Sacramento Metro AQMD
2019

ZEV Readiness in the Sacramento Region

Contents

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Produced with a grant from the California Energy Commission CEC-ARV-16-023

Overview

The Sacramento Metropolitan Air Quality Management District proposed to develop a regional plan that promotes zero emission vehicle (ZEV) deployment, specifically fuel cell electric vehicles and hydrogen refueling stations, as well as plug-in vehicles and direct current fast charging. The regional plan identifies infrastructure, policies, incentives, and processes to encourage high-mileage drivers to replace conventional vehicles with ZEVs. The plan initially focuses on the greater Sacramento metropolitan region, which includes the cities of Sacramento, West Sacramento, Davis, Elk Grove, and Roseville, and the unincorporated areas of Sacramento, Placer and Yolo counties. In consultation with stakeholders and assessment of data, the final plan also includes Sutter County, most of El Dorado County (excluding the Lake Tahoe area), and the eastern part of Solano County.

This project targeted high-mileage drivers throughout the Sacramento area; people who drive 2-to-3 times the number of miles as the average driver. Well-planned and well-placed infrastructure may encourage these drivers to replace gasoline or diesel cars, trucks, and buses with zero-emission fuel call and battery electric vehicles.

According to the U.S. EPA, a typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year. This assumes the average gasoline vehicle on the road today has a fuel economy of about 22.0 miles per gallon and drives around 11,500 miles per year. Every gallon of gasoline burned creates about 8,887 grams of CO_2.

This project used location analysis and regional planning data to target potential station locations that could serve several types of drivers and sizes of vehicles to serve the highest number of ZEVs with the lowest investment in infrastructure.

Increasing ZEVs in the near-term (within two years) requires thoughtful infrastructure planning, including funding sources, and outreach and education that involves local government, utilities, businesses, and non-profits. The team worked with an diverse group of utilities, governments, and industry to establish common messaging and goals about ZEVs.

To support the mid-term (2-5 years) ZEV deployments, the project team worked with local jurisdictions to build capacity so they can more quickly plan, permit, build, and commission hydrogen stations and DC fast charging. The team identified partnerships for successful grant applications, provided resources for codes and standards information, and identified collaborations for workforce development and job training initiatives.

The project team incorporated new clean-vehicle regulations for trucks and buses that were proposed by the Air Resources Board and considered the charging/refueling needs of fuel cell and battery trucks and buses that will be deployed in Sacramento in the next two to five years. Heavy-duty vehicles typically do not use the same stations as passenger cars use because trucks and buses need a longer time to refill and more space to maneuver.

The plan identifies optimal locations for hydrogen stations and direct current (DC) fast charging plazas that can encourage individuals and companies operate vehicles 100 miles or more every day to consider a ZEV.

Cities in the Sacramento region have been on the forefront of zero-emission technology. Adoption of zero emission vehicles (ZEVs)—hydrogen fuel cell and battery electric—has large been among people who have shorter commutes. Focusing on people who drive more than the often-cited 40 miles a day can have greater impact on greenhouse gas reductions from transportation. This project optimal locations for hydrogen stations and direct current (DC) fast charging that will encourage individuals and companies operate vehicles 100 miles or more every day to consider a ZEV.

According to the U.S. EPA's Household Carbon Footprint Calculator[1] an average car (gasoline car with fuel economy of 24.7 mpg) emits 8,784 pounds of CO2 annually when driving 30 miles a day, seven days a week. If that same car drives 560 miles a week (five days of 100-mile commute), it emits 23,424 pounds of CO_2 annually. Encouraging one high-mileage driver to switch to a ZEV has the same GHG reduction as three average drivers. These drivers need to be assured that they can quickly, reliably, and conveniently fuel their ZEVs without altering their driving patterns.

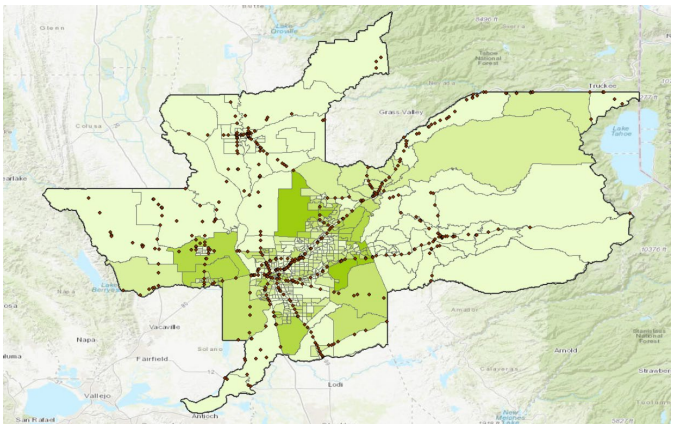
High-mileage drivers fall into three main categories:

- "Super-commuter" – People who commute at least 50 miles or 90 minutes one way between home and work census blocks.
- "Service worker" – People who drive a vehicle as all or part of their work.
- "Livery driver" – People who drive vehicles to transport paying customers.

Buses are a fourth type of high-mileage vehicle and can include fixed-route transit, commuter coaches, vanpools, and private shuttles.

Using a combination of data sources, the team identified 42 locations in six counties that are potential sites for DC fast charging plazas and/or hydrogen stations that can support at least two types of drivers. Locations are based on land use, traffic patterns, fueling patterns, and expected growth of ZEVs between 2020 and 2030 in the Sacramento region (Figure 1).

Figure 1: The Sacramento Region



[1] https://www.epa.gov/ghgemissions/household-carbon-footprint-calculator

The 30-mile Myth

When battery (BEV) and fuel cell (FCEV) electric vehicles entered the retail market between 2011 and 2015, the vehicles had less range that gasoline cars. Early advocates pointed to data from the National Household Travel Survey and AAA that found the average person drives less than 30 miles a day.[2] Although the range has significantly improved with many car models—up to 350 miles for FCEVs and 250 miles for BEVs—zero-emission vehicle (ZEV) advocates continue to address range anxiety by citing that the average American drives about 30 miles a day.

Why is this a myth? First no person considers themselves as "average." Most people think about the days that they do drive more—errands at lunch, carpools for after-school activities, evening socializing, and weekend excursions. People buy cars for the exceptional days, not the average day.

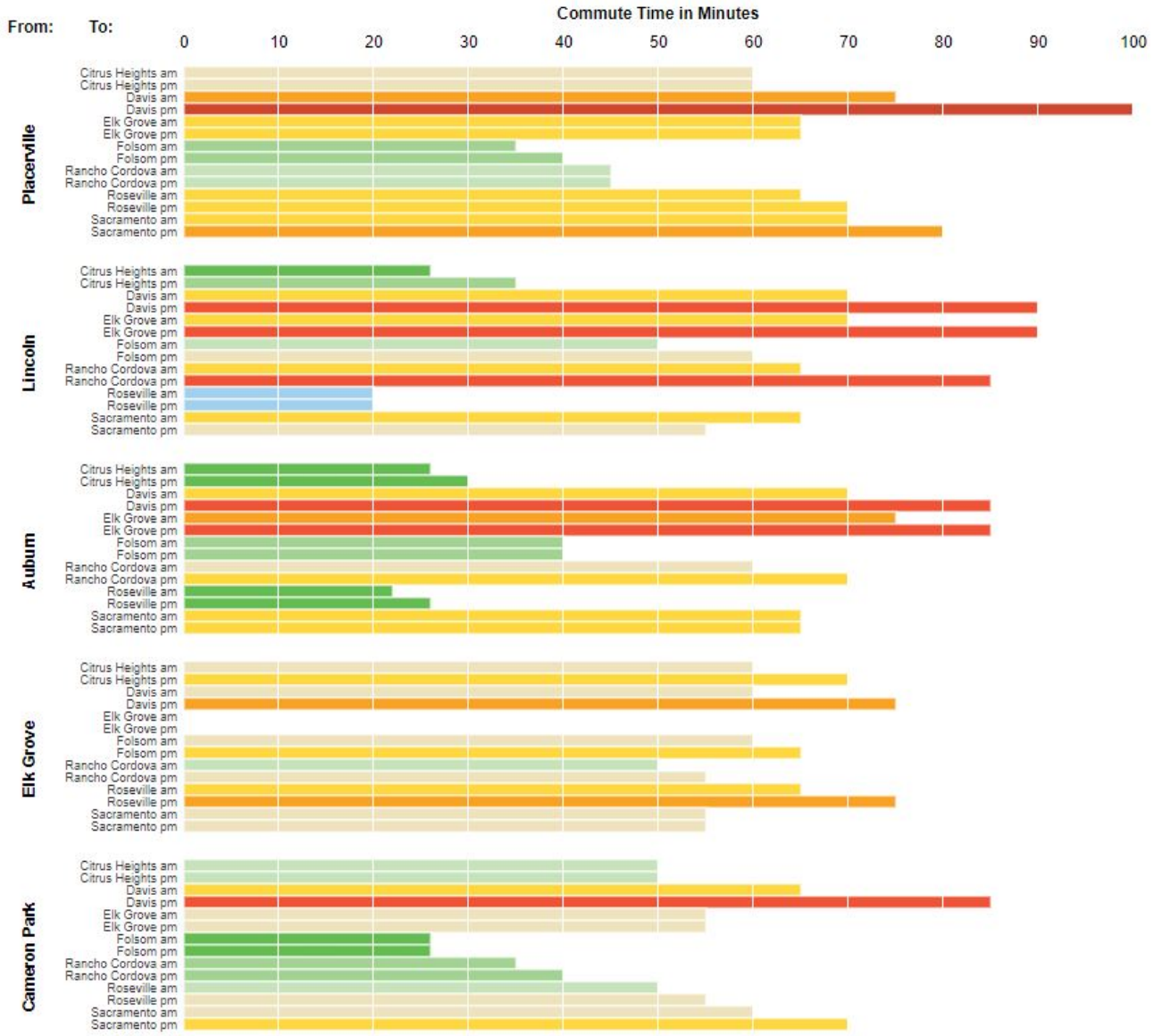
Second, distance has little to do with time on the road. An annual study[3] that uses Google data shows ranks Sacramento in about the middle of the best and worst cities for commute but drilling down that data shows that people that commute from outside Sacramento can spend more than an hour on the road as shown in Figure 2. An August 2019 *Sacramento Bee* article by Phillip Reese showed that 20 percent of Sacramento's state workers commute at least 45 minutes each way to work.[4]

According to the U.S. EPA's Household Carbon Footprint Calculator[5] an average car (gasoline car with fuel economy of 24.7 mpg) emits 8,784 pounds of CO2 annually when driving 30 miles a day, seven days a week. If that same car drives 560 miles a week (five days of 100-mile commute), it emits 23,424 pounds of CO2 annually.

Encouraging one high-mileage driver to switch to a ZEV has the same GHG reduction as three average drivers. These drivers need to be assured that they can quickly, reliably, and conveniently fuel their ZEVs without altering their driving patterns.

