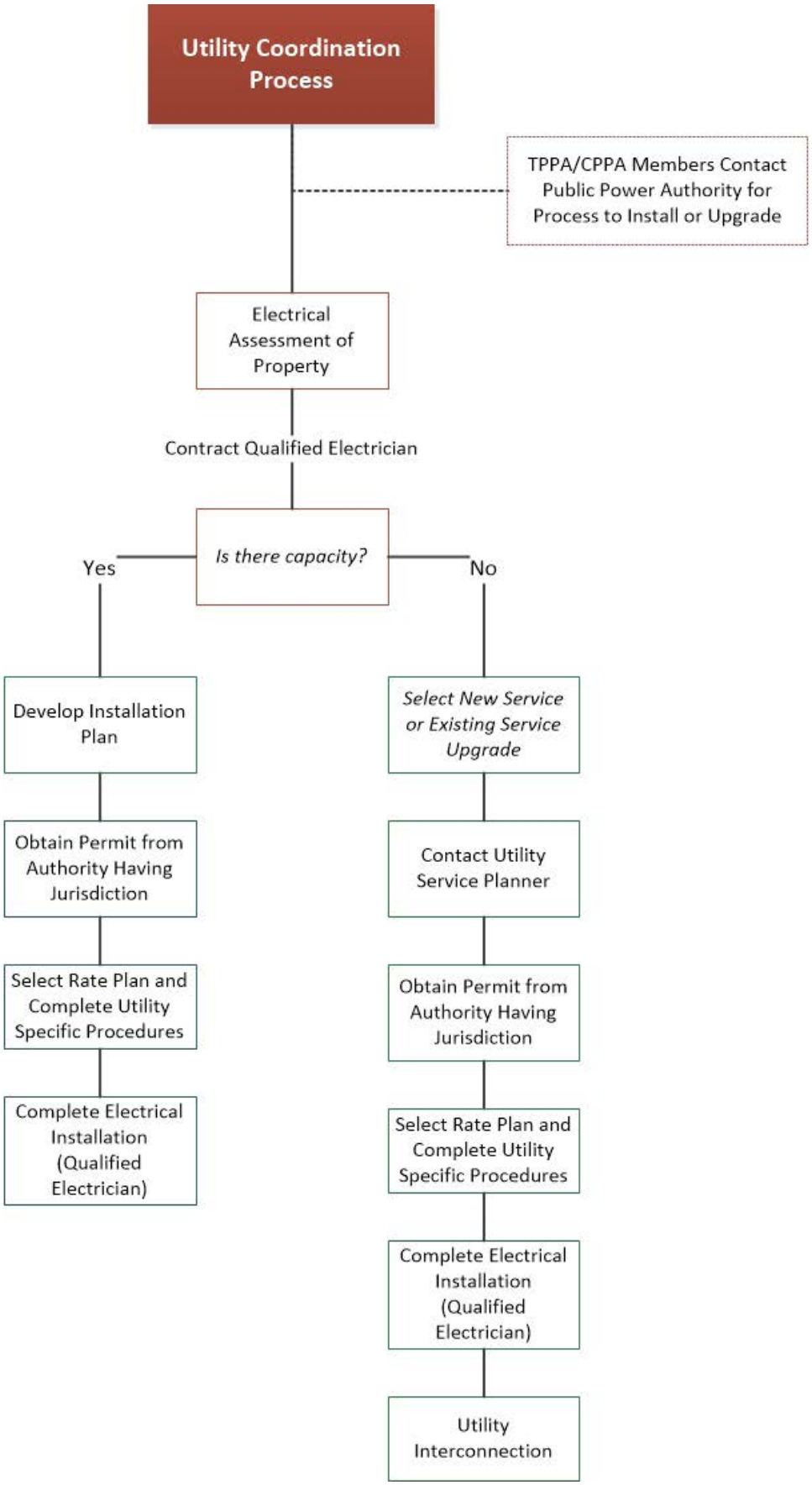


Figure 48: Utility Coordination Process



EVCS Installation Scenarios

Upgrading Service and Additional Service Drop

For buildings without sufficient existing electrical capacity for their planned EV charging loads there are two main options to consider. First is an **electric service upgrade to the property.** This may be costly and trigger requirements to bring the property up to current building code. This option may make the most sense as part of a larger electrical or other property rehabilitation project. Replacing a building's main service entrance and panel requires coordination between the property owner, the Authority Having Jurisdiction (AHJ) for a permit, and the Utility Provider.

