Sacramento Region Medium- and Heavy-Duty Zero Emission Vehicle Blueprint Planning Project ARV-21-032

Medium and Heavy-Duty ZEV Blueprint for Sacramento County and West Sacramento • December 9, 2022

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1 Executive Summary

The project's intent was to identify the "home base" locations (depots) of the largest fleets that operate MD/HD vehicles in Sacramento County and West Sacramento and then map those locations to existing grid capacity.

Using this information, the project team could then identify optimal locations for charging and hydrogen stations that would enable MD/HD operators to transition to zero-emission vehicles (ZEV). Simultaneously, the team would identify technologies that could mitigate grid impacts and identify the approaches and systems needed for workforce development, station installation, and funding to support an organization's transition to ZEVs.

The transition to ZEVs must happen in stages and Figure 1 summarizes the actions identified in the ZEV Blueprint by stage:

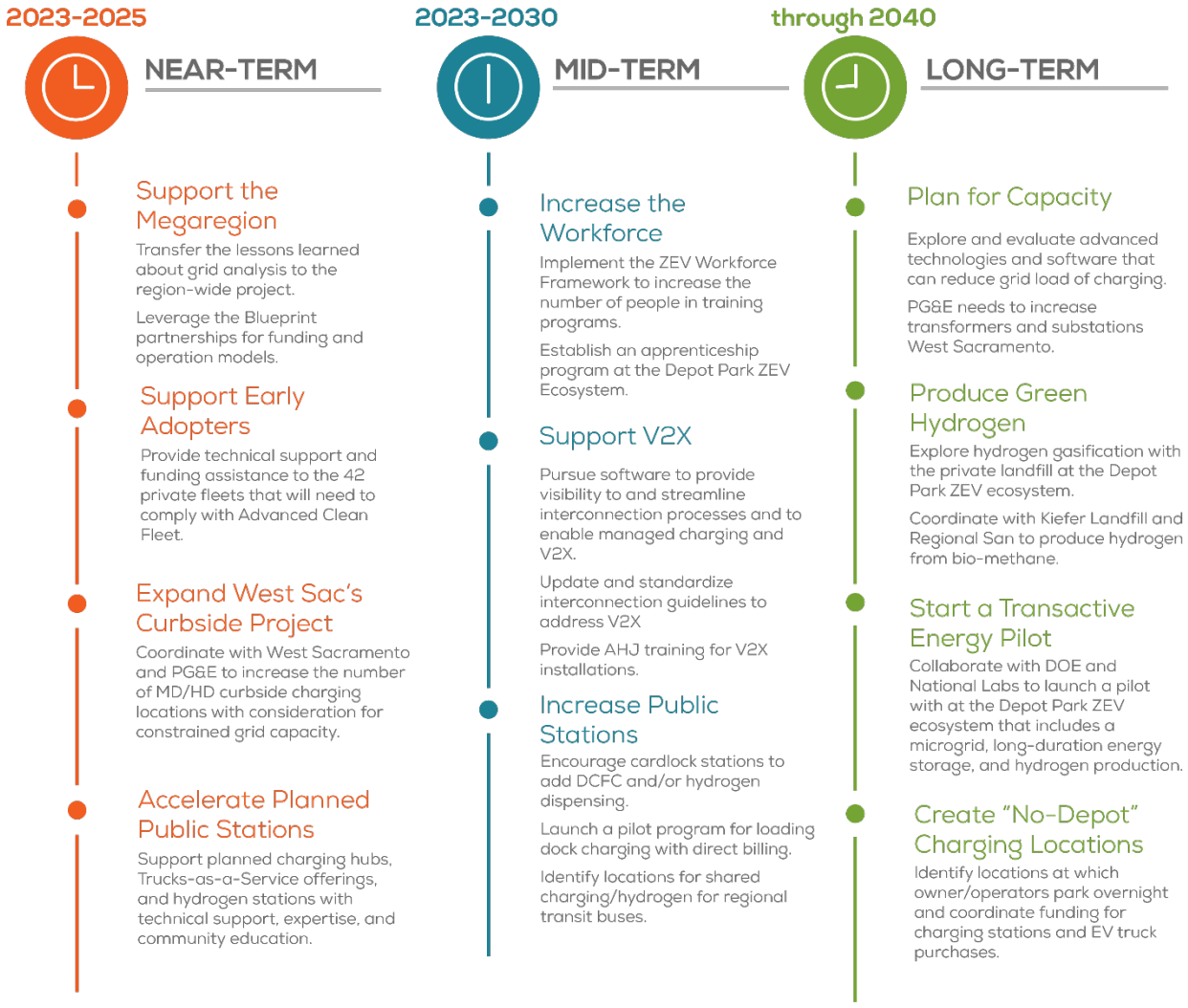


Figure 1: Sacramento Area MD/HD ZEV Infrastructure Timeline (source: Frontier Energy)

Near-term actions are those that have already started and need funding, technical support, a larger workforce, more education, and/or access to vehicles and charging to continue or to accelerate.

Mid-term actions are those that require planning now to implement current technologies and concepts. These are "no-regrets" actions that will avoid or reduce the likelihood of future stranded assets.

Long-term actions are those that require investment, pilot projects, preparation and potentially changes in the status quo. They encourage innovation and thinking beyond business as usual.

MD/HD Vehicles in the Sacramento Area

The project team counted 24,389 trucks and buses domiciled at 4,818 unique addresses in Sacramento County and the City of West Sacramento. Fleets range from hundreds of vehicles at a single address to a single commercial vehicle registered at an owner's apartment. Additionally, the project area contains hundreds of additional addresses at which trucks park temporarily (for an hour or so) to load and unload freight.

Three zip codes account for the greatest total of vehicles and the greatest number of unique addresses (Table 1). These three are likely to have the biggest impact on the grid.

Table 1:Zip codes with greatest number of MD/HD vehicles

Zip Code	Sum of MHD Vehicles	Unique Addresses	Area Description
95691	3,245	120	West Sacramento: Industrial Blvd area
95828	2,597	116	Sacramento: Depot Park and surrounding area
95826	1,630	68	Sacramento: Depot Park

Other areas with large numbers of MD/HD vehicles are the Richards Blvd area, Market Street in Natomas, Dino Drive in Elk Grove, the area around the Jackson Highway, and North Highlands, and in Rancho Cordova. These areas may include multiple zip codes.

Some are municipal fleets, like the County of Sacramento, but most are private operators that include goods movement and construction. SMUD and PG&E also fall into the "large fleet" category. Most goods movement operators are related to distribution of agriculture and finished food products.

We also identified about 3,700 unique addresses that have one or two MD/HD vehicles registered, and many of the addresses are residences. Most of the vehicles have a California Motor Carrier Permit and are Class 8 tractors that an individual uses to haul a client's trailer. Others are small businesses with names that include words like roofing, construction, water heaters, and tires.

Using assumptions from the National Renewable Energy Laboratory (NREL)[1] and a study SMUD commissioned from Guidehouse, the team estimated that 26% of the vehicle population will be ZEV by 2040, most of them battery electric vehicles, and will require a variety of fueling/charging strategies.

ZEV Charging/Fueling

Through interviews, surveys, focus groups, and input from the project's technical advisory committee, the project team identified three deployment models for future charging and hydrogen fueling:

1. **Depot Charging and Fueling** – Nearly all large fleets have a dedicated fuel depot. The large fleets interviewed for this project stated they expected to deploy charging stations in their parking lots. Those larger fleets that expressed interest in fuel cell vehicles prefer a dedicated hydrogen station. Dedicated charging/fueling allows fleet operators to control costs, both for the fuel and the for the employee or contractor fueling the truck. It also ensures vehicles will be charged or fueled and ready for work. Required safety measures and maintenance may make dedicated hydrogen refueling challenging for smaller fleets.
2. **Public Charging and Fueling**—Smaller fleets and owner-operators fill their vehicles at public locations that include unattended cardlock stations or regular gas stations. These are typically equipped with high canopies and room for larger vehicles to maneuver. Local drivers may also use travel plazas (truck stops), but these are more common for over-the-road truckers. Fleets expressed interest in siting Level 2 charging stations at their business location(s) in combination with truck-accessible public DC Fast Charge (DCFC) stations for on-route charging or charging when parked for loading and unloading. Those interested in fuel cell vehicles expected to use public or cardlock hydrogen stations. Additionally, a network of transit agencies in surrounding counties serve the Sacramento region.

[1] https://www.nrel.gov/docs/fy22osti/82081.pdf

To support their transition to ZEV, the region will need at least five publicly accessible facilities for shared charging/hydrogen.

3. **"No Depot" Overnight Charging**—Individual owners of heavy-duty trucks and buses typically park their vehicles at truck service businesses and self-storage facilities. Individual owners further shared that charging stations at overnight parking facilities would be helpful, particularly if charging involved a flat fee mirroring how drivers currently pay for parking.

We anticipate first adopters will likely be the 42 larger entities identified as part of this project that are subject to compliance requirements under the pending Advanced Clean Fleets (ACF) rule. Most of those fleets will choose BEVs and depot charging and, therefore, the SMUD team identified the locations at which larger fleets have depots and compared those to grid capacity.

In most Sacramento County locations, SMUD has sufficient grid capacity to serve the initial MD/HD fleet transition electricity as a transportation fuel through 2030. System upgrades depend, to some degree, on development and adoption of managed charging and V2X (vehicle-to-building, vehicle-to-grid) technologies. Expansion of fleet charging after 2030 will require more substantial investments in system upgrades.

For the City of West Sacramento, a preliminary grid analysis by a third-party vendor found PG&E may face constraints. This calls for further investigation by PG&E. With a hydrogen station planned at the Port of West Sacramento, fleets in the West Sacramento area may favor fuel cell trucks (FCEVs).

The team also identified areas in Sacramento County and West Sacramento that have a concentration of smaller fleets and independent operators. These will likely be second and third movers to ZEVs and will need a combination of public and depot charging, and public hydrogen stations. The team identified locations of existing truck-only gas stations that are good candidates for adding ZEV fuels.

SMUD identified several activities that help pave the way for MD/HD infrastructure deployments. These include:

- Introducing a grid capacity evaluation request form that provides customers a preliminary determination of site capacity and ballpark cost estimate at no cost and on a much shorter timeline than a full Rule 16 service application. Rule 16 is the standard process through which commercial customers formally request an evaluation of electrical service capacity at one or more proposed installation sites.

- Procuring or developing software that provides visibility to grid constraints and streamlines interconnection request and implementation processes.

- Exploring potential partnerships with private vendors to co-develop site aggregation and charge management software based on open architectures and standards with 100% interoperability and vendor-agnostic charging station solutions.

- Working to update and standardize interconnection guidelines to address V2X, update interconnection tool data elements, and to update GIS and ADMS/DERMS distributed generation feature to accommodate V2X technologies and capabilities.