[2] https://nhts.ornl.gov/ and https://newsroom.aaa.com/wp-content/uploads/2015/04/FACT_SHEET_American_Driving_Survey_Methodology_and_year_1_results_May_2013_to_May_2014.pdf
[3] https://wallethub.com/edu/best-worst-cities-to-drive-in/13964/
[4] Article is available only with a Sacramento Bee subscription. @TheStateWorker summarized the data on Twitter. https://twitter.com/thestateworker?lang=en
[5] https://www.epa.gov/ghgemissions/household-carbon-footprint-calculator

Figure 2: Commute Time in Minutes (Partial List)



Opening the Nesting Dolls

The Sacramento PEV Collaborative, a monthly meeting of public agencies, non-profits, academia, and business, and the Transit Coordinating Council organized by the Sacramento Area Council of Governments (SACOG) were starting points for vetting ideas and identifying data sources. During the project, Sacramento Metro Air Quality Management District (SMAQMD) organized meetings with all the area utilities and all the area air districts. The project team also met separately with infrastructure developers (hydrogen and charging), local governments in each county, and conducted interviews with Uber and Lyft.

Discussions with these groups led to a series of questions that needed to be answered, very similar to opening a nesting doll only to find another one inside:

- Groups had various definitions of "Sacramento region." With input from all stakeholders, agreement was to focus on Sacramento, Yolo, Placer, and Sutter counties, El Dorado County minus Lake Tahoe, and Solano County from Vacaville east. (Figure 1) This encompasses most of the 100-to-150-miles-a-day travel in the area.
- Groups defined zero emissions vehicles differently. ARB defines zero emission vehicles as BEVs, FCEVs, and plug-in hybrids with 20 miles or more of electric range, and light-, medium-, and heavy-duty vehicles. However, different stakeholders excluded one or more categories of vehicle from incentives, grants, and their own proposals for funding. If all air districts, SACOG, and cities use a consistent definition in regulations, funding, and incentives, it will be clear which vehicles and intfrastructure are included or excluded from which programs.
- Groups used several different sources of information to estimate the numbers of ZEVs and infrastructure. One result from PEV Collaborative meetings during this project was a public release of registration data from the California Department of Motors Vehicles.[6] Although the data isn't current or detailed, it was enough to create a common starting point for vehicle projections.
- Groups did not coordinate charging infrastructure placement. Public charging was planned for locations that were at times across the street from each other because one was within city limits and the other in the county.
- Groups had different viewpoints about workforce development. Many were focused on including ZEV repair into existing auto mechanic programs at community colleges. Interviews with people for this project and others indicated that the biggest workforce development needs are for electricians, data scientists, and multi-lingual customer service representatives.

Common Messaging

This exercise uncovered two opportunities for messaging that SMAQMD can lead within the region:

1. Creating a common understanding of station use. The project team recommended that stakeholders evaluate hydrogen and DCFC stations in terms of availability to provide fuel when the driver needs it rather than how often a station is used. For example, a charging station might be used twice during the business day, however it is unavailable to other drivers. If a driver cannot fill or charge because a station is in use, offline, or out of order that station is unavailable. Measuring how often drivers are without fuel is a better gauge of future need than measuring how many cars use a station.
2. Creating a common messaging that addresses time anxiety instead of range anxiety. An ICCT report[7] about DCFC in the U.S. and other countries indicated that drivers value the time saved by fast charging over the added cost. This is a key finding for messaging, particularly for work-related driving. Messages about ZEVs must resonate with people for whom time is absolutely money.

[6] https://www.dmv.ca.gov/portal/dmv/detail/pubs/media_center/statistics
[7] https://www.theicct.org/sites/default/files/publications/ZEV_fast_charging_white_paper_final.pdf

Local practices for ZEV infrastructure

Most local governments had permitted Level 2 charging, but few had experience with DC fast charging or hydrogen stations. All were aware that the California State Building Codes[8] require support for battery electric vehicle charging and none of the jurisdictions in the Sacramento region applied for local ordinances that are more stringent than the State standards in 2016. At least two cities, Sacramento and Davis, are considering more stringent ordinances for the new code cycle.

In addition to building codes, jurisdictions have city codes that define parameters for land use. Codes include zoning, design, utilities, civil rights, and a host of other topics. Of the cities in the Sacramento region, only Davis has adopted city codes that specify design and dwell time in public EV parking spaces.

Many participants believed that local government, utilities, and air districts are responsible for charging infrastructure, but not hydrogen stations. One example is that a city waived its requirement for curb improvement when a DCFC was added to a shopping center but required extensive curb and property improvements when a hydrogen dispenser was added to a gas station.

Cities can use codes for the following purposes related to ZEV infrastructure:

- Remove references to fueling stations as storing liquid fuel below ground
- Clarify if EV charging or hydrogen fueling are considered an “automotive related use”
- Allow or disallow charging in the right of way (curbside)
- Establish streamlined permitting for ZEV infrastructure (already required for home EVSE)
- Determine hardship exemptions to the CALGreen EVSE requirements
- Identify ZEV infrastructure in Transportation Management Plans
- Clarify if the jurisdiction will allow public DCFC plazas and hydrogen stations to meet the “spirit of intent to provide charging” (a provision the CALGreen allows)
- Incorporate DCFCs and hydrogen stations into design standards

The following two pages are a checklist and a list of resources provided to the jurisdictions that participated in this project.

[8] https://codes.iccsafe.org/content/chapter/15761/, effective date is January 1, 2020

CITY CHECKLIST FOR ZEV INFRASTRUCTURE	
Jurisdiction website has online resources for installing electric vehicle charging stations and hydrogen stations	
Jurisdiction has formally adopted an expedited, streamlined permitting process for electric vehicle charging stations. In developing an expedited permitting process	
Jurisdiction has a publicly available checklist of EVSE requirements to be eligible for expedited review. Applications that satisfy the checklist requirements are deemed complete.	
Jurisdiction has established a process to prioritize competing applications for expedited permits, including sending correction notices detailing all deficiencies in incomplete applications.	
The checklist and permitting documents are on a public website.	
The checklist and permitting documents are available at the plan desk.	
The jurisdiction has a defined fee structure for EVSE and hydrogen stations	
The jurisdiction does not require traffic studies for DC fast charging plazas or hydrogen stations that are added to existing service stations.	
Local law is limited to those standards and regulations necessary to ensure that the EVSE or hydrogen station will not have a specific, adverse impact upon the public health or safety.	
The city waives or minimizes impact fees, landscaping fees, and curb improvements.	
The city has direct contacts with the utility's EV program.	
The city has or is formulating a ZEV readiness plan, adoption plan, or strategy that city council has adopted. The plan is inclusive of plug-in and fuel cell vehicles, and includes light-, medium-, and heavy-duty vehicles.	
The city has or is formulating a climate action plan that includes transportation and the plan is general enough to include all ZEV options.	
Community Development and Public Works staff are aware of and connected with funding sources from the state, air district, and utility.	
Jurisdiction is coordinating with County Weights & Measures about upcoming regulations for the sale of electricity as fuel.	
Jurisdiction's codes include provisions for charging cars in parking lots and in the right of way, including design standards.	
Jurisdiction is aware of and can enforce ADA design standards for charging stations and hydrogen stations.	
Jurisdiction's general and specific plans exempt ZEV infrastructure from restrictions on vehicle-related businesses.	

Resources and Best Practices

2019 California Green Building Standards Code, Title 24, Part 1
https://codes.iccsafe.org/content/chapter/15761/

Electric Vehicle Charging Station Permitting Guidebook
http://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf

Electric Vehicle Charging Station Permit Scorecard
http://www.business.ca.gov/Portals/0/Files/Permitting%20Electric%20Vehicle%20Charging%20Stations%20Scorecard_Updated_7.9.19.pdf

Hydrogen Station Permitting Guidebook
http://www.businessportal.ca.gov/wp-content/Documents/ZEV/Hydrogen-Permitting-Guidebook.pdf

EV Charging Station ADA Accessibility Overview
http://www.bcag.org/documents/PEV%20Readiness%20Plan/Appendices/Appendix%20F.%20Accessible%20PEV%20Charging%20Stations.pdf

City of Sacramento EV Blueprint
http://www.cityofsacramento.org/Public-Works/Electric-Vehicle-Initiatives/EV-Strategy

Hydrogen Station Map
www.cafcp.org/stationmap

Charging Station Map
www.plugshare.com

EMERGING BEST PRACTICES FOR ELECTRIC VEHICLE CHARGING INFRASTRUCTURE
https://theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf

Defining High-Mileage Drivers

In 2013, the U.S. Census Bureau dubbed people who travel 50 miles or 90 minutes one way between work and home as "super commuters."[9] According to census data than 188,000 people commute 50 miles or more between a job in the Sacramento region and their home census district.[10]

"Service workers" is a designation this project used to identify people that use a vehicle during the work day and includes delivery trucks, tradespeople, personal service providers (e.g., home health care, real estate agents), and sales people. Vehicles might be owned by a company—like a fleet of Amazon delivery vans—or by an individual, like a social worker's car. A combination of census data and labor statistics indicates about 290,000 jobs in industries that use vehicles for work, although not every job equals a vehicle. Sacramento Clean Cities estimated about 44,000 medium- and heavy-duty vehicles in use by local companies and municipal fleets. Service workers typically drive 100 or more miles a day 10-to-15 miles at a time.

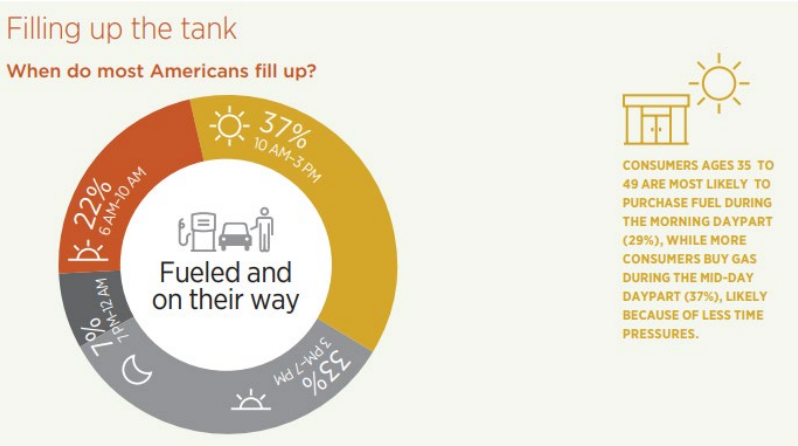
"Livery driver" is a Bureau of Labor designation for a person who drives a taxi, ride-share vehicle, or limousine. Livery drivers typically drive 100 or more miles a day 5-to-10 miles at a time in a personal vehicle or a car/SUV that a company owns. On-demand transit vehicles, like those operated by Via in West Sacramento and Sacramento RT's SmaRTride service, may also fall into this category. Because gig-economy (TNC) drivers don't necessarily list their occupation as livery driver and TNC operators neither pay payroll taxes for drivers nor are not required to have a license or permit, it's difficult to know how many people are driving for a living.