A second option may be to add a **second service drop to an existing site**. Although the electrical code generally favors a single electrical connection point, exceptions exist for several situations. New services could support EV charging without requiring modifications to existing building supply. A new service entrance could be located close to the parking area where the power is needed and allow all charging to be segregated to its own utility meter, offering the freedom to choose the most suitable tariff for EV charging.

The **PG&E EV Charge Network program** uses the second service model, with the added benefit of providing PG&E clear ownership of all the make-ready infrastructure connected to the new service. The EV Charge Network program is available at workplaces and multi-unit dwelling (MUD) apartment complexes.

For more information on utility coordination, see Appendix D: Utility Coordination Guide.

Fleet Adoption

California has adopted several transportation fuel laws and goals that establish targets for low-emission and zero-emission vehicles operating on state roads. To meet these goals, the State passed Assembly Bill No. 118 in 2007, which allocated grant funds via the Alternative and Renewable Fuel and Vehicle Technology Program (AFRVTP) and the California Air Resources Board (CARB) and established a low-carbon transportation plan. These programs provide annual funding to address barriers around the production and deployment of alternative fuels, vehicles, and infrastructure.

To further reduce petroleum reduction and greenhouse gas (GHG) emissions, in 2012, Executive Order (EO) B-16-12 mandated that at least 10% of State-operated fleet purchases of light-duty (LD) vehicles be ZEVs by 2015 and 25% by 2020. In 2016, the State's 2016 ZEV Action Plan was adopted, increasing the requirements for ZEVs in the State's light duty fleet to be 50% by 2025, and a 2018 update began the process of setting annual ZEV purchasing requirements for the medium-duty State fleet.

Many local jurisdictions are electing to set their own targets for ZEV adoption in support of State goals within their climate or energy plans.

Under CARB's Innovative Clean Transit program, small transit agencies purchasing buses must ensure that 25% of those vehicles are zero-emission buses (ZEBs), starting in 2026, and all purchases must be ZEBs starting in 2029. By 2040, small transit agencies must operate completely zero-emission fleets. The five major transit agencies operating in the Central Sierra region are all classified as small agencies and will be required to submit a ZEB rollout plan to CARB by January 1, 2023.

In 2018, the Governor directed CARB to assess possible regulatory requirements to ensure greater inclusion of ZEVs in public and private light- and heavy-duty vehicle fleets. If CARB's assessment results in new regulation, public fleets are likely to be the preliminary focus. A similar process was followed to establish the current regulations for ZEBs. In the ZEB example, the transition deadlines included benefits for jurisdictions that took early action which suggests that there may be similar incentive for jurisdictions to take early action transitioning their public fleets.

ZEV Suitability for Fleet

ZEVs offer higher fuel efficiency, cheaper fuel, lower maintenance costs, and unique performance benefits over internal-combustion counterparts.

Accessible charging and fueling infrastructure are crucial for successfully incorporating ZEVs into fleets. It is a best practice to evaluate, site, and construct enough infrastructure prior to adding ZEV vehicles. Ideally, electricity demand evaluations are completed, and the appropriate number of charging/fueling stations are installed before vehicles are ordered. While charging at lower power levels (2kW - 7 kW) is adequate for the small batteries found in passenger cars, vehicles with high gross vehicle weights typically require larger batteries. These large vehicles may require higher-powered charging (30kW – 500kW) in applications that require minimal downtime.

Fleets that acquire vehicles ahead of infrastructure do so at their own risk. Vehicles may be 'bricked' or become stranded assets if charging is not available. To mitigate potential delays and problems arising from long charge times, it's appropriate to provide one Level 2 charging plug per light-duty vehicle in service. The recommended vehicle-to-plug ratio typically increases as chargers get more powerful. For example, as many as 36 light-duty vehicles per day can be served by a single 50kW DC Fast charger. The exact ratio is highly dependent on vehicle routes and load.

Fleet Analysis

Fleets have unique characteristics that must be considered before implementing a program. These differences include fleet size, duty-cycles, electrical capacity of buildings, operator attitudes towards change and stated goals of the organization.

The first step in supporting the deployment of fleet EVI is to assess the gaps and technical concerns by analyzing the fleet's vehicle inventory, duty-cycles and available infrastructure to produce a strategy and schedule for fleet electrification.

