CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Central Sierra Zero Emission Vehicle Readiness Plan

Prepared for: California Energy Commission

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Gavin Newsom, Governor

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PREFACE

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

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

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

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued GFO-16-601 to support new and existing planning efforts for zero-emission vehicles (battery-electric vehicles and hydrogen fuel cell electric vehicles and including plug-in hybrid electric vehicles). In response to GFO-16-601, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards March 7, 2017 and the agreement was executed as ARV-16-019 on June 27, 2017.

ABSTRACT

To meet state and regional targets, Tuolumne County Transportation Council's engaged the Center for Sustainable Energy to develop a Central Sierra Zero-Emission Vehicle Readiness Plan for the four-county area: Alpine, Amador, Calaveras, and Tuolumne.

The goal of the Plan is to improve opportunities for zero-emission vehicle readiness in the Central Sierra region and resolve barriers to the widespread deployment of private and public zero-emission vehicle infrastructure. In pursuit of this goal, the following critical project objectives were identified:

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

Keywords: Central Sierra, Zero Emission Vehicle, Readiness Plan, Plug-in Electric Vehicle, Tuolumne, Alpine, Amador, Calaveras, Planning

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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-16-2012 tasked the California Energy Commission and other state agencies to support benchmarks to bring 1.5 million zero-emission vehicles to California's roads by 2025 (and Executive Order B-48-18 later extended the target to 5 million zero-emission vehicles by 2030), and the California Air Resources 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 zero-emission 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 zero-emission vehicles among Central Sierra residents.

The Tuolumne County Transportation Council in collaboration with the Center for Sustainable Energy developed this Zero-Emission Vehicle Readiness Plan with funding from the CEC. The Plan places the Central Sierra 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 zero-emission vehicle conditions, identifies barriers to zero-emission vehicle deployment in rural communities, and 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, Amador, Calaveras, and Tuolumne. The regional population is approximately 139,438 people, 45 percent of whom are close to retirement and live locally year-round. The second largest segment of individuals within the region (10.2 percent) 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 zero-emission vehicle drivers and zero-emission vehicle infrastructure but has not achieved wide adoption. Zero-emission vehicles encompass two types of vehicle technology: hydrogen fuel cell electric vehicles (FCEVs) and battery electric vehicles. FCEVs use the same electric motors as battery electric vehicles but use energy from hydrogen instead of batteries. Additionally, battery electric vehicles and plug-in hybrid electric vehicles are considered plug-in electric vehicles (PEVs) and utilize charging infrastructure. Not all PEVs are zero-emission, since plug-in hybrid electric vehicles can use internal combustion engines in addition to batteries. It is possible for fuel cells instead of internal combustion engines to help power plug-in hybrid electric vehicles, making them zero-emission, but such models are not yet widely available. Both battery electric vehicles and FCEV technologies 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 limited State-funded FCEV infrastructure projects proposed before 2025.

State of California vehicle registration data from 2018 indicates that there are 203 PHEVs and 196 battery electric vehicles stations in the four-county region. Growth projections identify two scenarios for PEV growth: Scenario A and Scenario B. Scenario A, High PEV Projection, anticipates 2,233 PEVs by 2025, representing 0.17 percent of the estimated statewide PEV

fleet. Scenario B, Low PEV Projection, estimates 1,548 PEVs by 2025, representing 0.12 percent of the estimated statewide PEV fleet.

As of early 2020, there are 27 sites that offer electric vehicle 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 are mainly located in small cities in the foothills. This 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, between 230 and 320 EV charging units will be required by 2025. These projections indicate a need for 191 to 249 destination Level 2 charging station plugs and 39 to 71 direct current fast charging plugs to support the expected growth in number of electric vehicles by 2025. This means that the number of destination Level 2 charging plugs will need to increase nearly 5-fold over the next 5 years, and the number of direct current fast charging plugs will need to increase nearly 7-fold over the same time.