Buses are a fourth type of high-mileage vehicle and can include fixed-route transit, commuter coaches, vanpools, and private shuttles like those operated by area casinos. All operate more than 100 miles a day, but their duty cycles are very different.

Fueling Patterns of High-Mileage Drivers

In 2010-2012, California Fuel Cell Partnership (CaFCP) members researched people's driving and fueling habits to understand where to locate the first hydrogen stations. Research from CaFCP and the National Association of Convenience Stores (NACS) shows that commuters fuel at one of three places: near home, near work, and near an entertainment center (e.g., the gym, shopping center, restaurant.) People fuel nearly equally throughout the day, as shown in Figure 3.

Figure 3: Times of day that Americans fill their cars with conventional fuels[11]



[9] https://money.cnn.com/2013/03/05/news/economy/megacommutes/
[10] Based on 2017 Origin-Destination data from the U.S. Census Bureau. https://lehd.ces.census.gov/data/
[11] https://www.convenience.org/Topics/Fuels/Documents/How-Consumers-React-to-Gas-Prices.pdf

Potential differences with ZEV fuels

Super commuters:

- Hydrogen—same as gasoline model, but limited number of stations will require people to drive slightly out of the way.
- DCFC—20-to-40 minutes to charge makes it more likely for commuters to charge at lunch or on their way home from work. DCFC plazas need to be located where people can be productive. Drivers are unlikely to drive from place to place if the charger is occupied.

Service vehicles: Independent workers that drive light-duty vehicles (e.g., home healthcare workers, personal trainers, real estate agents) buy gasoline similarly to commuters. Company drivers have two different models: some fuel vehicles during the workday and others rely on support staff to fuel vehicles at private or public stations. Large trucks and buses fill a truck-only stations that have higher canopies, more room for maneuvering, and are designed for 15-minute fueling time.

Fueling is "on-the-clock" time. Wage and hour laws do not address time spent charging a car as work or non-work time,[12] but the meal break regulation[13] states that an employee cannot work during the break. Based results of recent class action suits, it's likely that the State of California would deem charging a vehicle as work time even if the vehicle was charged while the driver ate lunch.

- Hydrogen—Trucks use a different fueling protocol that passenger vehicles use. Ideally, at least one station will have a fueling island specific to trucks. It is unlikely that a fleet operator would have a private hydrogen station and, therefore, time spent driving to a from a station needs to be calculated in operational costs.
- DCFC—Charges must be strategically located; drivers cannot wait in line or drive from location to location. Because charging is likely to be considered work hours, delivery vehicles and local trucks that need midday charging will likely need to return to base or charge at a load/unload zone.

Livery drivers: TNCs (Uber, Lyft, etc.), taxis, and hired cars look for stations at the gateways to Sacramento's core. They report most trips originate in downtown and midtown Sacramento, and stations that are easily accessible along the major highways are preferable. In interviews for other ZEV projects, drivers stressed that time was most important; every minute not driving is a minute not making money.

- Hydrogen—same as gasoline model. Stations must be strategically located so that drivers do not lose time driving out of their way.
- DCFC—Charges must be strategically located; drivers cannot wait in line or drive from location to location. Ideally, DCFCs can be located at car washes, near mobility hubs, and at top destinations (e.g., Cal Expo, Raley Field, Old Sacramento, UC Davis).

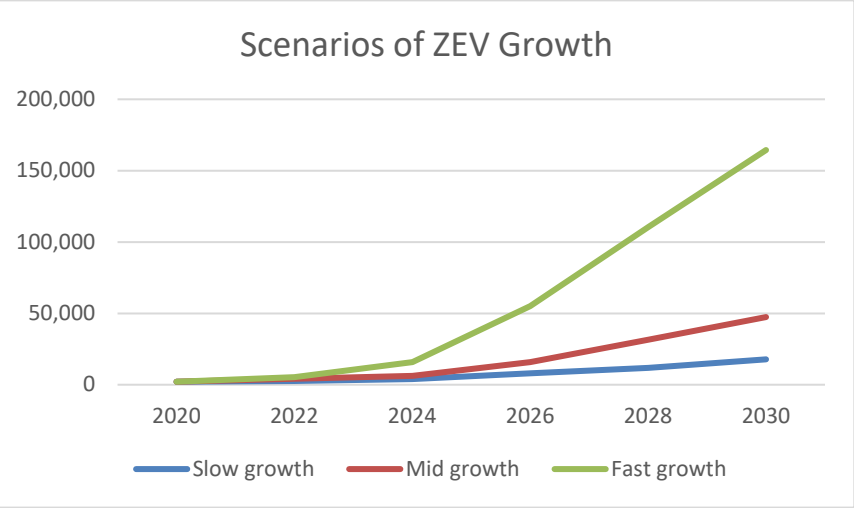
Types of vehicles and stations

Fuel cell and battery electric cars are currently available in the Sacramento region, and more makes and models are introduced every year. In 2019 the first ZEV SUVs were introduced, and pick-up trucks are expected by 2021. Two area transit agencies—Sacramento Regional Transit and Yolo County Transit Authority—will jointly operate 12 battery-electric buses in 2020 as a shuttle between Davis and Sacramento. Pilot projects with ZEV delivery vans and trucks are also planned for 2020.

[12] https://www.dol.gov/whd/FOH/FOH_Ch31.pdf
[13] https://www.dol.gov/whd/state/meal.htm

By looking at current ZEV registrations; projected growth of households, new car sales, and ZEV sales; and regulatory requirements for trucks and buses, the number of ZEVs in the Sacramento region by 2030 could from a conservative 58,230 to an aggressive 365,279. Figure 4 illustrates the growth curve for all three scenarios.

Figure 4: Results of ZEV growth scenarios



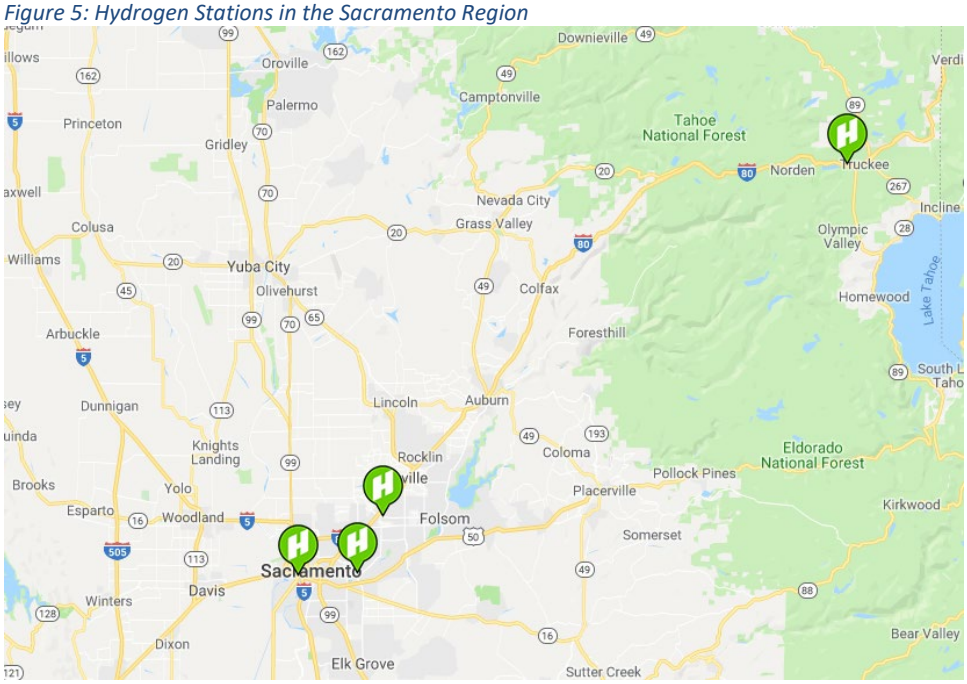
From the forecast, it appears that ZEV registrations climb from thousand to tens of thousands between 2024 and 2026. Infrastructure needs to be placed to encourage adoption before 2024 and then support a growing number of vehicles through the end of the 2030.

Hydrogen Stations

With significant funding from the California Energy Commission, 100 hydrogen stations are planned statewide. Hydrogen is a regulated motor fuel in the State of California and the codes and standards for design, safety, measurement, and payment like those of conventional fuels. Hydrogen storage and dispensing equipment is added to existing fuel stations and can fill hundreds of cars daily. As of September 2019, the Sacramento region currently had four hydrogen stations as shown in the California Fuel Cell Partnership's station map[14] in Figure 5.

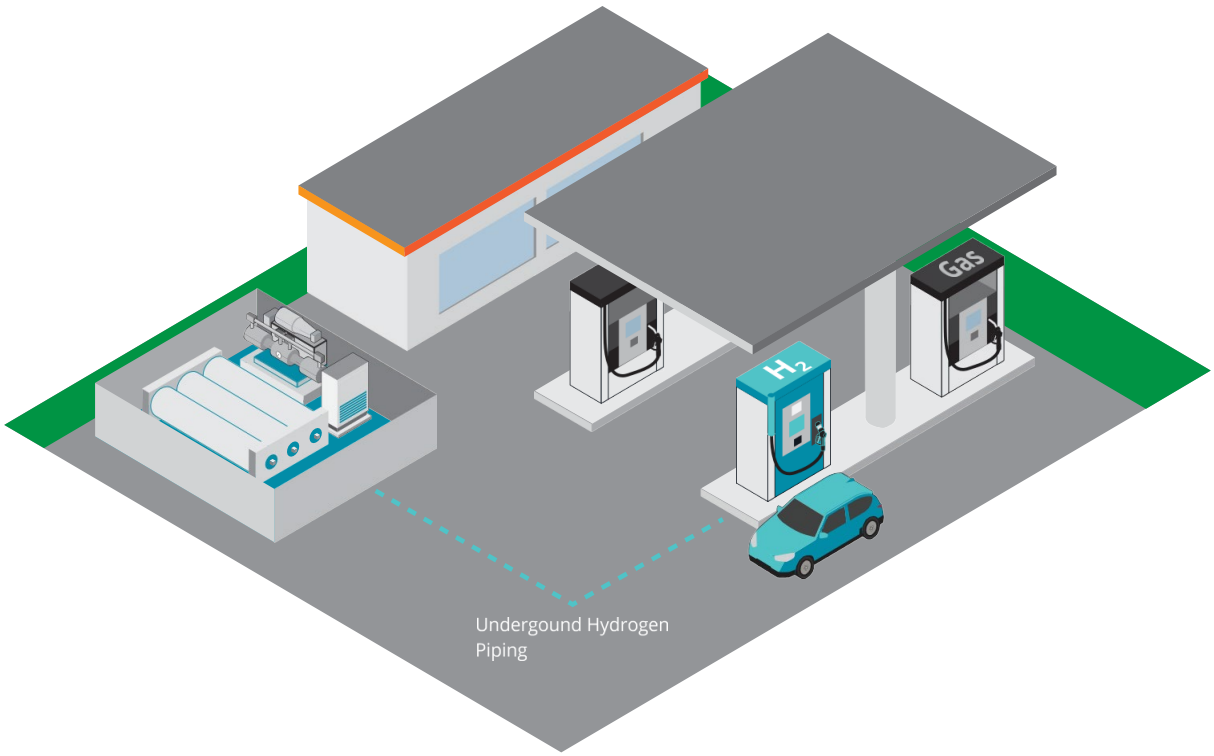
[14] Cafcp.org/stationmap

Figure 5: Hydrogen Stations in the Sacramento Region



To support high-mileage drivers, the region needs about 15 hydrogen stations with multiple fueling positions. Some stations may need a separate dispenser or island for trucks and buses. Figure 6 is an illustration of a generic hydrogen station.