The Project team analyzed fleet data from 11 fleets to identify vehicles which have satisfactory plug-in electric replacements in the marketplace or are soon expected to. The existing fleet were categorized for replacement as follows:

Response	Meaning	Existing Vehicle Type	Replacement Vehicle Type
Yes	There are reasonable EV replacements on the market for these vehicles.	Sedans, SUVs, Vans	Wide range of sedans, hatchbacks, and compact SUVs
No	No reasonable EV replacements exist and are not expected in the next 5-10 years.	Heavy-duty vehicles, police/firefighting, construction equipment	N/A
Consider w/ reservations	Replacements exist but may not be suitable for use.	3/4 or 1-ton work trucks, incl. service bodies, buses	Plug-in hybrid service trucks, BEV cutaway busses
Future potential	No reasonable EV replacements in the same vehicle class exist but are expected in the next 5-10 years.	Compact/full-size pickup trucks	Plug-in pickup trucks

Table 40: Replacement Counts from Central Sierra Fleet Analysis

Yes	231
No	301
Consider with Reservation	165
Future Potential	78
Total	**824**

Sedans and crossovers are widely available and largely cost-effective now. However, a significant portion of the fleet in the Region consists of larger work vehicles, such as pickup trucks. While there are some options currently available within this segment (see ICE Alternative Guidebook), it is expected to expand within the next few years.

The Region presents unique local challenges to electric vehicle adoption. EVs operating in the area's characteristic mountainous terrain and winter weather will experience shortened range.

Elevation affects ZEBs and ZEVs because climbing requires more power than traveling the same distance without elevation change. When grade changes are significant, vehicle range diminishes which requires more charging infrastructure be installed to provide adequate coverage.

Similarly, in cold conditions, batteries are less efficient at discharging electricity, and below 40 degrees Fahrenheit will suffer from decreased discharge performance. Charging performance will also be inhibited if the battery is not pre-warmed in cold weather, though many vehicles offer built-in battery heaters as an option. Mass transit vehicles, such as commuter shuttles or buses, may require alternative heating sources in cold weather to avoid using the onboard electric heat and depleting the battery.

State Grants and Rebates

The California Energy Commission (CEC) and CARB offer alternative transportation grants and rebates through the AB 118 Program and other low carbon transportation funding. Funding is allocated annually and the FY 2017-2018 budget for the CEC AB 118 Program (www.energy.ca.gov/altfuels/) was approximately $100 million. CARB managed approximately $400 million in rebates and projects in FY 2017-18 and 2018-19 through the Air Quality Improvement Program/Low Carbon Transportation funding plan (www.arb.ca.gov/msprog/aqip/aqip.htm).

The Center for Sustainability (CSE) manages CARB's Clean Vehicle Rebate Project (CVRP) (https://cleanvehiclerebate.org/), which provides rebates of up to $2,500 for light duty battery electric and plug-in hybrid vehicle purchases. Table 41, CVRP Rebate Amounts for Light-Duty Vehicles, summarizes the rebates available.

Table 41: CVRP Rebate Amounts for Light-Duty Vehicles

Vehicle Class	Maximum Incentive
Light duty hydrogen fuel cell vehicles (FCEV)	$5,000
Light duty zero-emission vehicles (ZEV)	$ 2,500
Plug-in hybrid electric vehicles (PHEV)	$1,500
Zero-emission motorcycles (ZEM)	$ 900

Note: Eligible vehicles and associated rebate amounts are subject to change. Visit the CVRP program site for eligible vehicle models and associated rebates.

Rebates for commercial vehicles including trucks and buses are available through CARB's Hybrid Truck and Bus Voucher Incentive Project (HVIP) (www.californiahvip.org). As of March 2019, the HVIP estimated fund balance was over $60 million. A summary of the incentives available is provided in the CARB HVIP Voucher Amounts for Trucks and Buses tables below. Additional incentives are available for transit buses, vehicle conversions, hybrid vehicles that have an all-electric range greater than 35 miles, and for vehicles providing service within disadvantaged communities

Table 42: HVIP Voucher Amounts for Zero-Emissions Trucks & Buses

Gross Vehicle Weight (in pounds)	
5,001 – 8,500 lbs	$20,000
8,501 – 10,000 lbs	$25,000
10,001 – 14,000 lbs	$50,000
14,001 – 19,500 lbs	$80,000
19,501 – 26,000 lbs	$90,000
26,001-33,000 lbs	$95,000
> 33,001 lbs	$150,000