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

CHAPTER 1:
Overview

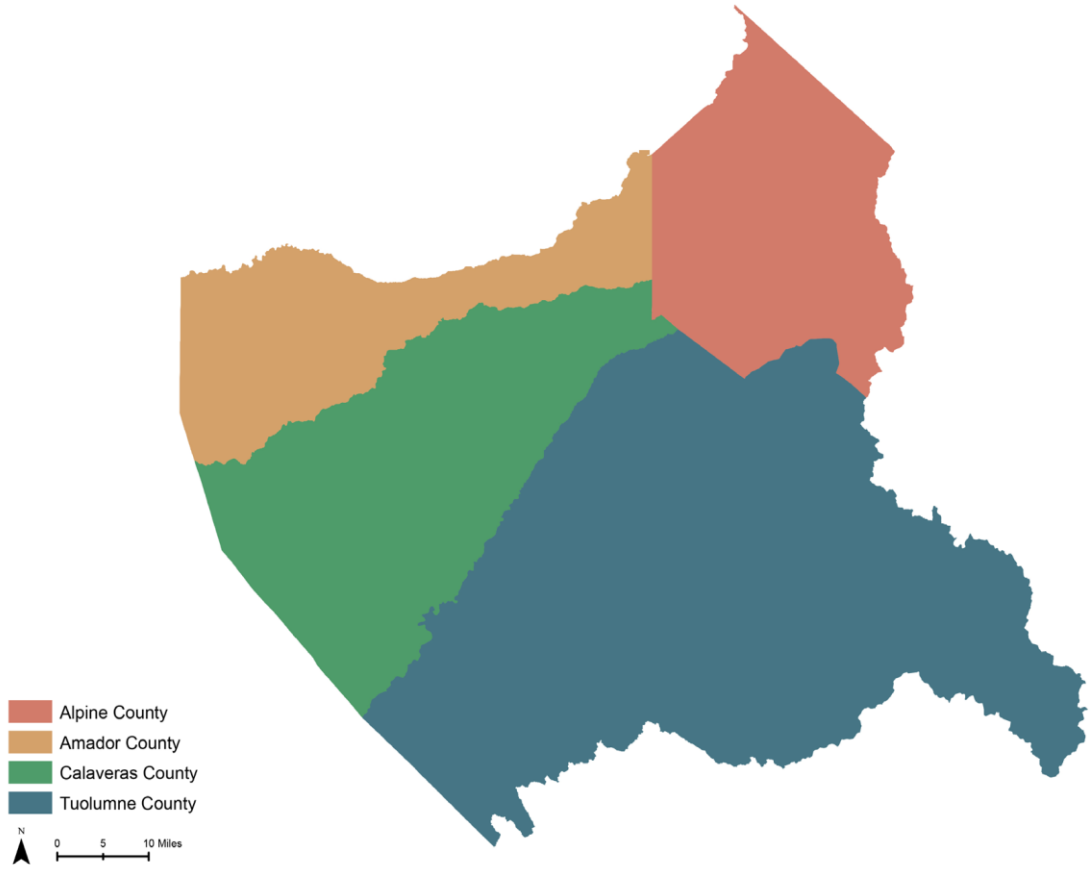
Introduction

The Tuolumne County Transportation Council in collaboration with the Center for Sustainable Energy developed the Central Sierra Zero Emission Vehicle (ZEV) Readiness Plan,[1] which is designed to help accelerate the transition to electric vehicles for the four-county Central Sierra region, and plans for the future deployment of charging stations.

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). 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: Map of Central Sierra Region



[1] The Central Sierra Zero Emission Vehicle (ZEV) Readiness Plan
https://www.tuolumnecountytransportationcouncil.org/centralsierrazevplan

The primary grant project deliverable was a 170-page Central Sierra ZEV Readiness Plan for a four-county area: Alpine County, Amador County, Calaveras County, and Tuolumne County.

Source: Central Sierra ZEV Plan

Unique Barriers to the Region

The Central Sierra region has several barriers to electric vehicle (EV) and EV infrastructure 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, the equipment must be "network-capable," meaning able to communicate with a backend network operations center that collects, stores, and manages data from the EV chargers. To have this capability, EV chargers communicate via Wi-Fi, 3G/4G cellular communication, or through a local area network that utilizes a wide area network. As a result, networked EV chargers must be deployed in areas with adequate cellular network coverage and/or internet cable running to the equipment.