Figure 6: Illustration of a Hydrogen Station



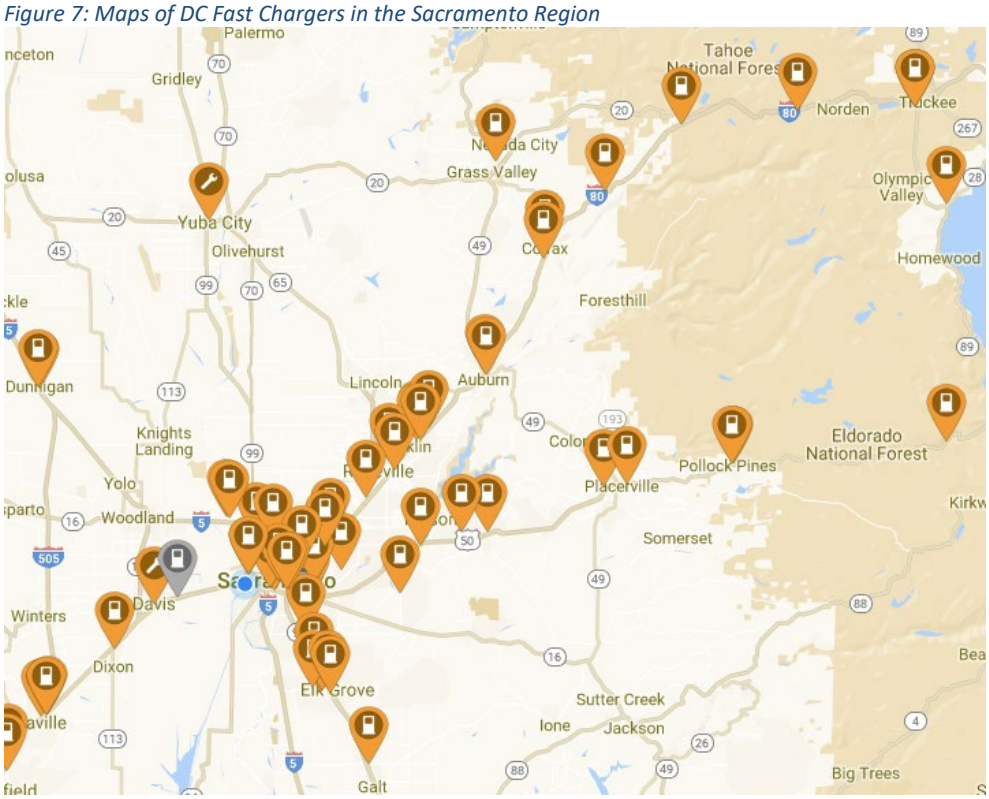
The business model for hydrogen stations is like that of conventional fuels. Station operators buy fuel from a distributor and sell fuel for a profit. They may also sell ancillary products. Gasoline and diesel can be differentiated by additives (e.g., detergents, octane enhancers); hydrogen cannot have additives. Currently, hydrogen is not cost-competitive with gasoline, although economies of scale can achieve cost-parity. Grant funding and Low Carbon Fuel Standard credits are essential to reducing operating expenses and customers' fuel cost.[15]

DC Fast Charging

The Sacramento region has about 50 DC fast chargers open and under constriction as shown in the map from PlugShare[16] in Figure 7. This map does not include the Tesla-only stations. Electricity as a fuel is in the rulemaking process and is expected to be regulated in 2021. Regulations will require consistency in payment and measurement, and potentially could trigger design changes to meet requirements of other fuels (e.g., an ingress and egress).

Most existing locations have one connector, and many are co-located with Level 2 charging. Funding from the California Energy Commission, California Air Resources Board, utilities, air districts, Sacramento Area Council of Governments, and federal subsidies and tax credits have funded the early infrastructure. Most DCFC are at shopping centers; a few are car dealerships and hotels. Sacramento has one curbside DCFC and two DCFCs are at the Sacramento International Airport.

Figure 7: Maps of DC Fast Chargers in the Sacramento Region

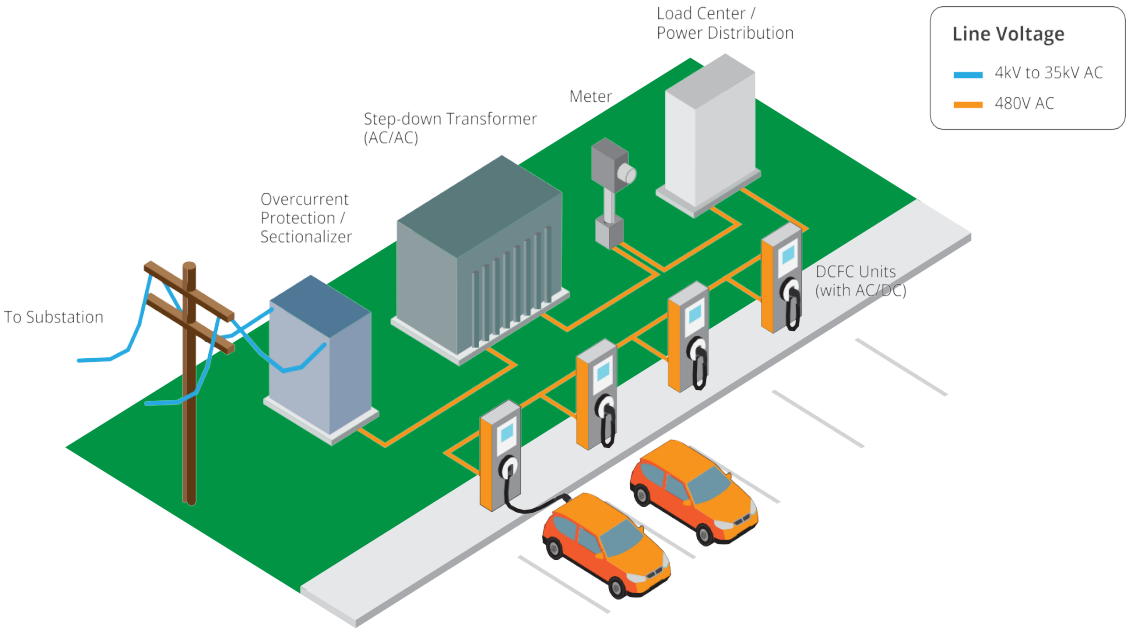


[15] California Fuel Cell Partnership projections

[16] www.plugshare.com

To support high-mileage drivers, the region needs about 320 DCFC plazas with an average of four connectors each to support multiple charging positions during peak hours. Some stations may need a separate trucks/buses quick charging position, potentially with overhead charging. Figure 8 is an illustration of a generic DCFC plaza in a parking lot configuration.

Figure 8: Illustration of a DCFC Plaza



The business model for DCFC is unknown. Analysis by Idaho National Labs (INL)[17] determined that direct revenue from charging is insufficient to achieve profitability. An urban community DCFC plaza that meets the INL study's minimum requirement would require customers to pay $0.69 per kilowatt-hour (equivalent to $5.91 per gallon of gasoline) to break even. Utilities are working with station developers on strategies to reduce electricity demand charges and Low Carbon Fuel Standard credits can reduce operating expenses.[18]

[17] https://avt.inl.gov/sites/default/files/pdf/reports/DCFCChargingComplexSystemDesign.pdf
[18] https://ww3.arb.ca.gov/fuels/lcfs/lcfs_meetings/080818presentation.pdf

Locations for ZEV Infrastructure

Infrastructure must provide coverage and capacity for daily use in work and leisure travel.[19,20] This particularly applies to FCEV and BEV users that travel more than 50 miles a day and have limited time for fueling stops. Government, utilities, and industry all grapple with determining how many stations are needed and where to put them. Existing research is based on early models of vehicles that had more-limited range and early adopters who were willing to be inconvenienced for the sake of progress.

The team reviewed existing plans and projections:

1. PG&E's micro-siting tool[21] developed with a CEC EPIC grant to identity locations in the PG&E service territory in which PG&E expects unmet need for fast charging locations by 2025. This project used PG&E's scoring spreadsheet as a model for evaluating potential ZEV infrastructure locations on a pass/fail basis, and then a one-through-five rating system for meeting driver needs.
2. SMUD reports about fast-charging the indicated need for DCFCs every three miles along the major freeways. Each location would have one DCFC connector.[22]
3. Idaho National Labs study completed in 2017 accounted for people traveling 100-to-150 miles a day. It served as a base for identifying behavior patterns of DCFC users and initial design of a DCFC plaza.
4. Information from the Sacramento Clean Cities Coalition to help understand the number of fleet and heavy-duty vehicles in the Sacramento region, and identify electrification plans and strategies.
5. The City of Sacramento's EV Blueprint that included an EVSE Infrastructure Tool that uses a scoring model to identify census tracks for Level 2 charging based on user-selected criteria. The City used the tool to identify City-owned facilities that could best provide public charging to renters in low-income and disadvantaged communities.
6. Multiple studies and forecasts by the Sacramento Area Council of Government that models travel demand, land use, and regional growth.

Using this information, the team concluded that to meet the needs of the three types of high-mileage drivers, including trucks, ZEV infrastructure needs to have capacity before coverage—fill more vehicles at each station rather than build more stations that serve few vehicles. It is highly likely that multiple drivers will fuel/charge at the same time in the middle of the day and on the commute home.

- Place DCFC plazas and hydrogen stations within ½ mile of major freeways and arterials to support local and distance travel.
- Position ZEV stations to serve at least two types of drivers to increase the base load to off-set high capital and operational costs.
- Identify locations that can also serve transit vehicles, including buses and private shuttles, so that operators and agencies can share the cost of infrastructure instead of each build their own.