All jurisdictions in the region are well-positioned to review applications for commercial charging stations and hydrogen stations and issue permits in a timely fashion but will need additional technical expertise for newer technologies like vehicle-to-grid charging.

Longer term, the Sacramento area will need innovative solutions that balance energy demand and supply and looks at novel charging solutions. Including both hydrogen and charging may accommodate onsite energy generation and long-duration energy storage. An islanded microgrid with vehicle charging and hydrogen production will provide much-needed resiliency for emergencies that create prolonged power outages.

The Depot Park ZEV Ecosystem

The region that was once the Sacramento Army Depot is now a large industrial area known as Depot Park. It includes about 4,000 MD/HD vehicles in large and small fleets and is situated adjacent to neighborhoods in disadvantaged communities. Depot Park includes two truck-only fueling stations, a privately owned landfill that handles appliances and electronics, many warehouses and distribution centers, and a large solar array with battery energy storage. The park is on its own electric distribution network and has sufficient grid capacity to accommodate fleet electrification in the near- to medium-term.

Depot Park is an ideal environment for all activities identified in this action plan, including job training and workforce development. The diversity of vehicle types, the opportunity to offer both ZEV fuels, and the potential to create an islanded microgrid for future resiliency could make Depot Park a leader in deploying near-term ZEV technologies and a proving ground for next-generation technology, software, and deployment concepts.

Workforce Development

In 2021, Valley Vision released a report about ZEV-related jobs in the Sacramento region. and predicted 1,200 total jobs in non-business-related career-technology education (CTE) programs

The MD/HD ZEV transition will affect key occupations differently. Roles related to service technicians will require upskilling to incorporate high-voltage electrical safety. ZEV operators or drivers will require less training to understand the differences in basic maintenance and safety inspections before operation when compared to an internal combustion engine vehicle (ICE). Occupations like sales managers will require the least amount of training so they understand the fundamentals of ZEV and their benefits to potential consumers.

The California Mobility Center created a framework, detailed in the Job Training and Workforce Development section, to engage underemployed and unemployed people to prepare them for a variety of EV-related careers. CMC noted that the approaches used

to engage potential participants in career training needs change. They identified opportunities to overcome barriers to getting people interested in taking training and then keeping them in the class until they can start earning wages.

The Human Side of the Transition

The ZEV transitions must benefit the people who live and work close to freeways and industrial zones, and more importantly, work with the community members to ensure the project doesn't have unintended consequences. Ongoing community engagement will be vital to ensure that ZEV fuels create opportunities small businesses and living-wage jobs for residents from all backgrounds.

The transition to ZEVs will create about 1,200 ZEV-related jobs in Sacramento over the next five years. The Sacramento Region is uniquely positioned to recruit, train and support workers in a way that also address enduring poverty in target populations. The ZEV Workforce Framework developed in this project must be implemented so that we can build a strong workforce and provide the workers that employers and operators need to build vehicles and stations, install, and maintain stations, operate ZEV equipment, and interpret the data.

Key Challenges Identified During the Project

1. MD/HD vehicle registrations are difficult to track and challenging to align with the physical addresses of depots or domiciles. Every commercial vehicle that operates in California must be registered in California, even if they only drive through the state. Vehicles are often registered at a business address, not the depot at which they are domiciled. Additionally, not all MD/HD vehicles that will be electrified need to be registered as commercial vehicles. For example, terminal tractors that operate in parking lots don't require DMV registration.
2. Forecasting grid capacity at the local and site level will continue to be a challenge as EV charging (all classes) and building electrification continues alongside increasing adoption of DERs such as solar and energy storage systems. We expect technologies will continue to evolve in the coming years and these will impact demands on the distribution system in difficult to predict ways. The industry is by its very structure averse to investing in build out of grid capacity to meet future demand that may not materialize, resulting in higher rates and stranded assets. For example, a transformer or substation that is at 80% capacity today could be 100% capacity tomorrow when a transition in ownership sees a warehouse converted to indoor agricultural growing. Alternatively, the same facility could end up at 50% capacity when a pandemic hits and every office closes for an extended period (as witnessed during the COVID-19 outbreak).
3. Electric Vehicle Infrastructure Training Program (EVITP) certification requirements will likely create a resource bottleneck and delay charging station deployment. Demand for EVITP-certified installers will soon surpass installers' availability unless the program scales substantially to make training and testing widely available.

2 Introduction

The Sacramento area has been a major distribution center since the 1849 Gold Rush. Warehouses and fulfillment centers have populated the region since the first ships arrived. The archival photograph in Figure 2 depicts boats arriving at what is now the Pocket Area to unload cargo on to wagons for transport to the gold mining camps.

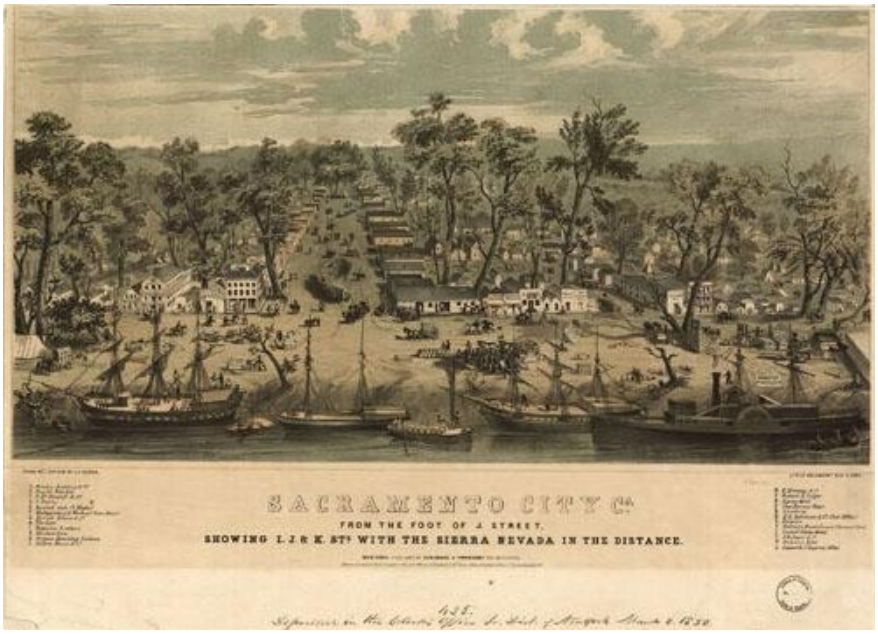


Figure 2: Historic Sacramento River Front

Today, goods movement and through freight arrives and departs the Sacramento region by truck, rail, and ship. Much of that cargo is related to food, beverages, and agriculture, and the distribution of oil, gasoline, and ethanol.

Local businesses and non-profits operate vehicles used for delivery, construction, landscaping, repair services, emergency preparedness and response, utility services, and refuse management. Cities, schools, and transit agencies operate a variety of buses that move people, and the region has two post offices that move letters and packages.

The Sacramento Area Council of Governments (SACOG) is the regional metropolitan planning organization for the six-county Sacramento region. SACOG's Economic Vitality Report noted the economic importance of transportation, distribution, and warehousing and projected jobs in this sector would increase by 21.7% by 2035. The report also noted the air quality impacts of "heavy and frequent truck traffic."[2]

State climate and air pollution policies aim to transition the state's trucks and buses from fossil fuels to electricity and hydrogen. State policy similarly prioritizes improving air quality and reducing the burden of pollution on those most affected by it. What is envisioned is a just transition, —one that creates economic and work opportunities, treats everyone fairly, and leaves no one behind.

To ensure the Sacramento Area Medium- and Heavy-duty (MD/HD) Infrastructure Blueprint would incorporate land use and planning, community impacts, workforce development, economic, and goods movement considerations, the Sacramento

[2] https://www.sacog.org/sites/main/files/file-attachments/9_-_economic_vitality_final.pdf?1456333787

Municipal Utility District (SMUD) assembled a diverse team of regional partners that brought a variety of perspectives.

This "Blueprint" planning document represents the culmination of months of analysis and consideration across key study areas by nine regional partners in the Sacramento area, as shown in Figure 3.

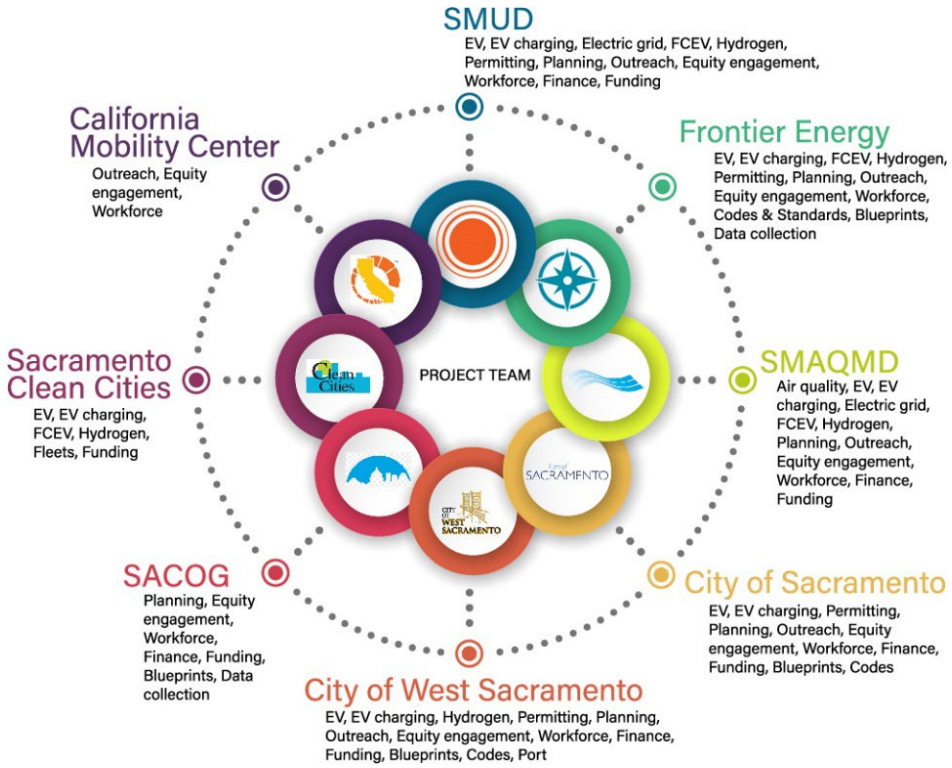


Figure 3: The Sacramento MD/HD Blueprint Team (source: Frontier Energy)

3 Background

The SACOG map in Figure 4 shows the routes that local and through freight routinely use. Color coding indicates high, medium, and low use. Goods movement routes have not changed substantially since the first iteration of the map in 2008. Without new bridges or highways, organizations that transport goods remain close to existing freeways. Surface routes have changed slightly with development of two industrial parks in West Sacramento, development of distribution centers in Natomas, and the build out of the Sacramento area's former military bases as industrial parks.