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 is a potential barrier for EV charger connectivity (and potentially wider EV adoption), except along major travel corridors.

The cellular coverage limits the areas where networked chargers can be deployed, especially in remote regions and along certain travel corridors. To accept payments for usage, the chargers must either have a credit card reader connected to Wi-Fi or a cellular network or facilitate payment through an app, which also requires the charger be connected to the internet via Wi-Fi or cellular connection. In remote locations where cable service for internet does not exist, installing charging equipment will require significant confidence in the cellular coverage. As a result, installing networked chargers 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.

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 chargers 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. These are unique challenges to the successful deployment of zero-emission vehicles (ZEVs). Elevation affects zero-emission buses 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. The region's elevation changes from 500 ft. near the valley to almost 13,000 in the mountainous terrain.

Project Milestones

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

1. Create and maintain a regional electric vehicle infrastructure collaborative;
2. Integrate the Central Sierra Zero Emission Readiness Plan into local planning efforts;
3. Utilize and promote funding opportunities;

4. Track Plan progress and report to community;
5. Prioritize investment in direct current fast charging at a 20-mile radius;
6. Develop a regional electric vehicle infrastructure expert & technical advisory program;
7. Plan for zero-emission bus 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)

CHAPTER 2:
Zero Emission Vehicle Technology

Plug-in Electric Vehicle

A PEV is a vehicle in which there is an onboard battery that is recharged by energy delivered from the electricity grid. A PEV is commonly referred to as an electric vehicle. There are two types of PEVs: 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. Hydrogen fuel cells instead of internal combustion engines can help power PHEVs, making them zero-emission, but such models are not yet widely available. Additionally, as technologies develop and components become cheaper and lighter, onboard energy generation equipment like solar panels could be included in a PEV's structure to reduce or eliminate the need to plug in. Such vehicles are not yet proven as an economical alternative and are not widely available.

Electric vehicles come in all shapes and sizes, no longer limited to light-duty passenger vehicles:

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

Battery Electric Vehicles

A 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 battery is charged typically 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, maintenance is typically cheaper and simpler than for internal-combustion engine vehicles; for example, the vehicle will never require an oil change.

Plug-In Hybrid Electric Vehicle

A 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. PHEVs 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. Per above, it is possible for fuel cells instead of internal combustion engines to help power PHEVs, making them zero-emission, but such models are not yet widely available.

Fuel Cell Electric Vehicles

A hydrogen 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 electric motor. Hydrogen is found in organic matter and in water. The majority of hydrogen for transportation is produced by extracting it from natural gas. Hydrogen can also be extracted from water via electrolysis. While this is a more energy-intensive method, the electrolysis of water could be powered by renewable energy.

Fuel cell vehicles are zero-emission vehicles that emit only water vapor and warm air as exhaust. Per above, FCEVs could also have batteries and be PHEVs, but these models are not yet widely available.

This type of vehicle is ideal 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.

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 and other off-road equipment

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 a renewable and clean-burning form of diesel.

Typically, biodiesel can be blended with petroleum diesel. Biodiesel blends range from B2 (2 percent biodiesel, 98 percent petroleum diesel) to B99 (99 percent biodiesel, 1 percent petroleum diesel). B20 (20 percent biodiesel, 80 percent petroleum diesel) is the most common biodiesel blend in the United States. B20 provides similar fuel economy, horsepower, and torque as diesel fuel.

A similar 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 or renewable diesel, 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 including corn, sugar cane, barley, and wheat.

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

Flex-fuel vehicles can use regular gasoline and E85 interchangeably:

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

Compressed Natural Gas

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

Compressed natural gas is a fuel that has been compressed and stored as a gas in high-pressure tanks at 3,600 pounds or more per square inch (psi). Liquified natural gas is a fuel that is cooled to a temperature below -260°F.

Nearly 87 percent of natural gas consumed in the U.S. is domestically produced, and its combustion emits 20-40 percent less carbon monoxide and 80 percent 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 produce 22 percent less greenhouse gas than comparable diesel vehicles and 29 percent less than gasoline vehicles.