Table 43: Maximum HVIP Voucher Amounts for Hybrid Trucks & Buses

Gross Vehicle Weight (in pounds)	
6,001 – 8,500 lbs (plug-in hybrids only)	$8,000
8,500 – 10,000 lbs (plug-in hybrids only)	$10,000
10,001 – 19,500 lbs	$15,000
19,501 – 26,000 lbs	$20,000
26,001 – 33,000 lbs	$25,000
> 33,000 lbs	$30,000
> 33,001 lbs	$150,000

Transit (Looking Ahead)

Starting in 2026, the California Air Resources Board Innovative Clean Transit regulation requires 25% of small transit agencies bus purchases to be zero-emission (CARB § 2023.1., 2018). Small transit agencies are required to have a fully zero-emission fleet by 2040. Each agency is required to develop a rollout plan detailing how it plans to purchase clean buses, build out necessary infrastructure and train the required workforce.

Tuolumne County Transit

Operating 21 total vehicles, Tuolumne County Transit is classified as a small agency, with a rollout plan due by 2023. Starting on January 1, 2026, 25% of new bus purchases must be ZEBs; starting January 1, 2029, all new purchases must be ZEBs (CARB § 2023.1., 2018). If no eligible cutaway buses, motor coaches, or articulated buses have passed Altoona bus testing and received a passing report by January 1, 2029, these bus types will be excluded from the mandate until options are available.

Alpine County Local Transportation Commission

Operating 2 total vehicles, Alpine County Local Transportation Commission is classified as a small agency, with a rollout plan due by 2023. Starting on January 1, 2026, 25% of new bus purchases must be ZEBs; starting January 1, 2029, all new purchases must be ZEBs (CARB § 2023.1., 2018). If no eligible cutaway buses, motor coaches, or articulated buses have passed Altoona bus testing and received a passing report by January 1, 2029, these bus types will be excluded from the mandate until options are available.

Calaveras Transit

Operating 14 total vehicles, Calaveras Transit is classified as a small agency, with a rollout plan due by 2023. Starting on January 1, 2026, 25% of new bus purchases must be ZEBs; starting January 1, 2029, all new purchases must be ZEBs (CARB § 2023.1., 2018). If no eligible cutaway buses, motor coaches, or articulated buses have passed Altoona bus testing and received a passing report by January 1, 2029, these bus types will be excluded from the mandate until options are available.

Amador Transit

Operating 16 total vehicles, Amador Transit is classified as a small transit organization, with a rollout plan due by 2023. Starting on January 1, 2026, 25% of new bus purchases must be ZEBs; starting January 1, 2029, all new purchases must be ZEBs (CARB § 2023.1., 2018). If no eligible cutaway buses, motor coaches, or articulated buses have passed Altoona bus testing and received a passing report by January 1, 2029, these bus types will be excluded from the mandate until options are available.

Yosemite Area Regional Transportation System (YARTS)

Operating 20 total vehicles (10 maintained and 10 leased), Yosemite Area Regional Transportation System is classified as a small transit organization, with a rollout plan due by 2023. Starting on January 1, 2026, 25% of new bus purchases must be ZEBs; starting January 1, 2029, all new purchases must be ZEBs (CARB § 2023.1., 2018). If no eligible cutaway buses, motor coaches, or articulated buses have passed Altoona bus testing and received a passing report by January 1, 2029, these bus types will be excluded from the mandate until options are available.

Education & Outreach

This section identifies actions that TCTC, RTPA, and Regional stakeholders should take to promote EV/EVI adoption. Engaging stakeholders and providing valuable materials will guide the implementation of the Plan and increase the understanding of PEV growth in the Region. The Outreach Plan (see Appendix F) identifies six Target Audiences for Regional stakeholders to engage during Plan implementation, the Engagement Channels to facilitate public outreach, and the Goals and Tactics that will enable, engage, empower, and encourage the implementation of the Plan through collaboration with key stakeholders, sector-specific influencers, and decision-makers.

Enable RTPA members and local municipalities to implement the Plan through actionable steps and engagement strategies.