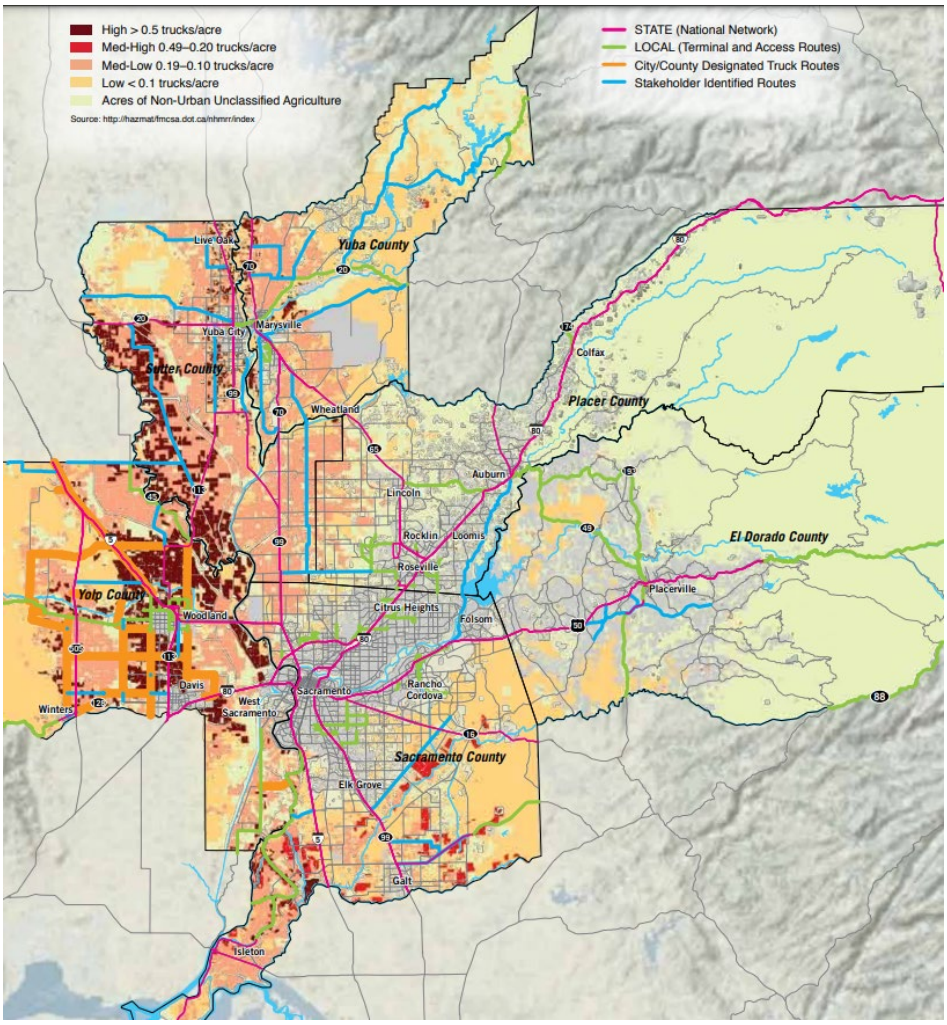


Figure 4: Regional Goods Movement Routes (source: SACOG)

SACOG's planning efforts are aimed at reducing road congestion and lowering traffic-related accidents and supporting zero emission vehicles to reduce the environmental impacts of truck traffic, particularly in disadvantaged areas.

In June 2020, the West Coast Clean Transit Corridor Initiative released a report commissioned by SMUD and nine other utilities in California, Oregon, and Washington. It explored deployment of fast charge stations along freight routes from the Mexican

border to Canada, as shown in Figure 5.[3] One of the report recommendations was to identify gaps in electric capacity and supply early and develop a plan to increase capacity, especially in rural areas that have smaller utilities.

Figure 5: West Coast Clean Transit Corridor (source: WCCTC)

SMUD, Sacramento County's electric utility, has a 30-year-plus track record of development and deployment of battery electric vehicles (EV), fuel cell electric vehicles (FCEV), and associated infrastructure. SMUD's intimate knowledge of the region's electric grid is a key prerequisite for all alternative fuel vehicle infrastructure projects and widespread vehicle electrification is a central enabler of its commitment to 100% zero carbon energy generation by 2030.

Sacramento's Twin Rivers Unified School District Transportation Department was the first school district in the nation to deploy battery-electric school buses. Twin Rivers currently maintains 55 electric buses. Washington Unified School District in West Sacramento operates seven electric school buses. Sacramento Regional Transit operates 25 battery electric buses. Yolo Transit runs six electric buses between Davis and Sacramento (although it does not stop in West Sacramento). Each of these operators use dedicated charging stations.

Three sites for public charging and two hydrogen stations for MD/HD vehicles are in the planning or design stages:

- West Sacramento's Corp Yard at 4300 West Capitol Avenue will have two DCFC ports available to the public. The pull-through design will accommodate up to 40-foot MD/HD vehicles.
- Elkhorn Plaza, a public street, will feature two curbside DCFC ports that will accommodate light duty and MD/HD vehicles.

[3] https://www.westcoastcleantransit.com/

- Start-up company WattEV is in the early stages of developing a public charging hub and Trucks-as-a-Service business model for freight operators to be sited near Sacramento International Airport off I-5 and Powerline Road.
- Two MD/HD hydrogen stations are planned - one at the Port of West Sacramento to support multiple port-related fuel cell pilots and to offer public hydrogen fueling, and one at McClellan Park in Sacramento that will operate as a card-lock station.

Through this project, SMUD and its partners built on the data from SACOG, WTTCC, and the Sacramento Metro AQMD's original regional ZEV study to identify additional actions and activities in the near-term (now), mid-term (through 2030), and long-term (through 2040) that can accelerate the transition to zero emission vehicles.

4 The Census of MD/HD Vehicles

The count of MHD vehicles has never been simple. Trucks and buses that move people and freight are required to obtain a California Motor Carrier Permit (MCP).[4] However, the regulation exempts several vehicle applications, like U-Haul trucks, pick-up trucks used for construction or landscaping, and airport shuttles. Additionally, every truck that *operates* in California must have an MCP, including those that don't have a physical presence in California. And the MCP is issued to the business address, not the address at which the vehicle parks. Counting MCPs doesn't accurately reflect the addresses at which vehicles park.

To count the MD/HD vehicles that park at West Sacramento and Sacramento County addresses, the project team used a variety of sources:

- California Department of Motor Vehicles county-level registration information
- California Highway Patrol terminal inspection data
- Air Resources Board reporting databases
- U.S. Department of Transportation databases
- California insurance databases
- FleetSeek, a private database,
- Information from Guidehouse used in a previous SMUD project
- Local knowledge and relationships with business and fleet operators

Using these data sources supplemented with visits to sites, the project team counted 24,389 trucks and buses at 4,818 unique addresses. The vehicle population changes every day as businesses expand, close, move, and change their operation. Overcounts in some areas off set under counts in others. We grouped the vehicles into two sets: addresses with three or more registered vehicles and addresses with 1-2 registered vehicles.

Figure 6 offers a screen shot view of a custom Google map that shows the locations of the 1,092 addresses at which three or more vehicles are registered (a total of 20,375 vehicles). Colored icons indicate clusters of addresses within a zip code and the number at the bottom of each pin indicates the MHD vehicle count at each unique address.[5]

The remaining 4,014 vehicles are registered at 3,726 unique addresses. Most of these vehicles have a California Motor Carrier Permit and are Class 8 tractors that an individual uses to haul a client's trailer. Others are small businesses with names that include words like roofing, construction, water heaters, and tires. The addresses are distributed throughout the project area, with clusters of addresses in Carmichael, South Sacramento,

[4] https://www.dmv.ca.gov/portal/vehicle-industry-services/motor-carrier-services-mcs/motor-carrier-permits/
[5] View the custom interactive Google map https://www.google.com/maps/d/edit?mid=1S05zEOgWxj3BwibiaiHfBXJkSvVk0O89&ll=38.449641778583924%2C-121.320062&z=10

West Sacramento, and North Highlands. Some addresses are in business parks, but most of the addresses we checked are single- and multifamily residences without accommodations for truck parking.

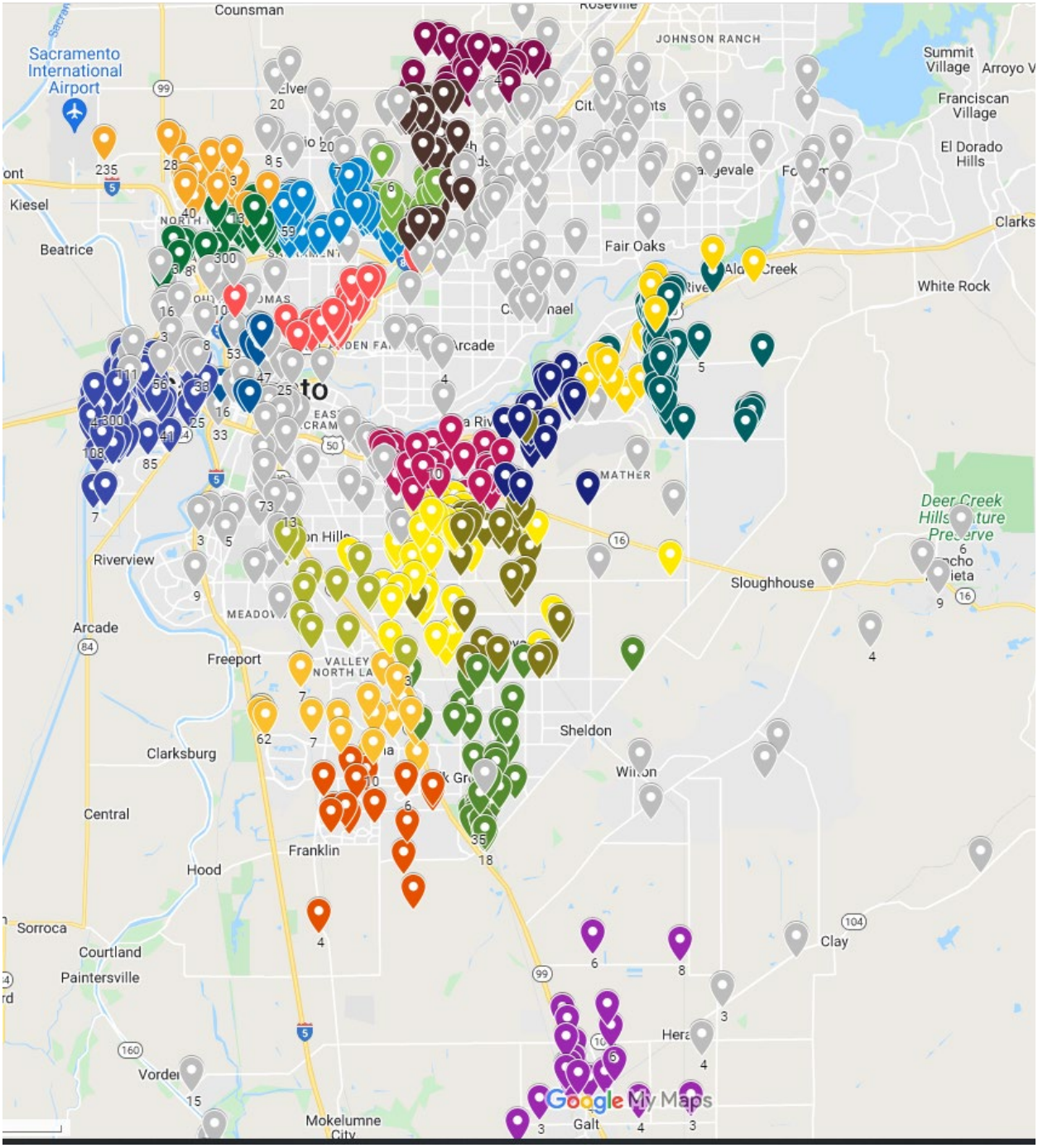


Figure 6: Locations with 3+ Registered MD/HD Vehicles (Source: Frontier Energy via Google Maps)

Three zip codes in two areas have the greatest number of vehicles and unique addresses as shown in Table 2.