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[19] "Charging ahead: Electric-vehicle infrastructure demand" McKinsey, 2018: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/charging-ahead-electric-vehicle-infrastructure-demand

[20] "A California Road Map - Bringing Hydrogen Fuel Cell Electric Vehicles to the Golden State" (2012): https://cafcp.org/sites/default/files/20120814_Roadmapv%28Overview%29.pdf

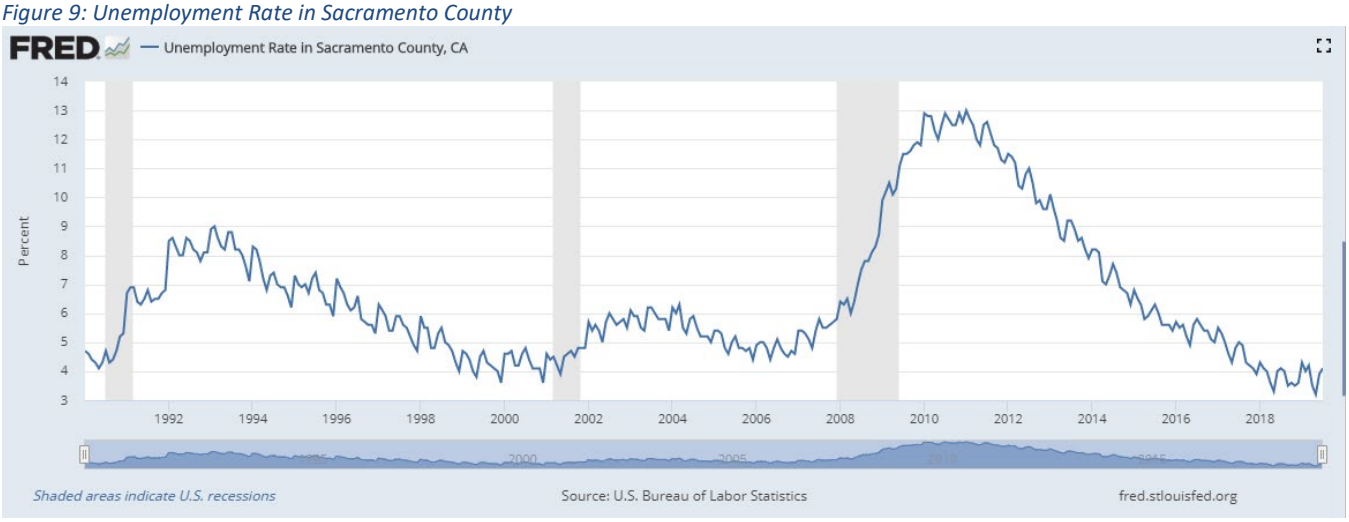
[21] https://www.pge.com/en_US/about-pge/environment/what-we-are-doing/electric-program-investment-charge/direct-current-electric-vehicle-fast-chargers.page

22 New information has changed SMUD's outlook and the report is no longer available. It was referenced in comments to the CEC docket. https://efiling.energy.ca.gov/GetDocument.aspx?tn=223687&DocumentContentId=53841

How People Drive

To effectively place stations, the team needed a sense of traffic movement throughout the region and identified data sources that included traffic counts, land use and planning, and economic data. At the beginning of the project, the team noticed that most of the available data was from 2012 and did not paint a realistic picture. Figure 9 is a Federal Reserve Economic Data chart that shows the annual unemployment rate in Sacramento County. Within unemployment teetering around 12 percent in 2012, fewer people were driving to work or for work than in 2017. The team also noted that traffic demand models were based on housing and commercial developments planned before the recession but were not built.

Figure 9: Unemployment Rate in Sacramento County



In October 2017, data for 2015 and 2016 was available from the U.S. Census department and U.S. Bureau of Labor Statistics[23], at which point the Sacramento Area Council of Governments updated its Travel Demand Model (TDM) and land use and planning tools. Sacramento County and parts of other counties published updated traffic surveys, and cities and counties revised their general plans. Date from a recovered economy was vital in predicting ZEV deployment strategies. Appendix A is a list of data sources used to model travel behavior.

Data was added to ArcGIS, a geographical information system, to paint a picture of the region and target areas that met criteria:

- Commercial and/or industrial zoning
- High-traffic routes and intersections
- Census tracts with larger numbers of jobs
- Locations of known fleet yards, including transit agencies
- Places without existing ZEV infrastructure

The resulting map showed about 100 intersections, highway ramps, park-and-ride lots, and business centers. The team used SACOG data about the 2020 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS)[24] and Green Region Plan[25] to eliminate locations outside the regional growth blueprint. The team also consulted with regional air districts, utilities, and other stakeholders about future development of master-planned communities and mobility hubs, and areas that would need substantial investment in basic infrastructure including electricity, communication lines, drainage, and street improvements.

[23] From the American Community Survey released in October 2017
[24] https://www.sacog.org/2020-metropolitan-transportation-plansustainable-communities-strategy-update
[25] https://www.sacog.org/sites/main/files/file-attachments/green_region_plan_0.pdf

With 53 locations remaining on the map, the team used parcel data, Google Earth, and personal visits to identify pieces of property that had the potential to host a ZEV fuel station, and then evaluated each parcel's suitability with the scoring sheet in Table 1. If a location did not meet the Pass/Fail criteria, it was removed from further scoring.

Table 2 is the list of 42 potential locations for ZEV fuel stations with scores for each driver type and fuel type. Some locations have multiple developed and undeveloped parcels that could potentially host a ZEV fuel station; other locations have a single parcel that is appropriate.

The locations were programmed into a map-based website that includes all information from the scoring spreadsheet and enables users to view the locations by type of fuel and type of driver. The map from the website zevreadiness.frontierenergy.com is pictured in Figure 10.

Table 1: ZEV Station Scoring Criteria

Criteria	Description	Scoring format	SCORE				
			1	2	3	4	5
PASS/FAIL CRITERIA **Census tracts with 1, 2, or No in any row are removed from consideration**							
Traffic count	Proximity to high-traffic areas	1 - 5	1 - No high traffic streets	2 - More than 1/2 mile away from high-traffic streets	3 - Within 1/2 mile of two high-traffic streets	4 - On one high-traffic street and within 1/2 mile of a second high-traffic street	5 - At the intersection of two or more high-traffic streets
Driver types	Meets the driving patterns of driver types: super commuter, livery driver, service worker	1 - 5	1 - Mostly local traffic	2 - Not near an exit ramp or intersection	3 - Less than 1 mile from exit ramp, intersection, or business district	4 -Less than 1/2 mile from exit ramp, intersection, or business district	5 - At exit ramp, intersection, or business district
Space	Has or can have space for equipment	Y/N	Y = Appears to have space to add equipment to existing location or space to build a new station				
Zoning	Zoned correctly	Y/N	Y = Commercial or industrial zoning				
CENSUS TRACT CRITERIA							
Disadvantaged community	Meets California definition	Y/N	Y = Ranks 80% percentile or greater on CalEnviroScreen				
Future location	Designated for new development	Y/N	Y = Vacant land with commercial/industrial zoning and within regional blueprint				
Transit	Potential to provide fuel to buses	Y/N	Y = Near a public or private transit yard				

	Service workers	Number of service industry jobs in tract	1 - 5	1 - less than 100	2 - 101-400	3 -401-700	4 -701-1000	5 -More than 1001
	Super commuters	Number of people who commute at least 50 miles from tract to home census tract	1 - 5	1 - less than 50	2 -51 to 100	3 -101 to 500	4 -501 to 1000	5 -More than 1001
	Livery use	Potential to provide fuel to taxis, TNCs, shuttles, rental cars	1 - 5	1 -Rural location	2 - Not on typical livery route	3 - Along route to destinations	4 - Near a dispatch or home base	5 - On a main route for cars, vanpools, and shuttles
DCFC PLAZA SITING CRITERIA								
	Amenities	Food and shopping are close by	1 – 5	1 – Not available at potential site, nor within a 2-minute walk via safe path	2 – Available at potential site, or within a 2-minute walk via safe path during business hours	3 – Available at potential site, or within a 2-minute walk via safe path, at least 12 hours/day, 7 days/week	4 – Available at potential site, or within a 2-minute walk via safe path, at least 16 hours/day, 7 days/week	5- Available at potential site, or within a 2-minute walk via safe path, 24 hours/day, 7 days/week
	Activities	Medium dwell-time activities are close by (health club, medical office, grocery store, recreation)	1 – 5	1 – Not available at site, nor within a 2-minute walk via safe path	2 – Available at site, or within a 2-minute safe walk during business hours	3 – Available at site, or within a 2-minute safe walk at least 12 hours/day, 7 days/week	4 – Available at site, or within a 2-minute safe walk at least 16 hours/day, 7 days/week	5- Available at site, or within a 2-minute safe walk, 24 hours/day, 7 days/week
	Availability	24/7 access	Y/N	Y = Always open, does not have a gate or require a key; well-lit and visible at night				
	Business use	Workers may be productive while charging	Y/N	Y = Near a business center, car wash, or fleet yard				

	Truck/Bus Access	Easy to get in and out of location	1 – 5	1- Private road	2 – Access street prohibits commercial vehicles	3 – Access for cars and package vans	4 – Access for box trucks	5 – Access for heavy-duty trucks and buses
H2 SITING CRITERIA								
	Amenities	Convenience store services are available	1 - 5	1 - Not available at potential site	2 - Restrooms only	3 - Convenience store on site	4 - Store on site and other retail/food within driving distance	5 - Store on site and other retail/food within walking distance
	Availability	24/7 access	Y/N	Y = Always open, does not have a gate or require a key; well-lit and visible at night				
	Business use	Can accept fleet fueling	Y/N	Y = At or near existing cardlock station and/or fleet yard				
	Truck/Bus Access	Easy to get in and out of location	1 - 5	1- Private road	2 - Access street prohibits commercial vehicles	3 - Access for cars and package vans	4 - Access for box trucks	5 - Access for heavy-duty trucks and buses