Several types of vehicles can use natural gas:

- Vans
- Pick-up trucks
- Refuse haulers
- Low-speed vehicles
- Heavy-duty trucks
- Transit buses
- Other light-, medium-, and heavy-duty vehicles

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 and have fuel systems that run on natural gas and use diesel fuel for ignition assistance.

Propane

Propane is also known as liquefied petroleum gas. 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
- School and transit buses
- Lawn equipment
- Trucks
- Shuttles
- Delivery services

Zero Emission Vehicle 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 visitors as a center for attractions, as well as support the continued adoption of electric vehicles among Central Sierra residents.

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

CHAPTER 3:
Electric Vehicle Service Equipment Installation, Operation, & Maintenance

Permitting

Recognizing the important role of permitting in the deployment of charging infrastructure, in 2015 California legislators passed a law requiring local governments to streamline the permitting process. Assembly Bill 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 (and a year earlier for communities over 200,000 people).

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 single-family residential, multi-family residential, and non-residential charging equipment installations.
- Prepare all guidance, including a permitting and inspection checklist and application materials allowing online submissions to meet local and state requirements.
- 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.

Americans with Disabilities Act/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 accessible 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 Americans with Disabilities Act (ADA)-accessible and therefore significantly wider than a typical parking space, including more space for adjacent access aisles. Property owners may have to sacrifice multiple standard parking spaces to build the first charging space.

When electric vehicle service equipment is installed in public parking garages and lots, it is important to note that under California Building Code Chapter 11B, Divisions 2 and 8:

- Installing EV infrastructure changes the use of the space from parking to charging.
- Depending on the number of EVSE to be installed, a certain number and type of accessible EV spaces are needed for the installation.
- Accessible spaces need to be on an accessible path of travel to the main entrance of the facility the EV infrastructure serves.

Americans with Disabilities Act 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. 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 and cannot operate vehicles.

CHAPTER 4:
Charging Behavior

Local Level – Consumer Behavior

The low market share of ZEVs for national, statewide, and four-county region (1.13 percent, 4.61 percent, and 0.20 percent, respectively) reflects a number of potential factors that may hinder adoption[2]. An August 2019 survey of more than 1,500 American new-car shoppers noted that common reasons not to buy an electrified vehicle revolved primarily around three facets: range anxiety, upfront cost, and a perceived lack of accessible chargers[3]. Despite these barriers, plug-in vehicle adoption is accelerating, with new PEV registrations in California showing a steady year-over-year increase between 2012 and 2018[4]. Determining the unique reasons for EV adoption within the Central Sierra region can help tailor outreach and planning efforts to best appeal to residents.

Based on 2018 EV vehicle registration data from the California Department of Motor Vehicles, 164,978 total vehicles were registered in the four-county region, with 399 (0.2 percent) of those being PEV vehicles.

In general, consumers who first adopt a new technology tend to make their decision based on specific values or decision factors that they feel outweigh the potential risks and/or perceived barriers.

Central Sierra region's survey data indicated that environmental factors were the primary motivation at a higher rate than the statewide average. The percentage of respondents who noted a desire to support the diffusion of EV technology was also higher than for the rest of the state, as were those who noted they had reasons for acquiring an EV that were not expressed as choices in the survey. Examples of these responses include "utilizing our PV system" and "decreased maintenance".

Conclusions

There are two major shifts at the market level which impact EV infrastructure planning in the Central Sierra region:

1. Market Condition: Driver behavior is moving away from range anxiety (capacity limitation) as vehicles on the market have longer ranges. It is being replaced by charge anxiety (infrastructure limitations).