Table 2: Zip codes with greatest number of MD/HD vehicles

Zip Code	Sum of MHD Vehicles	Unique Addresses	Area Description
95691	3,245	120	West Sacramento: Industrial Blvd area
95828	2,597	116	Sacramento: Depot Park and surrounding area
95826	1,630	68	Sacramento: Depot Park

Other areas with large numbers of MD/HD vehicles are the Richards Blvd area, Market Street in Natomas, Dino Drive in Elk Grove, the area around the Jackson Highway, and North Highlands, and in Rancho Cordova. These areas may include multiple zip codes.

The team estimated that 42 operators will need to comply with the proposed Advanced Clean Fleet (ACF) regulation. The proposed regulation would apply to fleets performing drayage operations, those owned by State, local, and federal government agencies, and by entities with $50 million or more in gross annual revenue and that own, operate, or control at least one MD/HD vehicle or own, operate, or control 50 or more MD/HD vehicles.

Some are municipal fleets, like the County of Sacramento, but most are private operators that include goods movement and construction. SMUD and PG&E also fall into the “large fleet” category. Many goods movement operators are related to distribution of agriculture and finished food products. Table 3 lists some of the 42 fleets that may need to comply with ACF and are most likely to be ZEV early adopters.

Table 3: Fleets to which ACF may apply

Name	City	Zip	Total MHD
Teichert	Sacramento	95826	400
City of Sacramento	Sacramento	95822	450

Name	City	Zip	Total MHD
United Site Services of CA	Sacramento	95811	394
USPS	West Sacramento	95691	300
Raley's/Ozark	Sacramento	95834	300
UPS	West Sacramento	95691	248
Penske	West Sacramento	95691	235
Amazon	Sacramento	95835	235
Ryder Truck Rental	West Sacramento	95691	222
Fedex Ground Package System	Sacramento	95828	200
Usko Express Inc	Rancho Cordova	95742	197
Devine Intermodal	West Sacramento	95691	137
Alcal Specialty Contracting	Sacramento	95834	136
Airgas Northern California and Nevada	Sacramento	95828	134
MCM Construction	North Highlands	95660	132
Allied Waste Services of North America	Rancho Cordova	95742	127

Name	City	Zip	Total MHD
Frito-Lay	West Sacramento	95691	125
Pepsi Beverages Co	Sacramento	95828	120
Cablecom	McClellan	95652	115
Wal-Mart Transportation	McClellan	95652	112
Tony's Fine Foods	West Sacramento	95605	111
Bimbo Bakery	Sacramento	95817	110
	West Sacramento	95691	85
Valley Slurry Seal Inc/VSS Emultech	West Sacramento	95691	109
Siemens Mobility	Sacramento	95828	109
Fedex Freight Inc	West Sacramento	95691	108
Golden State Utility	Sacramento	95826	108
Western Truck Center	West Sacramento	95691	105
PG&E	Sacramento	95826	104
AT&T/Pacific Bell	Sacramento	95816	100
USPS Royal Oaks	Sacramento	95815	100

ZEV Adoption

DMV data shows the change in MD/HD vehicle registrations by year. The project team used historical data to forecast future MD/HD vehicle growth. Using data from Guidehouse and NREL, we forecasted the growth of the MD/HD vehicle population through 2050 and then estimated the percentage of vehicles that would likely be ZEVs, shown in Figure 7.

Guidehouse projected ZEVs would comprise 26% of the MD/HD vehicles on the road in 2041 (24% battery electric and plug-in hybrid and 2% fuel cell electric). For 2050, NREL projected ZEVs would comprise 80% of the MD/HD vehicle population – 66% BEV and 14% FCEV.[6]

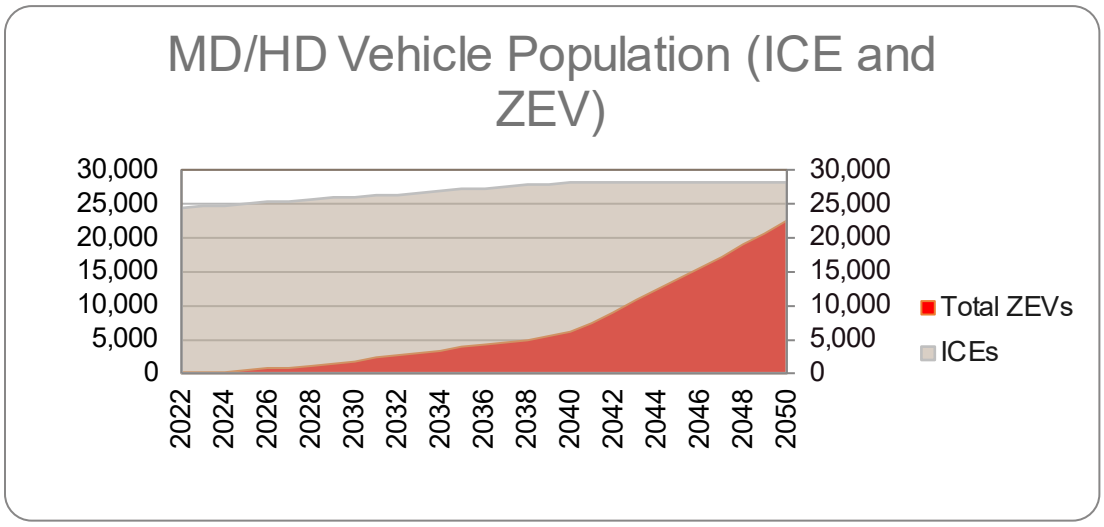


Figure 7: MD/HD Vehicle Projections (source: Frontier Energy)

Based on the current MD/HD vehicle population in Sacramento and West Sacramento, we expect most of these vehicles will be Class 7 and Class 8 trucks used for goods movement.

Many of the existing vehicles and regulated fleets use Class 3-4-5 for construction, utility services, and municipal public works. As of December 2022, no manufacturer has announced a ZEV version of vocational trucks. If available, we anticipate these ZEVs becoming dominate in the Sacramento area.

[6] https://www.nrel.gov/docs/fy22osti/82081.pdf

5 Forecasting Grid Capacity

SMUD's electrical grid is comprised of two systems to generate, transport, and deliver power. The bulk power system consists of generation and transmission of energy to load centers through a network of 115 kilovolt (kV) and 230 kV overhead and underground lines. The distribution system encompasses approximately 11,000 circuit miles of distribution lines, including 850 feeders (primary circuits) and 250 substations. Figure 8 illustrates SMUD's electrical system. Every utility has similar but not identical grid systems with more or fewer distribution lines, feeders, and substations.

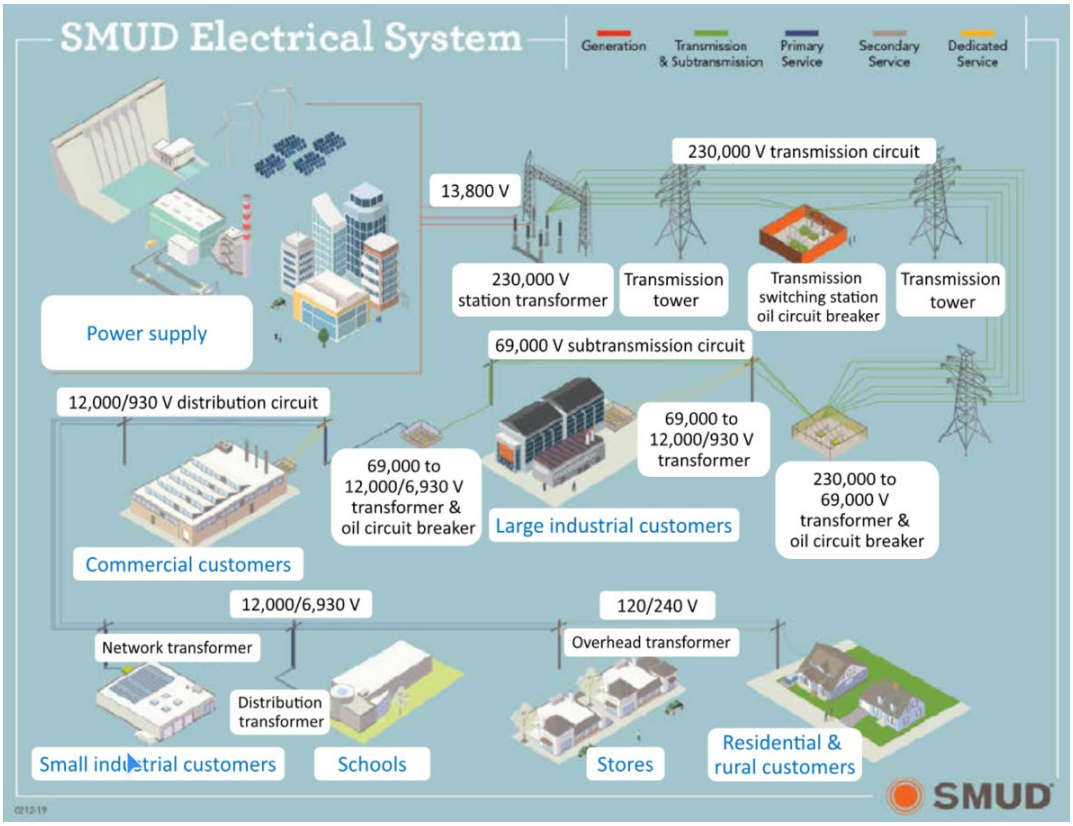


Figure 8: Diagram of SMUD's Electrical System (source: SMUD)

At a utility, network conditions and the capacity to meet customer needs change over time as appliances become more efficient, buildings switch from natural gas to electric, and as new buildings and charging stations enter the grid. While there is uncertainty in estimating available capacity, distribution planners design for projects based on forecasted generic and project specific loads (e.g., developments).