Table 2: List of Potential ZEV Station Locations

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
50	ED	Pollock Pines, Hwy 50	5	5	1	5	3	Yes	No	Commercial Zone in the County of El Dorado on the East/Northeast commuter route. Existing locations that may host a hydrogen station and/or DCFC plaza. Limited services and retail while charging. A current fueling location for shuttle buses and delivery vehicles. Could be a key location for public and private transit.
49	ED	Diamond Springs, Missouri Flat Rd @ Hwy 49	5	3	1	2	2		No	Commercial, Industrial, and Residential Zone in the County of El Dorado. Primary destination for super commuters traveling to El Dorado County and near Highway 50 and 49. Properties could be developed to host a hydrogen station and/or DC fast charging plaza. About 1,000 industrial- and service-related jobs in nearby census tracts and adjacent to multifamily housing.
50	ED	Camino, Carson Rd	5	3	3	5	3		No	Commercia Zone in the County of El Dorado on the East/West commute route. One existing location that may host a hydrogen station and/or DC fast charging plaza. Current station provides fuel to cars, trucks, and buses. Location is a gateway to Apple Hill and could serve tourists and tour operators. Very limited services and no retail.
50	ED	El Dorado Hills, White Rock Road @ Latrobe	5	3	5	1	3	Yes	No	One of two options being considered for an integrated mobility hub, which could include a ZEV fuel station to support buses and commuter vehicles.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
50	ED	El Dorado Hills. White Rock Road @ Clarksville Crossing	5	3	5	1	3	Yes	No	One of two options being considered for an integrated mobility hub, which could include a ZEV fuel station to support buses and commuter vehicles.
49	PLA	Auburn, Grass Valley Hwy	3	3	1	1	4		No	Commercial Zone in the City of Auburn on the East/Northeast commuter route. Existing locations that may host a DCFC plaza. 1,300 industry- and service-related jobs within nearby census tracts that could provide a base load for light- and heavy-duty vehicles.
65	PLA	Rocklin, Cincinnati Ave	3	5	3	5	1		No	Industrial Zone in the City of Rocklin with many transportation and warehousing businesses. Existing locations that may host a hydrogen station with room for truck and bus fueling. On the route to Thunder Valley Casino and several commercials recreation businesses. Could service livery drivers. No services or retail.
80	PLA	Roseville, Vineyard @ Foothills Blvd	5	5	3	5	2		No	Commercial Zone in the City of Roseville on a surface-street commute route. Existing location that may host a hydrogen station and/or DCFC charging plaza with room for delivery vehicles. About 3,000 industry- and service-related jobs in nearby census tracts. Near taxi/airport shuttle dispatching office. Few services and retail within walking distance.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
80	PLA	Penryn, Boyinton Rd	5	3	1	5	4	Yes	No	Commercial Zone in the County of Placer on a primary commuter route. Existing location directly adjacent to a park and ride lot that can host a hydrogen station and/or DCFC plaza. Undeveloped land in the immediately area. The current location provides conventional fuel for shuttle buses. Limited services and retail, but a fitness club is within walking distance.
80	PLA	Newcastle, Chantry Hill Rd	5	5	1	5	4	Yes	No	Commercial Zone in the County of Placer on a primary commuter route. Existing location mat host a hydrogen station and/or DCFC plaza. Adjacent to a park and ride lot and CHP base. Undeveloped land in the immediately area. The current location provides conventional fuel for shuttle buses. Could serve fleet vehicles and delivery between Sacramento and Reno. Limited services and retail.
65	PLA	Roseville, Blue Oaks Blvd @ Foothills Blvd	5	3	3	5	5		No	Commercial Zone in the City of Roseville on a surface-street commute route. Existing location that may host a hydrogen station and/or DCFC charging plaza with room for delivery vehicles. About 3,000 industry- and service-related jobs in nearby census tracts. Existing truck fueling station near a distribution center could support trucks and buses. DCFC at an existing car wash could support taxies and TNC drivers. Several fitness clubs within walking distance.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
65	PLA	Lincoln, Industrial & Highway 65	3	3	1	5	5	Yes	No	Undeveloped land in the County of Placer that has a park and ride lot. Directly on the route to Beale AFB, PG&E, and Toyota Amphitheater, and may support the commute between Roseville and Yuba City, and on to Chico. Recommend a local traffic study to assess potential usage.
NA	PLA	Placer Vineyards						Yes	No	Placer Vineyard Specific Plan
5	SAC	Elk Grove, Elk Grove Blvd @ I-5	5	1	1	5	5	Yes	No	Highway Commercial Zone on the South/Southeast commuter route. Several existing and undeveloped locations that may host hydrogen and/or DCFC plazas. Land on east side of I5 is within the County of Sacramento; west side is within the City of Elk Grove.
5	SAC	Elk Grove, Laguna Blvd @ I-5	5	1	1	5	5	Yes	No	Highway Commercial Zone on a South/Southeast commuter route. Several existing and undeveloped locations that may host hydrogen and/or DCFC plazas. Land on east side of I5 is within the County of Sacramento; west side is within the City of Elk Grove.
5	SAC	Sacramento, Delta Shores @ Cosumnes River Blvd	5	3	1	5	5	Yes	No	Commercial Zone near a South/Southeast commuter route. Area is under development and could provide a base load of service or fleet vehicles by 2025-2030. Some land in the City of Sacramento, some in the County of Sacramento.
99	SAC	Sacramento, Florin Road @ Hwy 99	5	5	1	5	5	No	Yes	Commercial Zone on a South/Southeast commuter route. Existing locations that may host hydrogen and/or DCFC plazas. 2,740 service-related jobs within nearby census tracts that could provide a base load for work vehicles.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
50	SAC	Folsom, Iron Point Rd	3	5	3	5	1		No	Commercial Zone in the City of Folsom on the East/Northeast commuter route. Existing locations that may host a hydrogen station. Largely offices and very limited services or retail. 13,000 industry- and service-related jobs within nearby census tracts that could provide a base load for light- and heavy-duty vehicles. Potential to serve livery vehicles, including vanpools.
5 and 80	SAC	Sacramento, Arena Blvd. @ I-5	3	1	5	5	5		No	Commercial Zone on multiple commute routes. Existing locations that may host a hydrogen station and/or DCFC charging plaza, and undeveloped land. About 9,000 industry- and service-related jobs in nearby census tracts. Could serve as a location for livery drivers serving the Sacramento airport. Surface roads can be congested, which impacts ease of getting off and on the freeway. Most land in the City of Sacramento; some in the County.
80	SAC	Antelope, Watt Ave	3	3	1	5	4	Yes	No	Commercial Zone in Sacramento County on a surface-street commute route. Existing locations and underdeveloped land that may host a hydrogen station and/or DCFC charging plaza with room for delivery vehicles. This area is likely to grow as development in Rio Linda, Elverta, and Roseville continues.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
99	SAC	Galt, Simmerhorn Rd	3	3	1	5	1		No	Industrial zone in the County of Sacramento on the North/South commute corridor. Existing commercial fueling facility may host a hydrogen station that could serve fleets and trucks as well as commuters. Less than 900 industry- and service-related jobs. Could serve delivery vehicles between Sacramento and Stockton. No services or retail within walking distance.
99	SAC	Galt, Twin Cities Rd @ Hwy 99	5	1	1	3	5	Yes	No	Highway Commercial Zone in the County of Sacramento on the North/South commute corridor. Existing locations may host a hydrogen station and/or DCFC plaza, and undeveloped land for future stations. Many existing services and retail within walking distance. Congested on ramp/off ramp makes location more challenging for fleets and delivery vehicles.
NA	SAC	Sacramento, Fruitridge Rd	1	5	3	5	3		Yes	Industrial Zone in the County of Sacramento; not on a commute route. Existing locations and underdeveloped land that may host a hydrogen station or DCFC plaza. Current station provides fuel for cars and trucks. About 16,000 industry- and service-related jobs in the nearby census tracts. Many warehouses, delivery services, and charter transportation services. No services or retail within walking distance.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
NA	SAC	Sacramento, Alpine Ave	1	5	1	5	1		Yes	Industrial Zone in the County of Sacramento; not on a commute route. Existing locations and underdeveloped land that may host a hydrogen station or DCFC plaza. Current station is a commercial-only station. Nearly 6,000 industry- and service-related jobs in the nearby census tracts. Many warehouses and delivery services. No services or retail within walking distance.
NA	SAC	North Highlands, Roseville Rd	1	5	1	5	1		Yes	Industrial Zone in the County of Sacramento; not on a commute route. Existing locations and underdeveloped land that may host a hydrogen station or DCFC plaza. Current station is a commercial-only station. Nearly 6,000 industry- and service-related jobs in the nearby census tracts. Many warehouses and delivery services. No services or retail within walking distance. DC fast charging for commuters is available nearby.
80/80	SAC	North Highlands, Watt Ave	5	3	3	3	3		Yes	Commercial Zone in the County of Sacramento between I-80 and Capital City Freeway. Existing locations and undeveloped land that may host a hydrogen station or DCFC plaza. Current station will not accommodate trucks. Nearly 6,000 industry- and service-related jobs in the nearby census tracts. Limited services or retail within walking distance. Two nearby federal office buildings may provide a base fleet of light-duty vehicles.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
80	SAC	Sacramento, North Market @ Northgate Blvd.	3	5	5	1	5		Yes	Commercial and Industrial Zone in the City of Sacramento. Well developed with warehouse, wholesale, and manufacturing business; no existing fuel station. About 11,000 industry- and service-related jobs in the nearby census tracts. Several livery operators in business park could provide a base fleet. No services or retail within walking distance. No space for a hydrogen station.
99	SAC	Sacramento, Franklin & 47th	1	5	5	2	2		Yes	Commercial and Industrial Zone in the County of Sacramento close to North/South commute corridor. Properties could be developed to host a hydrogen station and/or DC fast charging plaza. About 2,000 industry- and service-related jobs in the nearby census tracts. Two rental car operators could provide a base fleet.
NA	SAC	West Jackson Highway						Yes	No	West Jackson Highway Master Plan
80	SOL	Fairfield/ Vacaville Amtrak Station	5	5	1	3	3	Yes	No	Future location for a hydrogen station and/or DCFC charging plaza in the County of Solano. This is an undeveloped area adjacent to park and ride lots for Amtrak and Solano Transit. On the main road to Travis AFB and could serve as a location for commuters and vehicles doing business with the base.

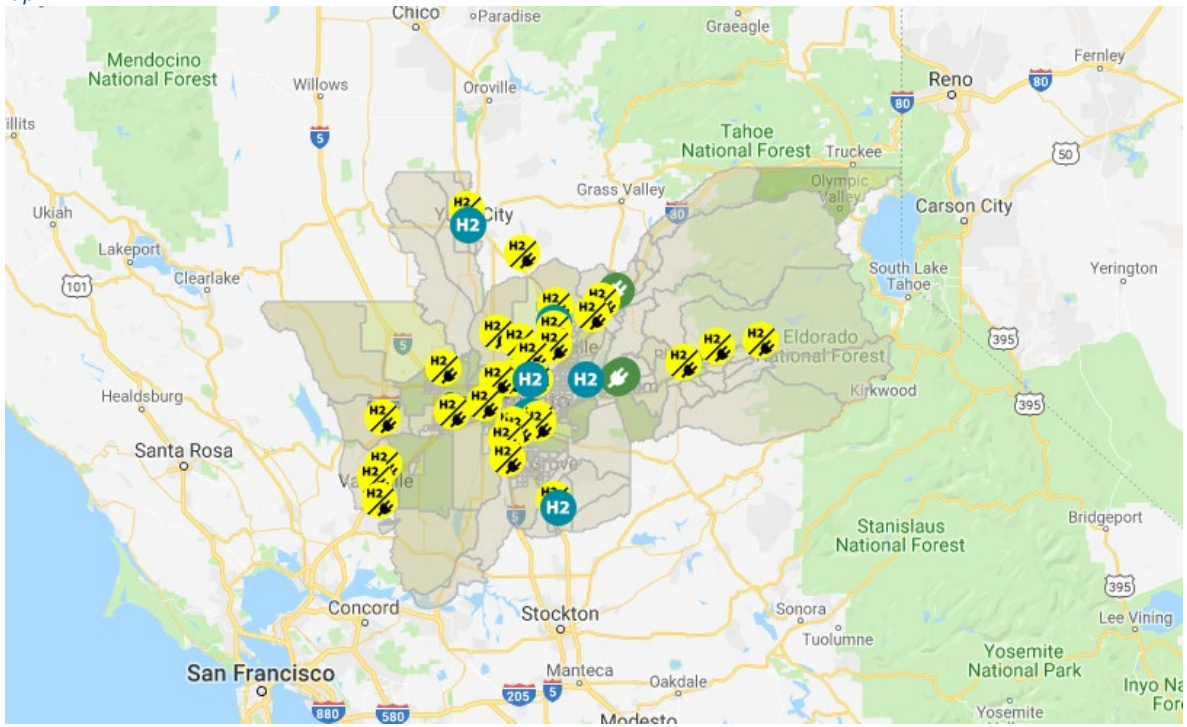
Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
505/80	SOL	Vacaville, Crocker Dr	3	5	1	5	1		No	Industrial Zone in the City of Vacaville with many transportation and warehousing businesses. Existing locations that may host a hydrogen station with room for truck and bus fueling. More than 7,000 industrial- and service-related jobs in nearby census tracts. Could also serve commuters between Winters and Vacaville. No services or retail within walking distance.
80	SOL	Vacaville, Davis St	5	1	5	5	5		No	Commercial Zone in the City of Vacaville on the East/West commute route. Existing locations that may host a hydrogen station and/or DCFC charging plaza. Adjacent to two park and ride lots. Solano County offers free Lyft rides for transit riders. Services and retail within walking distance.
505	SOL	Vacaville, Crocker Dr	3	5	3	5	3		No	Commercial/Industrial Zone in the City of Vacaville on the North/South corridor between Winters and Vacaville and near I-80. Existing locations and underdeveloped land that may host a hydrogen station or DCFC plaza. Current stations provide fuel for cars and trucks. About 8,000 industry- and service-related jobs in the nearby census tracts. Close to Genetech campus and could serve Genetech shuttles. No services or retail within walking distance.
NA	SUT	Sutter Pointe						Yes	No	Sutter Pointe Specific Plan https://www.suttercounty.org/doc/government/depts/ds/ps/cs_sutterpointe