Recommendations

1. **Create a Plan specific webpage:** TCTC or RTPA should develop a project website to serve as the central repository for project documents, webinars, and any outreach materials.
2. **Social Media:** Develop Central Sierra Zero Emission Vehicle Readiness Plan social media accounts.
3. **Webinar:** Host a webinar for introduction to the Central Sierra Zero-Emission Vehicle Plan.

Engage sectors in distributing information to facilitate Plan awareness.

Recommendations

1. **Promote and Share Toolkits:** Utilize channels and target audience partners to promote and share toolkits.
2. **Share information via partner social media accounts**: Develop tweets and posts for sharing Plan content on partner social media accounts including Visitor Bureaus, County Partners, City Partners, and Resorts & Tourism Destinations.

Empower Plan Champions to guide implementation at the local level.

Recommendations

1. **Create EV Task Force:** Create EV Task Force within each Partner County and meet monthly (conference calls) and quarterly (in-person) to develop county and city-specific actions and guide implementation of Plan.

Encourage Business Sector adoption of EVCS at commercial and retail workplaces.

Recommendations

1. **Business Sector Survey:** Build upon input from Business Sector Survey completed during the planning process.
2. **Business Sector Outreach:** Contact local Chambers of Commerce and Business Associations to facilitate outreach to interested business owners and share business-specific toolkit.

Local Business Survey

To understand the level of knowledge and attitudes about EVs, the Project Team conducted a survey of business owners and managers in the region. The survey was designed to:

- Understand business owners'/managers' interest in providing EV charging for customers/ employees
- Understand business owners'/managers' barriers and needs related to installing EV charging
- Provide direction regarding resources that can be included in toolkits to help business owners with installation of EV charging
- Offer opt-in for additional information and/or participation in planning efforts.

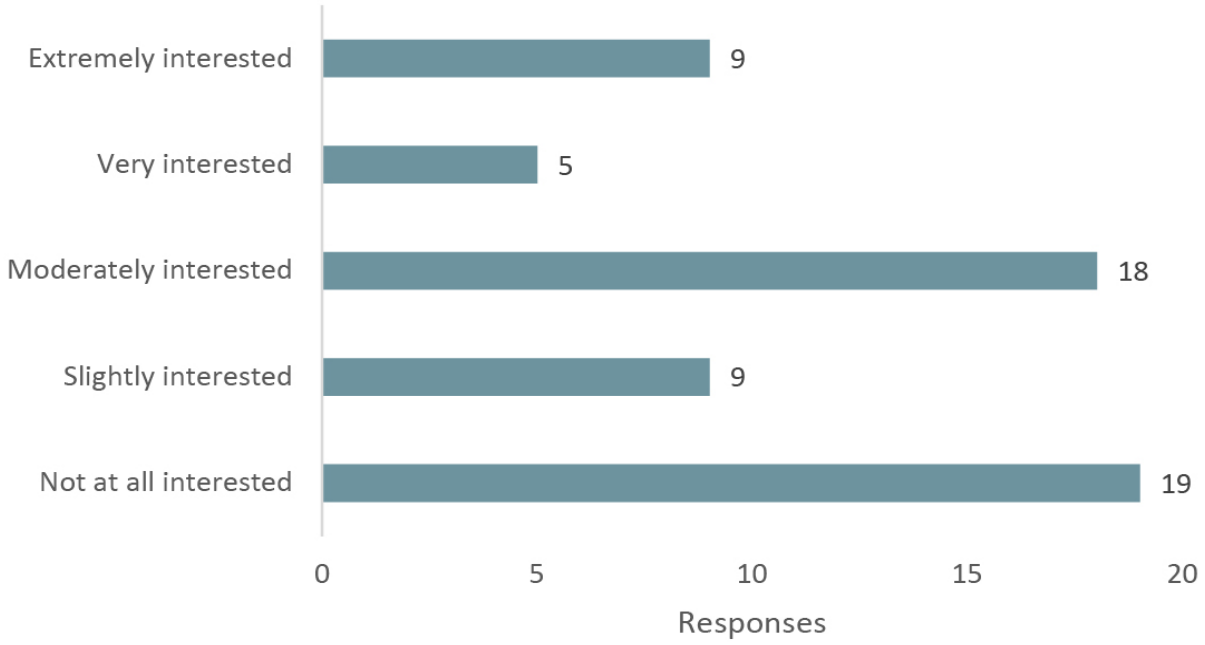
The survey was distributed to local businesses through local Chambers of Commerce, Business Associations, and other similar professional organizations. Though the sample is not representative of all Central Sierra business owners/managers, the responses provided valuable insights about what areas businesses find challenging with regards to installing EV charging, and which resources might be useful to helping them overcome those challenges. Question topics included questions about the business location and type, customer characteristics, existing EV charging, customer and employee inquiries, respondent interest in installing EV charging, information that would be useful to informing that process, and any barriers to installation the business might be facing.