The project team's aim was to identify areas with heavy concentrations of MD/HD vehicles and then map projected energy needs to available grid capacity. This project revealed

that mapping electrical loads to the grid ideally requires meter-level, or at least parcel-level data tied to a physical address.

For each new load, an engineer requires about eight hours of effort to determine the site and grid conditions, including service drops, line extensions, and transformers required to support the load. The MD/HD Blueprint project involved hundreds of new loads. Mapping every expected load would take many person-months, and each projection would need to be adjusted when new resources or loads come online or when existing resources or loads are taken offline.

Additionally, this forecasting carries greater uncertainties given the potential variability in EV charging. EV charging loads are approximations and upgrades required to serve those loads drive cost estimates for utility and customer-side upgrades. This inherent inaccuracy can strain the customer-utility relationship when actual costs depart substantially from earlier estimates.

The project team identified several actions that could shorten the time needed to develop maps for the purpose of forecasting grid capacity, not necessarily for estimating costs. In particular:

- Vehicle and charger-based load forecast data and energy analysis came from several public and private sources in a variety of formats. Each source brought its own definitions, assumptions, and techniques to calculate electrical loads from charging stations and assign those loads to circuits and feeders. Standard data definitions and methods of calculation would eliminate the need to normalize the data and mitigate errors.

- SMUD found that it needed to import all the data into ArcGIS, which required converting census tracts and zip codes into shapes or "polygons," and then matching those shapes to grid topology. This was time consuming and required that all the partners agreed about "polygons" used as areas.

The Sacramento Area Council of Governments is launching a new project, the Northern California Megaregion ZEV Medium- and Heavy-Duty Blueprint that will incorporate counties from the Bay Area to the Nevada state line and include multiple utility districts. The Megaregion Project is a good opportunity to leverage the extensive coordination among government agencies, utilities, and private industry to advance data standards and definitions, and establish parameters for mapping and ArcGIS imports. These standards can ensure that smaller utilities and all developers have a consistent way to quickly tell if a site may need utility upgrades early in a project without more-extensive engineering analysis.

To estimate the demand for charging from MD/HD vehicles, the project team provided SMUD's distribution planning team with an Excel file that had a year-by-year forecast of the numbers of vehicles (count) and location (address) for the priority fleets, and aggregated number of MD/HD vehicles by census tract for all other fleets and owner/operators. The count showed about 25,000 vehicles that park overnight in Sacramento County and West Sacramento and assumed that the number of overall vehicles will increase annually. It also assumed that the percentage of ZEVs will increase exponentially up to 26% of the total vehicles by 2040.

Based on the number of vehicles and expected use cases, the project team forecasted the electric load in Sacramento County and West Sacramento by year using a worst-case energy demand scenario to identify grid-side infrastructure investments that will ensure grid safety, reliability, and resiliency:

- EV adoption required by regulations drives infrastructure charging needs
- Vehicles charge in one of three periods during a 24-hour day
- Vehicles charge immediately upon plugging in (i.e., no mitigation from demand charges such as TOU-based price signals, onsite generation, or energy storage)
- Charging locations do not use load management
- High simultaneous charging and lower charging capacity (<20 kW) per vehicle

To reflect a more realistic adoption future, SMUD distribution planning staff assumed 53% of EV charging during system peak hours could be shifted to start after the end of today's system peak period (9:00 pm). This is a conservative representation of forecasted managed charging behavior. Staff then mapped the addresses of the priority fleets' associated loads to each address's adjacent distribution feeder, and distribution feeders were rolled up to the substation bank level. For the loads assigned to census tracts, SMUD staff manually assigned them to feeders and substations. Figure 9 shows the expected gride capacity (green lines), the locations of large fleets, (stars), and disadvantaged communities (background colors.)

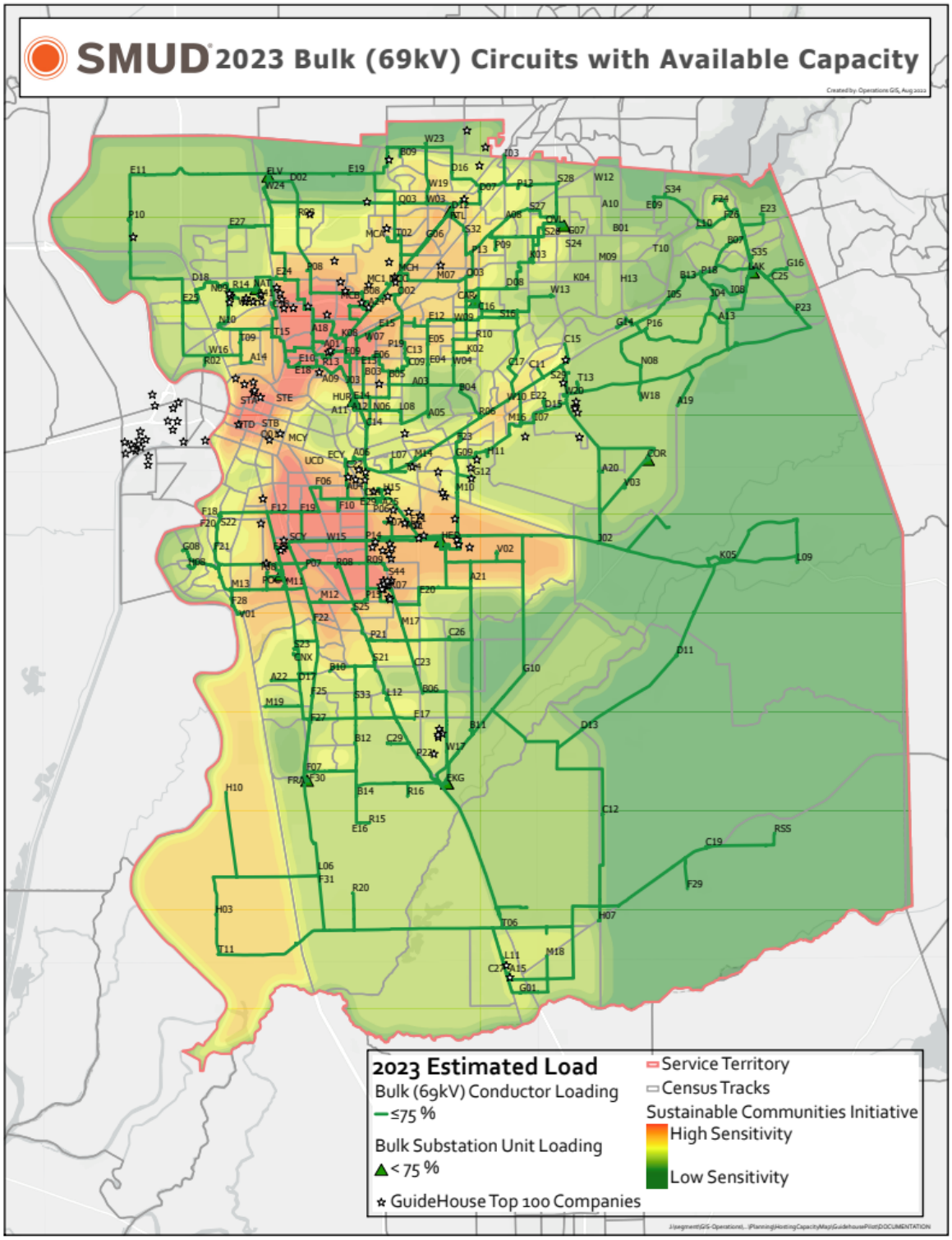


Figure 9: Grid Capacity Map of Sacramento County with Fleet Locations and DACs (source: SMUD)

SMUD estimated that existing resources can meet the electric charging needs for most of the 42 customers that are expected to have to comply with the proposed Advanced Clean Fleet rule.[7] The analysis showed that by 2030, only a handful of distribution substations may exceed their capacity. This suggests load shifting and managed charging technologies may help flatten charging load profiles and delay the need for new capacity investments.

To support early adopters, SMUD has already reduced the time and costs required for evaluation of new commercial electric service requests, known in the industry as Rule 16. Rule 16 is the standard process through which commercial customers formally request an evaluation of electrical service capacity at one or more proposed sites. Utility engineers review the customer's plans against site conditions and determine the electrical service upgrades the utility must perform up to the service meter (aka "to the meter" improvements) as well as the site improvements that must be completed by the customer to serve the electric loads required (aka "behind the meter" improvements). The report includes a technical evaluation, changes or clarifications needed for approval, as well as respective timelines for implementation and costs.[8]

For publicly owned utilities like SMUD, commercial customers pay an upfront fee for a Dialogues with fleet managers revealed fundamental disparities with the turnaround fleets and their advocates needed to make a basic determination about site feasibility (e.g., to support grant applications) and the typically lengthy Rule 16 process. As a result, SMUD introduced a separate preliminary assessment process to streamline and reduce upfront costs for fleets. Ahead of a potential Rule 16 application, EVSE project proponents can now submit a capacity evaluation form at no cost. SMUD's distribution planning team then provides customers a high-level preliminary determination of site capacity and ballpark cost estimate. This is performed on a much shorter timeline than a full Rule 16 service application.

West Sacramento/PG&E

The electrical grid serving the City of West Sacramento is similarly comprised, except that it is owned and operated by Pacific Gas & Electric (PG&E). PG&E is not a partner in this

[7] If passed as written, the regulated parties are municipal fleets, drayage operators, and entities with 50 or more vehicles and $50 million or more in gross annual revenue.
[8] https://www.smud.org/-/media/Documents/Rate-Information/Business-Rates/Rule-16-2018-clean.ashx

project and was unable to support SMUD's planning team within the timeframe needed. Because SMUD has no visibility into how PG&E assigns loads to its network, SMUD couldn't undertake an analysis for West Sacramento. To address this, SMUD procured Kevala, a third-party data analytics firm, to conduct a preliminary analysis using its proprietary software-as-a-service platform. Given the tight timeline Kevala used several publicly available data sources that included:

- City of West Sacramento GIS shapefiles and parcel data[9]
- California Energy Commission IEPR California Energy Demand (CED) 2021 Peak Demand Forecast (PG&E Mid-Demand Case)[10]
- PG&E Distribution System Data (GNA/DDOR) and Integration Capacity Analysis (ICA) Map [11]

Figure 10 shows the PG&E substations and associated primary feeder and secondary distribution lines within the city's boundaries and the red squares show the areas featuring clusters of MD/HD vehicles parked overnight.