Impact to Central Sierra Region: Unpredictable station availability, operation status, pricing, and network capability are concerns to all travelers. However, these factors may be particular worries for visitors. Destination-focused EV infrastructure planning may need to specifically

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[2] ATV Sales Dashboard, 2018 https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/

[3] Autolist, 2019 https://www.autolist.com/

[4] The California New Car Dealers Association, 2018 https://www.cncda.org/

consider visitor travel needs. Visitors typically drive longer distances to reach the area and rely solely on public/destination charging infrastructure (as opposed to home/workplace infrastructures). To better serve the visitor demographic, significant investment in direct current (DC) fast charger infrastructure along major corridors and short-dwell destinations is warranted. Having networked stations with reasonable pricing structures (less or consistent with gasoline prices), fees to discourage drivers from being plugged in after a full charge has been reached, and siting multiple stations at each EV infrastructure location are strategies that align with current consumer needs.

2. Market Condition: "Top off" charging at distributed stations is standard practice for drivers who fully replenish their batteries at home and/or workplace.

Impact to Central Sierra Region: "Top off" charging is likely to occur more frequently with residents than visitors. 94 percent of current EV drivers have detached single-family homes and 48 percent of respondents are either not working or work from home, suggesting a high level of access to at-home charging. If residents have access to both home-based charging and a DC fast charger network along major corridors and destinations, publicly funded infrastructure should prioritize Level 2 investment at publicly accessible destinations to cost-effectively add infrastructure. In addition to planning around market trends, current EV demographic data and business survey results provide useful insight that Central Sierra region planners and businesses should consider, including:

- Messaging to potential EV drivers should focus on fuel cost savings (based on EV survey responses and the data point that a majority of household incomes are below $100k) and potential to reduce environmental impacts, supported abundant natural resources to enjoy and protect as the major driver for local economy.
- Current businesses that have EV charging infrastructure have primarily installed it to serve customers. Level 2 chargers make up 23 percent of the infrastructure and are meant for customers that intend to visit longer than 2 hours. DC fast chargers make up 11 percent and are meant for customers that intend to visit less than 1 hour.

4 out of 13 respondents indicated that existing charging equipment is never used or only used a few times a month. To increase station utilization, public agencies, businesses, business groups (e.g. chambers of commerce) should work together to promote awareness of existing infrastructure availability.

CHAPTER 5:
Gaps Analysis

Electric Vehicle Infrastructure Growth Projections

EV infrastructure projections help transportation planners anticipate future EV charging demand and deploy adequate infrastructure. The CEC and National Renewable Energy Laboratory developed the electric vehicle infrastructure projection tool[5] to quantify the types of PEV charging infrastructure required to meet PEV drivers' needs. In 2017, the CEC and National Renewable Energy Laboratory used the tool to project infrastructure needs to meet California's 1.5 million ZEV goal by 2025[6]. To generate projections, the 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 model also generates low and high estimates.

For Alpine County's workplace level 2 charging, there would be 0 chargers in the low, medium, and high scenarios. For public level 2 charging, there are 3 chargers in the low scenario, 5 in the medium, and 6 in the high scenarios. For public DC fast chargers, there are 2 in the low, 3 in the medium, and 4 in the high scenario.

For Amador County in the low scenario, there are 20 workplace level 2 charging, 25 in the medium, and 30 in the high scenario. For public DC fast chargers, there are 25 in the low scenario, 31 in the medium, and 38 in the high scenario.

For Calaveras County, there are 21 Level 2 workplace chargers in the low scenario, 23 in the average scenario, and 25 in the high scenario. For public DC fast chargers, there are 24 DC fast chargers in the low scenario, 26 DC fast chargers in the average scenario, and 28 DC fast chargers in the high scenario.

For Tuolumne County's workplace level 2 chargers, there are 32 in the low scenario, 34 in the average scenario, and 35 in the high scenario. For public level 2, there are 61 in the low scenario, 74 in the average scenario, and 86 in the high scenario. For Public DC fast chargers, there are 14 in the low scenario, 20 in the average scenario, and 25 in the high scenario.