A total of 65 complete responses were collected; responses were received from business owners in all four Central Sierra counties. Business types varied, though the most common types were hotels, resorts, and casinos, and other business in tourism and recreation. There were also eight responses from restaurants or wineries. Most respondents reported their primary customers are out-of-towners. Most survey respondents had some level of interest in learning more about installing EV charging stations and expressed a positive perception of EVs or charging stations.

Respondents provided insights on the barriers they faced when researching EV charging as well as the types of useful information when contemplating installing EV charging. Based on this data, a significant gap exists and requires education and outreach efforts on the following topics:

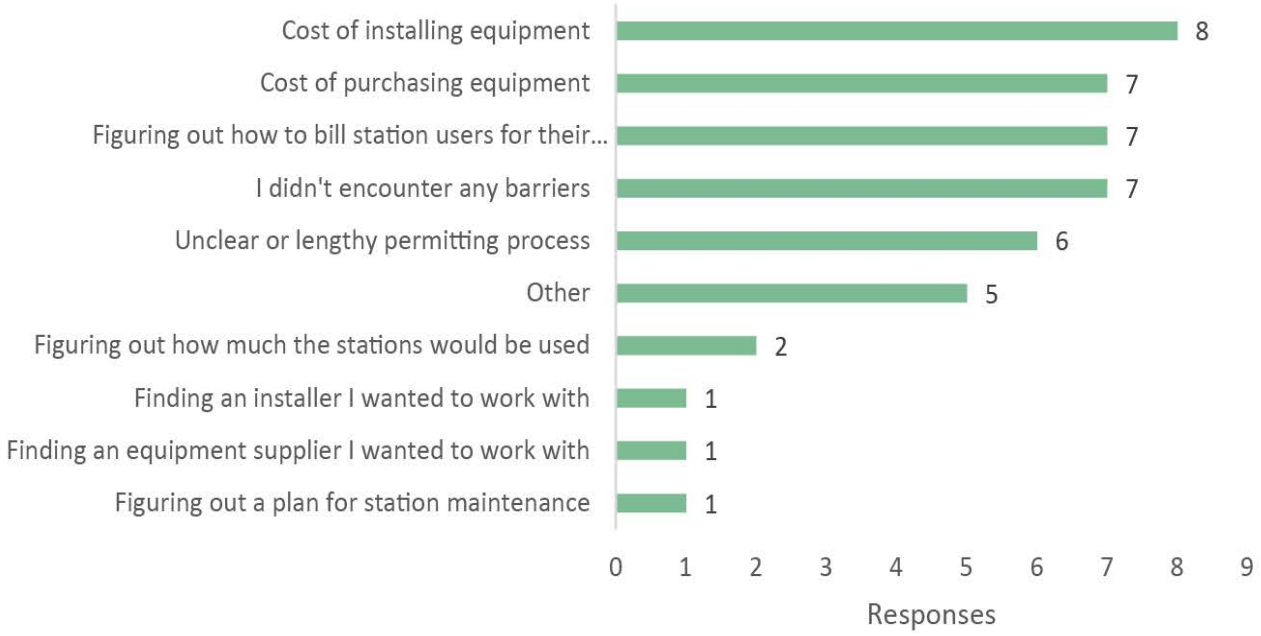
- Installation costs and available incentives
- Electrical panel capacity requirements
- Charging technology options
- List of EV charging infrastructure installers
- Guidance on billing users

How interested are you in learning more about installing EV charging station(s) at your business? (n=60)



Source: Business Survey, Center for Sustainable Energy, 2018

What barriers, if any, did you encounter when researching the idea of installing EV charging stations at your business? Select all that apply. (n=23)



Source: Business Survey, Center for Sustainable Energy, 2018

Business Outreach and Engagement

Given the level of moderate-or-higher interest shown by most (53%) of the respondents to the Local Business Survey, there may be significant interest in learning more about EV charging stations within the Central Sierra business community. One course of action may be to reach out to local Chambers of Commerce and/or business associations to make contact with business owners who may derive particular benefit from installing EV charging stations (ex. hotels and lodging, museums, outdoor recreation facilities).