[9] https://www.cityofwestsacramento.org/services/gis-maps
[10] Javanbakht, Heidi, Cary Garcia, Ingrid Neumann, Anitha Rednam, Stephanie Bailey, and Quentin Gee. 2022. Final 2021 Integrated Energy Policy Report, Volume IV: California Energy Demand Forecast. California Energy Commission. Publication Number: CEC-100-2021-001-V4.
[11] https://www.pge.com/en_US/for-our-business-partners/distribution-resource-planning/distribution-resource-planning-data-portal.page

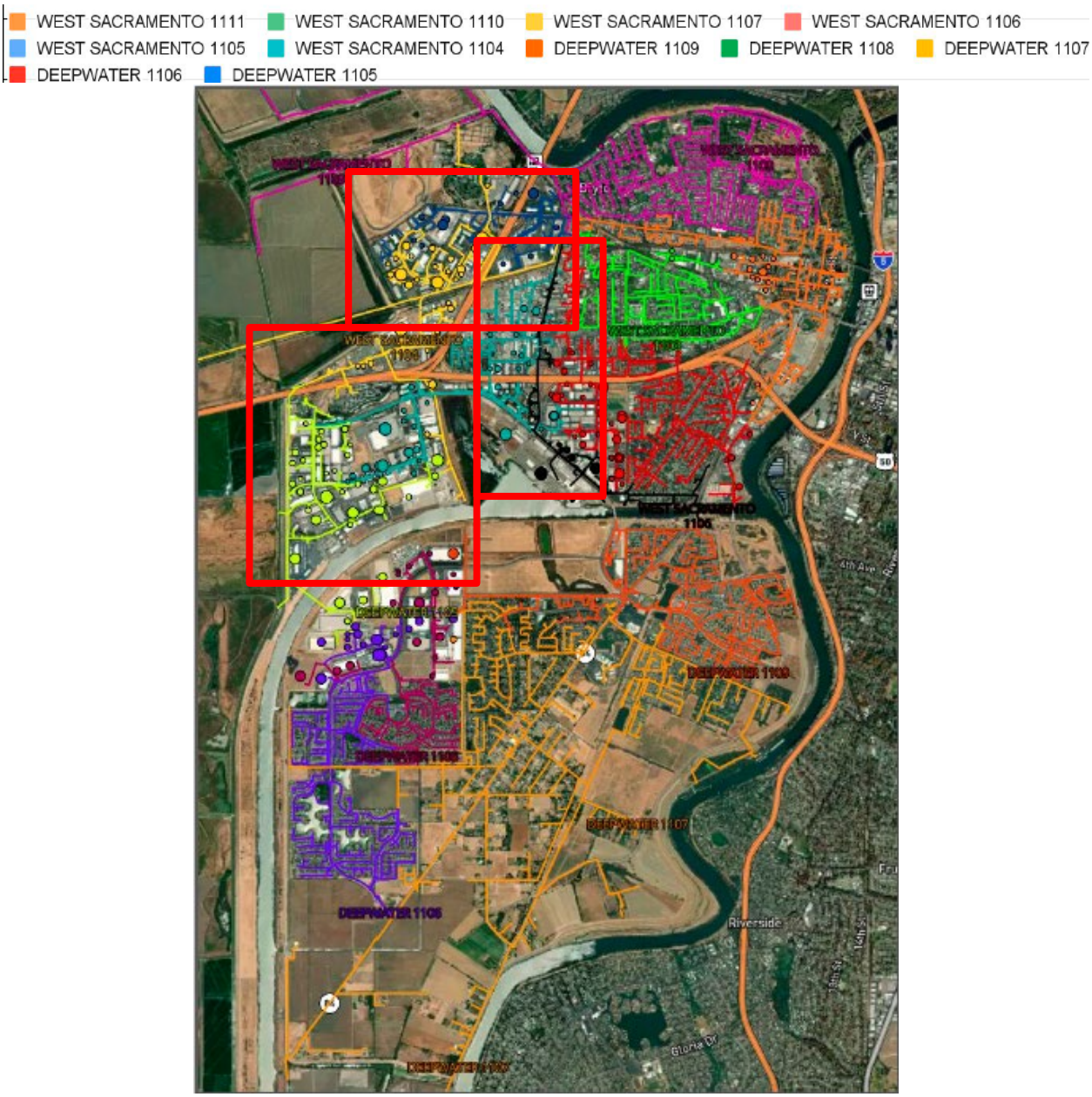


Figure 10: Grid Map of PG&E's distribution feeder and substation network in West Sacramento. (Source: City of West Sacramento)

When applying the projected fleet EV charging load growth calculations to PG&E's existing distribution system capacities,[12] the preliminary analysis shows that to meet the increased demand, PG&E may need to add substantial grid capacity by 2030. Detailed engineering analysis may find actual infrastructure upgrades are greater or less than this analysis projects.

[12] From public data available from PG&E. This requires further analysis by PG&E engineering services.

2023-2025

NEAR-TERM

Expand West Sac's Curbside Project

Coordinate with West Sacramento and PG&E to increase the number of MD/HD curbside charging locations with consideration for constrained grid capacity.

The City of West Sacramento is adding curbside Level 2 and DCFC throughout the city and has worked through the challenges of planning and permitting in the right-of-way and coordination with PG&E. The city currently has two locations for curbside MHD EV charging expected to be constructed in 2023. The first is located on Elkhorn Plaza between Casselman and Beardsley Drive accessible from Sacramento Avenue. Two accessible DC Fast Chargers (DCFCs) with 40-foot clear parking spaces parallel to the existing curb will be installed in this location approximately three-quarters of a mile from the eastern city boundary in the northeast part of West Sacramento.

The second location is within an off-street publicly accessible lot that includes two pull-through DCFCs with 40-foot clear parking located off the West Capitol Avenue primary arterial near the westbound Interstate 80 offramp, approximately one-half mile from the western city boundary. The City's Transportation Division is currently working to identify, design and install additional MHD accessible DCFCs, both curbside and within publicly accessible lots in both commercial and industrial districts, and is working to develop curbside design standards to accommodate future MHD EVSE needs.

In addition to the MD/HD available chargers already planned (at the City's Corp yard and at Elkhorn Plaza), City staff identified four other locations that could be available for MD/HD curbside charging:

1. Todhunter Avenue
2. Linden Road
3. Bridgeway Lakes Drive
4. Southport Town Center Parking Lot

Each of these is in, or adjacent to, residential neighborhoods and could support independent owner/operator vehicles. It may also provide on-route charging for Yolo County Transportation District buses, as well as the City's Via on-demand transit vans, school buses, and medium- and heavy-duty vehicles that deliver goods and services.[13]

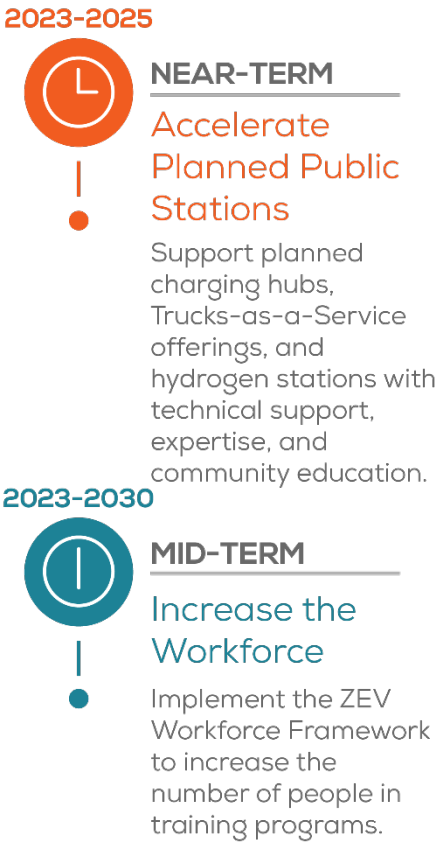
The project team will continue to support the City of West Sacramento in applying for funding and with technology solutions that may reduce the engineering analysis and more importantly, the grid upgrades PG&E requires. For example, battery-integrated chargers feature built-in batteries that allow the unit to dispense at up to 150 kW DC but interconnects to more widely available and less costly 208/240-volt power from the grid. Battery-integrated chargers can enable deployment of more DCFC units at more

[13] Locations may also accommodate light-duty EVs

locations, creating better distributed network coverage with lower grid upgrade costs than standard DCFCs without integrated storage.

SMUD will share information about SMUD's experience with offering incentives for battery-integrated chargers with PG&E. We recognize that PG&E must work with the California Public Utilities Commission (CPUC) to be able to offer incentives to its ratepayers. However, if PG&E were to offer battery-integrated chargers in its existing programs, it will help customers reduce interconnection costs in capacity-constrained locations.

West Sacramento has eight commercial fleets that are subject to the proposed Advanced Clean Fleet Regulation and is home to the US Postal Service distribution center.[14] Six of the largest fleets, all operators of Class 8 trucks used for goods movement, are in West Sacramento's industrial area near the Port. Many West Sacramento operators will choose BEVs and want to install charging stations.



A hydrogen station is planned for the Port of West Sacramento to support multiple port-related fuel cell pilots and to offer public hydrogen fueling. Supporting these companies' transition to fuel cell trucks would create a baseload for the station and minimize investment in electric capacity upgrades.

West Sacramento also provides an opportunity for workforce development and training. A partnership with CMC, Sacramento City College's West Sacramento campus, and City of West Sacramento's Kids Home Run program could create a pipeline of skilled workers for hydrogen stations and fuel cell trucks. The project team is supporting CMC in identifying specific careers in hydrogen station construction and servicing and discussing funding opportunities from the California Workforce Development Board's High Road Training Partnership project. Frontier Energy is the operator of the Hydrogen Fuel Cell Partnership and a partner in Kids Home Run, which provides paid internships for high school seniors. This collaboration, with support from CMC, makes West Sacramento an ideal location for a High Road grant.[15]

A deployment of multiple, visible charging stations along with the existing and planned hydrogen stations available for MD/HD vehicles provides a ripe opportunity to partner with

[14] Federal fleets are exempt from Advanced Clean Fleet Regulation
[15] https://cwdb.ca.gov/initiatives/high-road-training-partnerships/

UC Davis Institute of Transportation Studies to research the effect of ZEV infrastructure on ZEV adoption among West Sacramento businesses and independent operators.

Beyond the Grid

Intelligent charging will help with grid harmonization. Intelligent charging considers the batteries' state of charge (SOC), energy rates, peak load, and sometimes utility control signals to determine how EVs are charged. The three types of intelligent charging are:

1. **Automated Load Management (ALM)** is customer driven and balances charging to reduce peak power draw to reduce demand charges and the scale of behind the meter distribution infrastructure. ALM also shifts energy consumption away from periods when electric rates are higher.
2. **Managed Charging (V1G)** is the automated curtailment or shifting of charging for grid optimization needs and is utility driven. Utilities can use V1G to reduce system peak, reduce capacity demand on utility distribution infrastructure, or energy optimization to consume lower-cost energy or excess renewable energy.
3. **Vehicle to Grid (or building) (V2G/B)** is the automated partial discharge of the EV battery for grid optimization needs and is utility driven. V2G can offer broader services than V1G and potentially serve as a Virtual Power Plant in aggregate.