The modeling results show that residents with EVs will have a higher utilization rate than visiting EV drivers, with the largest disparity in the public Level 2 charging across all scenarios. Public Level 2 charging also has higher utilization than workplace Level 2 and public DC fast chargers charging. Alpine County projections remain the most static of all County projections, whereas Calaveras and Tuolumne have the most potential for large projects to install charging ports and appear to have the most need for electrical infrastructure based on projected demand. Alpine County could possibly benefit by utilizing existing infrastructure based on

[5] CEC EV Infrastructure Projection Tool (EVI-Pro) https://maps.nrel.gov/cec/?aL=0&bL=cdark&cE=0&lR=0&mC=35.06597313798418%2C-103.68896484375&zL=5

[6] California PEV Infrastructure Projections 2017-2025 https://efiling.energy.ca.gov/getdocument.aspx?tn=224521

lower projections county-wide. The regional electric vehicle infrastructure projection tool analysis estimates between 230 and 320 total charging ports are needed by 2025.

Visitor Plug-in Electric Vehicle & Electric Vehicle Infrastructure Projections

Although the Central Sierra region has a relatively low population in comparison to other parts of California, significant visitors are attracted to numerous regional destinations. The electric vehicle infrastructure projection tool projections paint a partial picture but do not account for EV infrastructure demand generated by this visitor travel. The California Statewide Regional Travel Model[7] estimates that 23,299 daily trips originated outside and ended within Central Sierra in 2010; that count is projected to increase by 89 percent to 44,068 daily trips in 2040 according to 2014 figures. Projections indicate that the number of visitors is expected to increase 46 percent through 2040. In the meantime, PEV (i.e. PHEV and BEV) populations are expected to increase approximately 3.2 percent.

The demand in 2025 for EV infrastructure for visitors was calculated for the average planning scenario (electric vehicle infrastructure projection tool "Average" forecast) only because it is the most reasonable target for planning. The calculation assumes that workplace Level 2 ports are not available to visitors and that the ratio of Public Level 2 and Public DC fast charging plugs needed to meet visitor and resident demand are the same. On average, the number of EV drivers visiting each County in 2025 is expected to be: 27 in Alpine County, 647 in Amador, 801 in Calaveras, and 758 in Tuolumne. Assuming these average daily EV visitor counts, the demand for each County was calculated by:

- 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 percent).
- Based on existing driver-to-charger ratios for residents (# drivers divided by # of projected plugs), determining the number of Level 2 (86) and DC fast charger (24) ports required to meet expected additional demand from visitor PEVs.

Distributing ports across all 4 counties based on existing proportions of Level 2 and DC fast charger plugs.

[7] The California Statewide Regional Travel Model https://dot.ca.gov/programs/transportation-planning/multi-modal-system-planning/statewide-modeling

CHAPTER 6: Recommendations

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

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

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

Yosemite Area Regional Transportation System Stops & State Park Entrances

Opportunities for charging infrastructure also exist along Yosemite Area Regional Transportation System stops and at State Park entrances. Visitors utilize the system to visit Yosemite and surrounding destinations and provide opportunities for EV infrastructure at park and ride locations.

Regional Destination Siting

The readiness plan recommends that charging be included in commercial and residential planning efforts through parking lots, garages, and on-street parking. As a regional tourist destination that attracts PEV drivers from across the state, 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 for further analysis:

- Alpine: Markleeville
- Amador: Amador City, Ione, Jackson, Plymouth, Sutter Creek
- Calaveras: Murphys, San Andreas, Angels Camp, Valley Springs
- Tuolumne: Big Oak Flat, Columbia, East Sonora, Groveland, Jamestown, Mi-Wuk Village, Moccasin, Sonora, Strawberry/Pinecrest, Tuolumne City

These areas are significant for implementing EV infrastructure because of one or more of the following factors: size, regional historic district, proximity to major travel corridors, Main Street designation, and parking infrastructure.

Destination charging is also a revenue-generating opportunity for site hosts, a good branding opportunity, and beneficial to the environment.

Revenue Generation and Cost Saving:

- Revenue can be collected from charging activity and potentially through generating Low Carbon Fuel Standard credits.
- Charging equipment can persuade customers to visit regularly.

- PEV fleets can save money by charging on-site rather than at other locations.

Good Branding Opportunity:

- Hosting a charging station symbolizes and 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.

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. The readiness plan identifies the closest location for EV infrastructure at these recommended points.