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
99	Sutter	Yuba City, Bogue Rd	5	5	1	5	1	Yes	No	Commercial/Industrial Zone in the City of Yuba City on the primary commute corridor. Existing locations and undeveloped land that may host a hydrogen station or DCFC plaza. Existing station serves cars, trucks, and buses. About 3,500 industry- and service-related jobs in the nearby census tracts. No services or retail within walking distance.
20	Sutter	Yuba City, Colusa Hwy	5	5	3	5	4		No	Commercial/Industrial Zone in the City of Yuba City on the primary commute corridor. Existing locations and underdeveloped land that may host a hydrogen station or DCFC plaza. In a central business/residential district. About 4,500 industry- and service-related jobs in the nearby census tracts. Some services and retail within walking distance. On route to Feather Falls Casino and could serve livery services and shuttle buses.
5	YOL	Woodland, Main Street	3	5	3	5	5		Yes	Commercial and Industrial Zone in City of Woodland on the North commuter route. Existing locations that may host hydrogen and/or DCFC plazas. 4,000 industry related jobs and 2,000 service-related jobs within nearby census tracts that could provide a base load for light- and heavy-duty vehicles. Yolo County Transportation District bus yard within one mile. On the main route to Cache Creek Casino and may serve livery drivers and shuttles.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
80	YOL	Davis, Mace Blv/Chiles Road @ I-80	3	3	5	5	5		No	Commercial Zone in the City of Davis on the East/West commute route. Several existing locations that may host a hydrogen station and/or DCFC charging plaza, and some undeveloped land. Adjacent to a park and ride lot. About 2,000 industry- and service-related jobs in nearby census tracts. Could serve as a location for livery drivers between Dixon/Davis and the Sacramento and Bay Area airports. Also near rental car lots.
80	Yolo	West Sacramento, W. Capitol Ave	5	5	3	5	3		Yes	Commercial/Industrial Zone in the City of West Sacramento on the East/West commute corridor. Existing locations and underdeveloped land that may host a hydrogen station or DCFC plaza with room for buses and trucks. About 13,000 industry- and service-related jobs in the nearby census tracts and near the intersection of three freeways. Adjacent to two park and ride lots.
505	Yolo	Winters, Grant Ave	5	5	1	5	3		No	Commercial/Industrial Zone in the City of Winters on North/South corridor between I-5 and I-80. Existing locations and undeveloped land that may host a hydrogen station or DCFC plaza. Current stations provide fuel for cars and trucks. About 1,400 industry- and service-related jobs in the nearby census tracts. Some services and retail within walking distance. On route to tourist destinations around Lake Berryessa.

Hwy	CO	Name	Commute	Service	Livery	H2	DCFC	Future Location	Low Income/DAC	Description
65	Yub	Wheatland, McDevitt Rd	3	3	1	5	5	Yes	No	Existing fuel station in the County of Yuba that can serve cars and heavy-duty vehicles. Directly on the route to Beale AFB, PG&E, and Toyota Amphitheater, and can support the commute between Roseville and Yuba City, and on to Chico. Recommend a local traffic study to assess potential usage.

Figure 10: ZEV Readiness Interactive Map



Transit and Trucks

Truck electrification has more challenges than cars, particularly related to range for long-haul trucks. Current battery and fuel cell prototype trucks have a range of about 300 miles, although Tesla and Nikola promise 500- and 700-mile range respectively. Both these trucks require large-capacity infrastructure for charging the battery or filling with hydrogen at truck stops on the nation's highways.

The California Air Resources Board's proposed Advanced Clean Truck Regulation is expected to be finalized in 2019 or 2020. If passed as written, the regulation will require:

- Manufacturers of Class 2B and Class 3 vehicles must have 3 percent of sales be ZEVs by the 2024 model year, increasing by 2 percent each year through 2030, when 15 percent of sales would need to be zero-emission vehicles.
- Manufacturers of Class 4 through Class 8 vocational trucks must have 7 percent of sales be ZEV by the 2024 model year. By 2030, it would increase to 50 percent.
- Manufacturers and integrators of Class 7 and Class 8 tractors (long-haul trucks) must have 9 percent of sales be ZEVs by the 2027 model year and increase to 15 percent by 2030.
- Large employers, including retailers, manufacturers, and freight brokers, and fleets that operate 100 or more trucks must report about their deliveries and shipments to help identify future strategies for purchasing and placing zero-emission trucks.

The Advanced Clean Truck Regulation will require ZEV sales beginning in 2024 and will not apply to all the trucks in operation. It is likely that uptake of ZEV trucks by fleets and freight operators will be in the dozens through 2024 and hundreds through 2030. Thoughtfully planned infrastructure can spur adoption of ZEV trucks through 2024, particularly local delivery vehicles.

The California Air Resources Board's Innovative Clean Transit[26] regulation requires all transit agencies in California to submit a transition plan to 100% electric buses as follows:

- Large transit agencies (those operating more than 65 buses) purchase 25% ZEV buses starting in 2023, 50% in 2026, and 100% in 2029
- Small transit agencies purchase 25% ZEV buses starting in 2026 and 100% in 2029

The Sacramento region has 14 transit agencies, and only Sacramento RT and Paratransit are large agencies. Table 3 lists the agencies and the buses each operates.

[26] https://ww3.arb.ca.gov/regact/2018/ict2018/ictfro.pdf?_ga=2.248038407.1483376234.1563302919-368227744.1484264568

Table 3: Transit Agency Rolling Stock

Transit Agency	Buses CNG	Buses Gasoline (g) or Diesel (d)	Cutaways Gasoline	Notes
Yuba/Sutter Transit		35[d]	16	13 of 35 are commuter coaches, cutaways diesel
Roseville Transit		27[d]	11	11 of 27 are commuter coaches
Paratransit Inc.			170	Paratransit is shifting to CNG
Unitrans	42	5[d]	1	Includes 5 double-deckers
Davis Community Transit			4	
Folsom Stageline		5	6	
Elk Grove e-tran*	52		10	Cutaways: 8 gasoline, 2 diesel
Yolobus	43	17[d]	11	Cutaways: diesel
Sacramento Regional Transit	192		21	Cutaways: 17 CNG, 4 gasoline
Auburn Transit	1	1[d]	3	
South County Transit-SCT Link		16[g] + 2[d]	16	2 diesel commuter coaches
East County		2	2	Purchased by Sac County for Amador Transit
Placer County Transit	12	2[g] + 5[d]	2	5 diesel commuter coaches
El Dorado Transit		27[d]	12	16 commuter coaches
Total	342	144	285	

**In April 2019, Sacramento RT started negotiations with the City of Elk Grove to assume the city's transit operations from e-tran.*

Only three of the agencies publicly indicated that they are starting their transition planning:

- SacRT has a 2019 goal to "work with various internal departments and partners to develop a ZEV fleet conversion plan to replace CNG and gasoline revenue vehicles to electric battery."[27]
- A short-range plan for the Placer County Transportation Planning Agency recommended that Roseville Transit should purchase four zero emission buses in 2026 to replace four fixed-route buses that are scheduled to retire.[28]
- YCTD is seeking funding to conduct an electrification study.

If we assume that by 2030, half of the existing fixed-route transit buses have been replaced by ZEBs, the Sacramento region could have 240 zero-emission buses on the road.

One opportunity is to fund a joint electrification study for all regional transit agencies and consider shared infrastructure instead of each agency building its own charging and/or hydrogen stations.