SMUD expects managed charging will substantially decrease system and peak load, which could amount to a measurable savings from avoided distribution infrastructure upgrade costs. Furthermore, when utilizing V2G, EV load would be shifted or curtailed, and the customer net load could also be decreased as the EV discharges to the grid. These technologies could help spread out infrastructure upgrade costs while also allowing for increased capacity for additional EVs. The impact of intelligent charging depends on use cases and customer participation.

To safeguard reliability, it is important that SMUD maintain a diverse resource portfolio that reflects different generation technologies and geographic diversity. EVs will likely be one of the most flexible resources of electrification efforts and could be pivotal for matching power consumption with renewable generation on an hourly basis. V1G and V2G will both play an important role in grid decarbonization because they constitute flexible loads that could be better aligned with the availability of renewable generation thereby reducing the amount of renewable energy curtailed.

Sacramento-area municipalities are all in compliance with the requirements for streamlined permitting, and station developers do not report any delays in obtaining permits. However, it's important to start working with authorities having jurisdiction (AHJs) now to prepare them for V2X deployments.

Hydrogen deployment can also avoid utility upgrades. Utility-controlled demand management and load balancing could shift excess energy to hydrogen production and compression; hydrogen dispensing has minimal grid impact. Due to the anticipated strains on PG&E capacity, hydrogen in West Sacramento may be a better option.

To reach each city and county's goals for carbon neutrality and carbon negativity, hydrogen must be produced from renewable sources. The Kiefer Landfill and Sacramento's Regional Sanitation District (Regional San) are both reliable sources of bio-methane. Both facilities currently operate co-generation facilities that burn the methane to create power for SMUD. In the future, some or all this methane could be converted to hydrogen and used in a stationary fuel cell for power and provide fuel to hydrogen stations. In this project, the team estimated that methane from the Kiefer Landfill could provide 57,000 kilograms of hydrogen per day, nearly meeting the projected 2035 demand for hydrogen.

Converting from co-generation to hydrogen production is a costly endeavor, and the currently low price of Low Carbon Fuel Standard credits currently makes this a less-attractive value proposition for producers. It will be important to work with the hydrogen producers, like Raven SR and Bayotech to develop the business case for green hydrogen.

Managing Charging and Electricity

Fleet operators that already use fleet management information software (FIMS) want to continue using the product they own. Utilities need a software platform that interoperates with vehicle fleets to enable utilities to manage energy supply. This could be made possible through interoperability with existing Distributed Energy Resource Management Systems (DERMS) employed by utilities. Ideally, the FIMS used by fleets would integrate with a charge management system that is integrated with the utility side DERMS system.

Many third parties (e.g., EVSPs, auto manufacturers, aggregators) are developing proprietary charge management solutions that claim compliance with open standards protocols. However, in real-world deployments, the data and communications are incompatible among different vehicles, charging stations, fleet management software, and utility systems. Considering this, SMUD is exploring the potential to acquire or co-develop a first-of-its-kind electric fleet ("eFleet") aggregation solution that will be fully interoperable and vendor agnostic.

An open architecture eFleet management platform would accommodate FIMS software brought by fleets that rely on them. Fleets that don't currently use FIMS software would have the option of adopting the eFleet dashboard. All EV operators (including light-duty vehicles) can use the eFleet tool for vehicle scheduling and energy management. The

utility would have a full view of the two-way energy flows between the grid and its individual fleet customers via a single unified dashboard. Ultimately, the tool would make it possible for fleets to participate in energy markets.

In sum, an overarching "eFleet of eFleets" platform would enable utilities to manage dynamic energy supply, leveraging rates and programs to influence energy use. It would also unlock value for the utility through grid integration and optimization.

6 The Depot Park Ecosystem

The region that was once the Sacramento Army Depot is now a large industrial area known as Depot Park, shown in Figure 11. It includes about 4,000 MD/HD vehicles in large and small fleets and is situated adjacent to neighborhoods in disadvantaged communities. It has sufficient grid capacity to accommodate fleet electrification in the near- to medium-term, two truck-only gas stations, distribution centers, truck service businesses, and a privately owned landfill. The California Mobility Center is in the Depot Park.

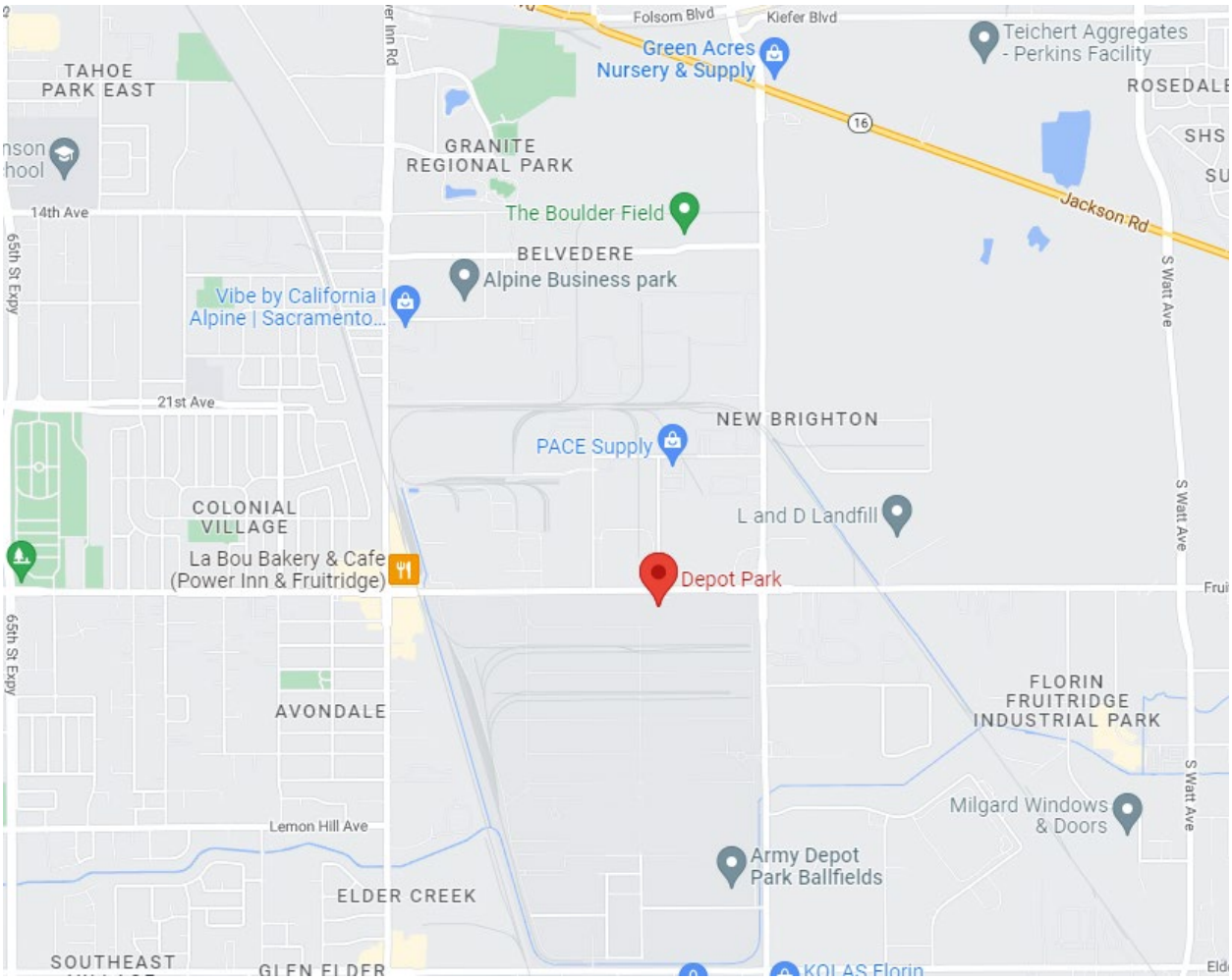


Figure 11: Depot Park Business Park (source: Google Maps)

This area presents an opportunity to create a ZEV ecosystem that incorporates both ZEV fuels, onsite electricity, and hydrogen production, all fueling deployment models, and workforce development.

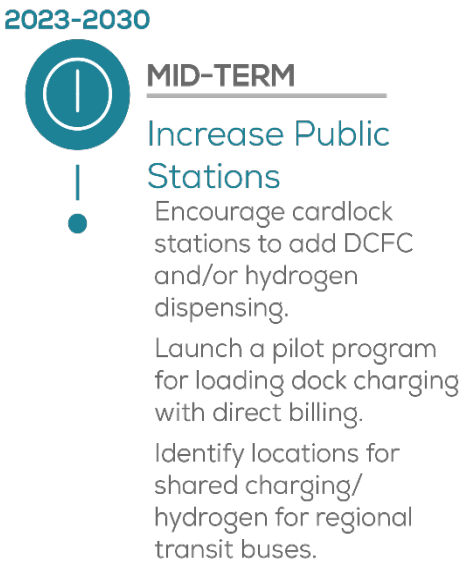
Fueling Deployment Models

Through interviews, surveys, focus groups, and input from the project's technical advisory committee, the project team identified three deployment models for future charging and hydrogen fueling:

1. **Depot Charging and Fueling** – Nearly all large fleets have a dedicated fuel depot. The large fleets interviewed for this project stated they expected to deploy charging stations in their parking lots. Those larger fleets that expressed interest in fuel cell vehicles prefer a dedicated hydrogen station. Dedicated charging/fueling allows fleet operators to control costs, both for the fuel and the for the employee or contractor fueling the truck. It also ensures vehicles will be charged or fueled and ready for work. Required safety measures and maintenance make dedicated hydrogen fueling challenging for smaller fleets.
2. **Public Charging and Fueling**—Smaller fleets and owner-operators fill their vehicles at public stations that have high canopies and room for larger vehicles to maneuver. Local drivers may also use travel plazas (truck stops), but these are more common for over-the-road truckers. Fleets expressed interest in siting Level 2 charging stations at their business location(s) in combination with truck-accessible public DC Fast Charge (DCFC) stations for on-route charging or charging when parked for loading and unloading. Those interested in fuel cell vehicles expected to use public or cardlock hydrogen stations. Additionally, a network of transit agencies in surrounding counties serve the Sacramento region. To support their transition to ZEV, the region will need at least five facilities for shared charging/hydrogen.
3. **"No Depot" Overnight Charging**—Individual owners of heavy-duty trucks and buses typically park their vehicles at truck service businesses and self-storage facilities. Individual owners further shared that charging stations at overnight parking facilities would be helpful, particularly if charging involved a flat fee similar to how they currently pay for parking.