Tourism can be an opportunity for destination charging using DC fast chargers, especially if existing infrastructure allows. If no infrastructure is available, DC fast charger implementation costs can become prohibitive without proper funding incentives. There could also be a market for lower-level charging at temporary lodging locations such as hotels. For other temporary locations such as rest stops and airport waiting areas, this could be ideal for low-level ZEV heavy-duty truck charging in the future, but more research will be needed to understand this feasibility for future applications. If other regional jurisdictions decide to explore state park and public area charging for on-demand public pickup services using medium-duty ZEVs, these duty cycles will need to be explored with other agencies as well.

CHAPTER 7: Implementation

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.

Create and Maintain a Regional Electric Vehicle Infrastructure 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 EV infrastructure adoption and deployment. The regional transportation planning agency should create a regional EV infrastructure collaborative to facilitate deployment and encourage inter- and intra-County engagement.

Integrate Plan into Local Planning

Regional local governments, employers, community-based organizations 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 EV infrastructure deployment.

Utilize and Promote Funding Opportunities (Grants, Incentives, and Low Carbon Fuel Standard)

The cost to deploy EV infrastructure 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

The regional transportation planning agency members should utilize the ZEV Plan website to function as a repository for all plan and outreach resources, future EV infrastructure resources, and to track regional progress on EV infrastructure deployment activities and progress towards the 2025 goals.

Prioritize Investments in Direct Current Fast Chargers in a 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 DC fast charging is a recommended pathway for improving PEV utility and accelerating market adoption. DC fast chargers sited on major travel corridors facilitate inter-county travel and extend the range of intra-county drivers, which increases annual EV miles driven. Utilizing a

20-mile charging radius, an additional 22+ DC fast chargers are recommended to provide adequate range coverage to facilitate all inter/intra-county travel by EVs.

Regional Electric Vehicle Infrastructure Expert & Technical Advisory Program

To help decision-makers with EV infrastructure deployment, regional partners should create an EV infrastructure expert and 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 homeowner associations) through outreach, education and workshops; services would be provided at no cost to the recipient. San Diego Association of Governments created a similar grant program as part of PEV readiness plan[8] implementation and to date has conducted over 150 unique consultations providing guidance for EV infrastructure installations.

Small Transit Agency Zero Emission Bus Planning

Small transit agencies must develop a rollout plan to transition to 100 percent zero-emission bus fleets by 2040. Small transit agencies must have the rollout plan submitted to the California Air Resources Board in 2023.

Engage the Business Community

Based on results of the business survey, regional businesses have interest in siting EV infrastructure. Many businesses in the region rely on tourism and business travelers so planning for increased EV adoption in adjacent regions is warranted.

Prioritize Investing in Public and Destination Level 2 Electric Vehicle Infrastructure

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.

Destinations (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 EV infrastructure as an added amenity and to support evolving driver/customer needs.

[8] The San Diego Regional Plug-In Electric Vehicle (PEV) Readiness Plan
https://www.sandag.org/uploads/publicationid/publicationid_1817_17061.pdf

GLOSSARY

AMERICANS WITH DISABILITIES ACT (ADA)—One of the most significant federal laws governing discrimination against persons with disabilities, passed in 1990. Prohibits discrimination against individuals with disabilities in employment, housing, education, and access to public services. The ADA defines a disability as any of the following: 1. "a physical or mental impairment that substantially limits one or more of the major life activities of the individual." 2. "a record of such impairment." or 3. "being regarded as having such an impairment."

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

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

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

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

ELECTRIC VEHICLE (EV)—A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

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

FUEL CELL ELECTRIC VEHICLE (FCEV) - A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle. FCEVs use the same electric motors as plug-in electric vehicles (defined below). Additionally, a hydrogen fuel cell instead of an internal combustion engine can power a plug-in hybrid electric vehicle (PHEV, defined below) but fuel cell PHEV models are not yet widely available.

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

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

conventional hybrid). Additionally, a hydrogen fuel cell instead of an internal combustion engine can power a PHEV, but fuel cell PHEV models are not yet widely available.

ZERO-EMISSION VEHICLE (ZEV)—Vehicles that produce no emissions from the on-board source of power (e.g., an electric vehicle)