Toolkits

Best practices for charging station permitting, installation, and maintenance vary between site types. Installing a bank of charging stations at a multi-unit dwelling, for example, should consider the unique charging behaviors: long dwell times that will likely initate charging sessions at roughly the same time. Those considerations don't necessarily apply to workplace or other site types.

To help contextualize the charging process at each of the site types identified in this report, "toolkits" were generated. These are short documents intended to serve as reference guides to the installation process from start to finish, connecting municipalities and site hosts to important resources to streamline the process as much as possible. These toolkits are enclosed as Appendix A.

Sustainable Tourism

As electric vehicles continue to grow in popularity, there has been observable increases in demand and interest in BEVs, PHEVs, and FCEVs. Visitors to the region may have interest in renting and/or carsharing electric vehicles for a wide variety of reasons, ranging from general curiosity to an interest in purchasing an EV and wanting to develop their familiarity with a specific model. Programs such as Orlando's Drive Electric Orlando PHEV/BEV rental program offer external benefits to PEV drivers, including preferred parking at area amusement parks and free charging at several regional hotels. Leveraging electric vehicles within the region would simultaneously provide additional justification for potential site hosts to install EV charging stations and place the Central Sierra region in a prime position to brand itself as a sustainable travel destination.

Training Opportunities

The electric vehicle industry is undergoing a period of rapid growth, expansion, and diversification. There is a distinct demand for professionals in a variety of spaces related to the EV sector, including charging station installers and EV maintenance.

Installation Training

With the growing number of PEVs in the Central Sierra there are increasing opportunities for qualified and properly trained electrical contractors to install EVCS at residential and nonresidential sites. Developing a network of informed contractors could help support increased EVCS deployment in the Central Sierra. Improper installations are often identified as primary sources of delays by permitting officials, so training contractors on proper installation procedures is another strategy supporting streamlined deployment.

Most licensed electricians can do simple EVCS installations, as the circuit is treated the same as any other load such as a dryer or air conditioning systems. EV infrastructure specific trainings have been offered through Joint Apprenticeship and Training Committees (JATCs) and International Brotherhood of Electrical Workers local offices (IBEWs) in Sacramento, Stockton, and Fresno. These trainings, especially the 16 hour Electric Vehicle Infrastructure Training Program (EVITP) have not been well attended to date. Trainings at JATCs are open to all qualified electricians, however few small firms and independent contractors attend these trainings. Because of low attendance rates, these trainings are infrequent and not readily accessible to firms based in the Central Sierra Region.

As part of outreach activities, TCTC/RTPA should promote the availability and benefits of EV infrastructure training programs. Additionally, the Permitting Guidebook should be shared with Cities, EV Infrastructure Installers, and other Regional stakeholders engaged in planning/installation of EV infrastructure as it has information on permitting and inspection best practices for contractors that could facilitate more efficient EVCS installations.

Vehicle Maintenance Training

Electric vehicles have significantly fewer moving parts throughout their drivetrains - lacking pistons and crankshafts, their motors require no oil, and the innate simplicity of electric motors mean there is less to go wrong. However, EVs still require certain familiar components: transmissions, heat exchangers (radiators), tires, and air conditioning. Additionally, the shift to integrating nearly every portion of the car into the electrical system of the vehicle represents a difficulty for drivers who are familiar with troubleshooting internal combustion engine vehicles. As PEV adoption continues to increase, opportunities to repair and maintain the vehicles themselves will become increasingly prevalent.

Columbia College currently offers regular automotive career courses, however, it has not offered any specialized electric vehicle training to date. Reaching out to the school in order to assess interest in offering an EV repair and maintenance course, or an EVI installation course may prove beneficial to improving EV penetration and adoption within the region.

Examining the neighboring regions, a number of partners in the Sacramento area have offered special trainings on EVs and EVI for public fleet staff on a yearly basis. Agencies in the Central Sierra region should send representatives to these trainings.

OBJECTS IN MIRROR ARE CLOSER
THAN THEY APPEAR

APPENDICES

Appendices

Appendix A: Toolkits

Appendix B: Fleet Adoption

Appendix C: ICE Alternative Guidebook

Appendix D: Utility Coordination Guide

Appendix E: Permitting Guide

Appendix F: Outreach Plan

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