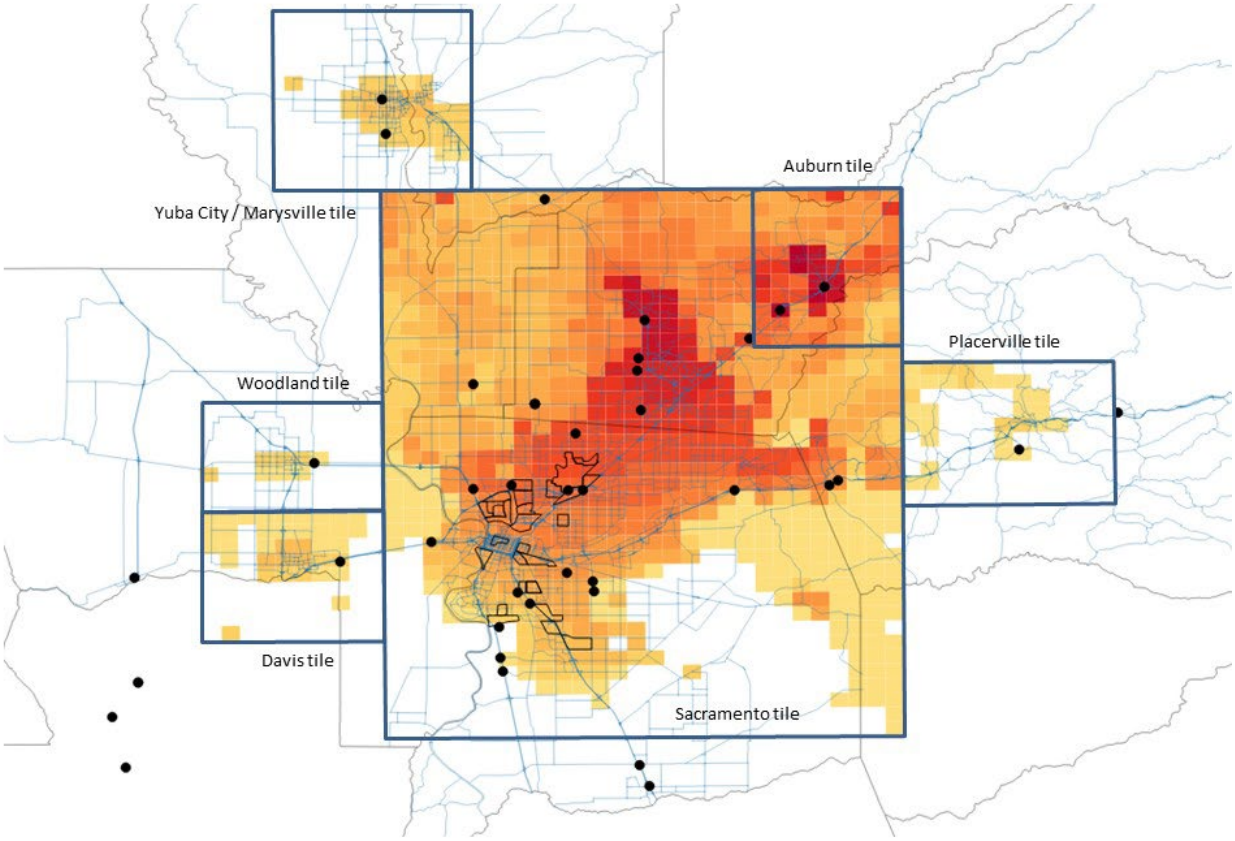
[27] https://www.sacrt.com/documents/financialdocs/FY18-19_Final_Budget.pdf
[28] http://pctpa.net/library/srtp/2018/Roseville/Complete.pdf

Heat Islands

In a Caltrans-funded project, SMAQMD is modeling the urban heat island effect for the Sacramento region. The project is identifying areas that have higher temperatures due to absorbed heat when compared to nearby areas that reflect heat. The project is also assessing effectiveness of different cooling strategies. The study was still underway in late 2019, but modeled results had shown the necessity of taking actions now to reducing extreme heat.

Figure 11 shows the 42 potential station locations overlaid with a map of the heat islands. The darkest red squares indicate a temperature different of 10 degrees higher than the surrounding area. Extreme heat can have negative effects on the range and durability of a battery, and increase the time needed to charge a battery.

Figure 11: Urban Heat Islands and Potential Station Locations



The heat island project suggests that charging stations (and hydrogen stations) can be designed to provide passive cooling can help protect battery health and maintain charging time, even in hot temperatures. Suggested solutions are:

- Add shade: Canopies are common at hydrogen stations, which are usually added to existing gas stations, but not common for DC fast charging. Incorporating light-colored shade structures, solar canopies, or trees and other native vegetation can cool the vehicle during charging and reduce reflective heat.

- Use higher-albedo pavement: "Albedo" is a measurement of thermal reflection. Asphalt and chip seal absorb up to 95% of incoming solar energy and then radiate the heat, which makes the air hotter. Newer concrete pavements reflect up to 50% of the sun's rays and reduce heat absorption.
- Use the shadows: Position chargers and hydrogen dispensers to take advantage of afternoon shadows, even if that means they absorb the morning sun. Using the shade from neighboring structures could minimize the effects of mid-day temperature rise.

By combining results of the heat island and ZEV readiness studies, Sac Metro AQMD can show specific locations that can most benefit from the combination of ZEV deployment and "cool" station design.

The Tipping Point

A tipping point is an accumulation of forces that move for change in one direction or another. At some point, the accumulation made enough change that things seem to be different. "A tipping point is something that has broad societal implications," said Oxford professor Margaret MacMillan, "and we usually don't see a tipping point until we are years past it."

Reports and forecasts about the potential of the ZEV market all mention the number of factors that need to move to influence the market. For example, the International Energy Agency[29] stated that to reach a fast-growth scenario for EVs:

- Automakers need to produce a wider range of EV models and at a variety of prices, potentially even redesigning the way vehicles are manufactured.
- Policies and incentives must bridge the cost gap between conventional and electric vehicles.
- Technical advances in batteries (and fuel cells) must help deliver substantial cost cuts and manufacturing capacity must increase.
- The supply of cobalt, lithium, and other raw materials will need to scale up in a way that is mindful of environmental impacts and social issues. End-of-life management of batteries (and fuel cells) may play a role availability of materials.
- The tax revenue base derived from vehicle and fuel taxes must be replaced, potentially by gradually increasing taxes on carbon-intensive fuels combined with distance-based charges.
- Electricity demand will increase, and demand will change as more cars fuel with electricity (or hydrogen). Electric mobility will need to play a role in increasing the flexibility of power systems.

Other factors simply influence the number of new cars sold: the economy, the age of the population, the distance between home and work, and the overall cost of owning a personal vehicle.

Building infrastructure alone does not reach the tipping point for ZEV adoption—evidence that "build it and they will come" doesn't yet exist. However, an ICCT study[30] found correlation between the public charging per capita, model availability, and median income and electric vehicle uptake, and between promotional activities that combined city and regional governments, utilities, businesses, nonprofit

[29] https://www.iea.org/publications/reports/globalevoutlook2019/

[30] *LEADING EDGE OF ELECTRIC VEHICLE MARKET DEVELOPMENT IN THE UNITED STATES: AN ANALYSIS OF CALIFORNIA CITIES*, ICCT, September 2016, http://www.theicct.org/sites/default/files/publications/ICCT_EV_Calif_Cities_201609.pdf

advocacy groups, and media with higher electric vehicle promotion actions.

It is essential to build charging infrastructure and hydrogen stations ahead of vehicle deployment, and equally important to build infrastructure so that as many drivers as possible use the fuel daily to create a business case for the developer. Strong, consistent regional messaging about both types of zero emission vehicles and fuels will also spur station development and vehicle adoption by business and municipal fleets.

Appendix A: Data Sources

EV and Hydrogen Planning Documents

- Sacramento PEV Collaborative *EV Readiness and Infrastructure Plan* www.cleancitiessacramento.org/uploads/2/7/8/6/27862343/sac_county_ev_inf_planfinal_6-20-17.pdf
- SACOG *Take Charge II* www.sacog.org/sites/main/files/file-attachments/master_takecharge_ii_12-21-16.pdf
- SMUD EV Innovator's Pilot - Load Impact Evaluation www.smud.org/-/media/Documents/Corporate/About-Us/Energy-Research-and-Development/research-EV-innovators.ashx?la=en&hash=F96D5C4B1826938B1A82A55C125725CAF9A4FC4D
- City of Sacramento, *Sacramento EV Strategy* www.cityofsacramento.org/-/media/Corporate/Files/Public-Works/Electric-Vehicles/EVStrategy_171019_PUBLIC_DRAFT_CityOfSacramento.pdf?la=en
- California Fuel Cell Partnership, *The California Fuel Cell Revolution* https://cafcp.org/sites/default/files/CAFCR.pdf
- California Energy Commission/NREL *California Plug-In Electric Vehicle Infrastructure Projections: 2017- 2025* https://www.nrel.gov/docs/fy18osti/70893.pdf
- UCLA, *FACTORS AFFECTING PLUG-IN ELECTRIC VEHICLE SALES IN CALIFORNIA 2017* - Final report, https://www.arb.ca.gov/research/apr/past/13-303.pdf
- SACOG*, 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy* - Chapter 9: Economic Vitality http://www.sacog.org/sites/main/files/file-attachments/chapter_9_economic_vitality.pdf
- Tahoe-Truckee, *Plug-in Electric Vehicle Readiness Plan - A Road Map to Charging Infrastructure and Zero Tailpipe Emissions 2017* http://tahoealternativefuels.com/wp-content/uploads/2017/06/Tahoe_Truckee_PlugInPlan_Final_web.pdf
- NREL*, California Statewide Plug-In Electric Vehicle Infrastructure Assessment* - Final Project Report May 2014 https://www.nrel.gov/docs/fy15osti/60729.pdf
- *EV Charging Stations: Permitting and Inspection - Sub-regional Workshop for Local Governments June 2, 2016* https://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/FINAL_Sub-regional_Workshop_Presentation_with_ZEV_slides.pdf
- NYSERDA *Best Practice Guides for Charging Stations* https://www.nyserda.ny.gov/Researchers-and-Policymakers/Electric-Vehicles/Resources/Best-Practice-Guides-for-Charging-Stations
- Governor's Office of Business Development, *Zero-Emission Vehicles in California: Community Readiness Guidebook (2013)* http://www.opr.ca.gov/docs/ZEV_Guidebook.pdf
- UC Berkeley, *PLUGGING AWAY How to Boost Electric Vehicle Charging Infrastructure (June 2017)* https://www.law.berkeley.edu/wp-content/uploads/2017/06/Plugging-Away-June-2017.pdf
- International Council on Clean Technology, *EV Charging Best Practices*, https://www.theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf
- International Council on Clean Transportation, *California ZEV Briefing*, https://www.theicct.org/sites/default/files/publications/CA-cityEV-Briefing-20180507.pdf

Data

- PG&E Micro-Siting Tool https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/EPIC-1.25.pdf
- SACOG http://data.sacog.org/datasets/130f6339af464cd19cc0da558668bd62_0?geometry=-122.128%2C38.451%2C-120.824%2C38.639
- SacDOT http://www.sacdot.com/Pages/TrafficCountProgram.aspx
- Caltrans http://www.dot.ca.gov/trafficops/census/
- MTC http://www.vitalsigns.mtc.ca.gov/traffic-volumes-regional-gateways
- SF County Transportation Authority http://tncstoday.sfcta.org/
- The Rideshare Guy, https://therideshareguy.com/rsg-2017-survey-results-driver-earnings-satisfaction-and-demographics/
- CPUC http://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Safety/Presentations_for_Commission_Meeting/2840_PowerPointforthe11515Meeting.pdf
- American Association of State and Highway Transportation Officials http://traveltrends.transportation.org/Pages/default.aspx
- U.S. Census https://www.apartmentlist.com/rentonomics/increase-in-long-super-commutes/ and http://digg.com/2018/super-commuters-map
- City of Santa Monica http://nelsonnygaard.com/wp-content/uploads/2008/03/SANTA-MONICA-Taxi-Study.pdf
- U.S. Census https://factfinder.census.gov and https://onthemap.ces.census.gov/
- California Department of Motor Vehicles https://www.dmv.ca.gov/portal/dmv/detail/pubs/media_center/statistics
- Center for Sustainable Energy/Clean Vehicle Rebate Project https://cleanvehiclerebate.org/eng/rebate-statistics
- CALSTART/California Hybrid Investment Voucher Program https://www.californiahvip.org/tools-results/#program-numbers