Depot Park has about 11 companies that will likely need to comply with the Advanced Clean Fleet regulation. SMUD will closely coordinate with the large fleet operators that include PG&E, Henrickson Truck Lines, and Hunt & Sons and to leverage SMUD's eFuel^{SM} Charging as a Service program. eFuel provides advice and technical support to guide fleets in their transition planning, and then provides an option for SMUD to install, operate, and maintain charging assets. This could reduce the upfront costs to the fleets and enable SMUD to deploy load management programs to mitigate exposure to demand charges.

In addition to the large operators' vehicles, about 300 MD/HD vehicles are registered to addresses in Depot Park and hundreds of other vehicles travel to Depot Park's distribution centers and warehouses. Other MD/HD vehicles, including Sacrament RT buses and County of Sacramento refuse trucks fill with renewable natural gas at the ReFuel station, which plans to add hydrogen. Ramos Oil operates a gasoline and diesel station in Depot Park with room to add pull-through charging lanes and/or hydrogen.



Loading Dock Charging Pilot

Interviews revealed that goods movement operators carefully plan routes to ensure drivers stay within the Federal Motor Carrier Safety Administration's (FMCSA) hours-of-service regulation.[16]

For example, a multistate grocery chain shared that a typical distribution route is about 150 driving miles one way. The driver takes a 30-to-60-minute break while the trailer is unloaded and reloaded, and then returns 150 miles to Sacramento. On the outbound trip, the warehouse can control the payload weight to ensure the load out matches the payload capabilities of the EV truck. However, it would be nearly impossible to control the payload weight on the return trip.

In another interview, a company that distributes linens relayed that drivers make multiple stops during a shift and spend between 20-45 minutes at the loading dock per stop. The departing leg transports clean linens; as clean linens are offloaded and replaced with heavier dirty linens the payload weight increases, which negatively impacts range.

[16] https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations

These operators, and others interviewed for this project, maintain they need ZEV trucks capable of between 350 and 400 miles of range and/or must charge during stops for loading and/or unloading. Operators of distribution centers and warehouses expressed little interest in adding charging stations because of the impact on the warehouse's electric bill. As one facility manager put it, "Why should *I* pay for *their* fuel?"

Further complicating matters, the 2022 California Green Building Standards Code, Title 24, Part 11 (CALGreen) requires new grocery stores, warehouses, and retail stores with planned off-street loading add raceways, service panels, and transformers for medium and heavy-duty charging stations but does not specify where those should be located (e.g., on the dock or in the parking lot) or specify DCFC or Level 2 charging.[17]

SMUD and the project team propose to investigate the potential for a pilot program with one of the busier loading docks in Depot Park, such as Milgard Windows, Cintas, Allied Van Lines/Colonial Storage, or Ferguson Supply. The project would explore innovative installation, operation, and payment models for the placement of DCFCs in loading areas so that drivers can recharge while loading and unloading. This pilot proposes to explore:

- If basic credit card reader (CCR) systems would be sufficient or if a specialized payment system that enables direct billing of the trucking company or operator, would be needed. Direct billing would need to work with multiple charging station vendors' systems to ensure that drivers can charge at every loading dock.
- Controls such as contract terms to ensure that the cost to charge is consistent among charging network vendors and facilities and that pricing remains affordable over time. Controls should ensure that a vendor cannot unreasonably increase the price per kilowatt from pennies to dollars once the vendor secures a captive client base.
- Technology solutions that will respond to the grid and enable drivers to complete their routes. For example, California endured an extreme heat wave in early September 2022 with tremendous grid impact. Individuals and businesses across the state reduced their energy use to avoid widespread blackouts. Responses like these could lengthen charge times for drivers, which, in turn, could force them to exceed their FMCSA hours and leave them and the truck stranded.

[17] https://codes.iccsafe.org/content/CAGBC2022P1 -- CG 5.106.5.4. EV Charging: medium and heavy-duty

through 2040

LONG-TERM

Create "No-Depot" Charging Locations

Identify locations at which owner/operators park overnight and coordinate funding for charging stations and EV truck purchases.

Produce Green Hydrogen

Explore hydrogen gasification with the private landfill at the Depot Park ZEV ecosystem.

through 2040

LONG-TERM

Start a Transactive Energy Pilot

Collaborate with DOE and National Labs to launch a pilot with at the Depot Park ZEV ecosystem that includes a microgrid, long-duration energy storage, and hydrogen production.

Several businesses at the southwest corner of Depot Park offer truck repair, towing, and other services and may provide overnight truck parking. These entities could be engaged to install charging equipment ideally suited for independent owner/operators who routinely use these facilities. During interviews, owner/operators expressed interest in having Level 2 charging that would be a flat monthly fee added to the fee they pay for parking.

Depot Park has a large existing solar array. Integrating an electrolyzer could use excess solar to produce hydrogen. Another option is to deploy a gasifier at the L & L Landfill, a privately operated refuse site that accepts a variety of hazardous materials. A gasifier, such as Sierra Energy's FastOx, turns waste into tar-free synthesis gas that can be further refined into hydrogen.[18]

Demand Management and Transactive Energy Pilot

Demand management (DM) enables utilities to interact on a limited basis with smart appliances, including charging stations, to briefly turn devices on and off or throttle power to help reduce demand when electricity use spikes. Communication is largely one-way after the customer sets their requirements and preferences (e.g., time(s) of day, kW needed, events per year). DM then adjusts energy delivery in such a way as to respect those preferences.

Transactive energy extends DM by coordinating energy generation, consumption, and delivery. It uses two-way communications so that in addition to the utility communicating with a device, the device can communicate with the utility and potentially to the power producer.

Pacific Northwest National Labs (PNNL) led two transactive energy pilots that involved buildings, one in Texas and one at its own campus in Spokane, WA. Both focused on distributed energy resources (DERs). The Depot Park ZEV Ecosystem can extend PNNL's projects by combining DERs with green hydrogen production and smart Level 2 charging. In this scenario, the existing microgrid would be enhanced so that it is islanded—it can function independent of the grid. The charging stations and hydrogen

[18] https://sierraenergy.com/

systems in the pilot would communicate with the microgrid's solar energy production and energy storage to balance and optimize energy production, storage, and delivery. The project team aims to connect with PNNL researchers and will seek funding for a transactive energy pilot for MD/HD charging stations in alignment with a microgrid developer. SMUD's proposed eFuel platform could be the management platform for the pilot.

The proposed pilot would require commitment from a hydrogen producer and at least one fleet operator.

7 Addressing Smaller Fleets and Individual Operators

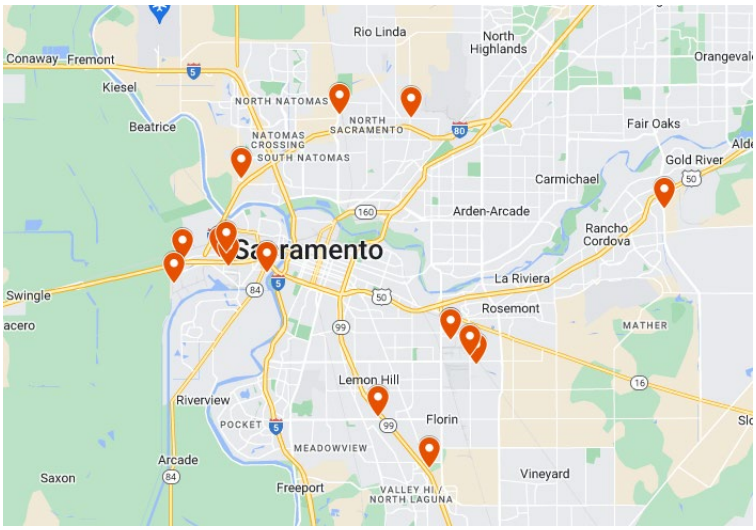
Small fleets—those with 3-25 MD/HD vehicles—are located at 900 addresses throughout the Blueprint area, plus the 3,000+ addresses with 1-2 vehicles. In addition to West Sacramento and Depot Park, which are the two largest clusters, the largest clusters with small fleets are listed in Table 4. The Unique Addresses number includes businesses with loading docks, but without domiciled or registered trucks. Individual operators are also clustered in these areas.

Table 4: Clusters of small fleets

Area	Sum of MHD Vehicles	Unique Addresses
Elk Grove—Dino Drive/Kent St./Waterman Rd.	117	14
Gold River/Rancho Cordova-Pyrites Way	122	6
Sacramento/North Highlands—Auburn Blvd/Chippendale Dr.	113	12
Downtown Sacramento/Richards Blvd.	497	65
North Sacramento/Natomas	346	52

Small fleets and individual operators will likely be second or third movers in the transition to ZEVs. Interviews and focus groups identified that operators plan to wait for costs of ZEVs to fall to levels comparable to conventional trucks and to evaluate real-world information about reliability and operating costs. They also want to see convenient, accessible, and reliable public charging and hydrogen stations capable of charging/refueling a ZEV in 10 minutes or less.

Most drivers said that they fueled at cardlock stations, which typically look like a parking lot with fuel pumps and a canopy. Some of these stations have fueling islands for light-duty vehicles, amenities like a convenience store, and/or are branded Shell or Chevron. Truck drivers use telematics or a fueling card from the Cardlock Fuel Network (CFN) to activate the dispensers.



Drivers reported that they don't typically stop at truck stops/travel plazas. Those stations cater to long-distance drivers that want one stop for fuel, food, and a mandatory rest period.

Figure 12 is a map of the existing cardlock stations and the one travel plaza in the Blueprint area.

Figure 12: Existing Cardlock Stations (source: Google Maps)

2023-2030

MID-TERM

Increase Public Stations

Encourage cardlock stations to add DCFC and/or hydrogen dispensing.

Identify locations for shared charging/ hydrogen for regional transit buses.

As the map shows, these stations are in the same areas as the census identified as homes to small fleets and independent operators. Adding a DCFC to these locations would emphasize the convenience of electricity as a fuel. Moreover, these sites are potential candidates for onsite solar and storage, which could help mitigate grid impacts. A combination of incentives, tax credits, carbon credits, and favorable SMUD rates could help operators like Ramos Oil invest in charging stations as a transition to the future. Working with operators that are part of the CFN network can create a business case for installing DCFC, solar, and battery storage to increase access to public charging for trucks and buses

Additionally, an MOU developed by Sacramento Regional Transit, SACOG, Sacramento Metro AQMD, and SMUD identified a need for strategically sited ZEV fueling stations to support the transition of area transit buses to ZEVs. Neighboring counties' transit agencies operate commuter buses to and from downtown Sacramento, and battery-electric buses will likely need to charge in Sacramento before returning to Vacaville. El Dorado Hills, Stockton, and other destinations. Sacramento and West Sacramento also have facility for non-transit operators, like Greyhound and WeDriveU, that will potentially need access to shared charging and/or hydrogen stations.

8 Job Training and Workforce Development

In 2021, Valley Vision released a report about ZEV-related jobs in the Sacramento region. Figure 13 shows the job types in a mature "mobility cluster" in Greater Sacramento and the existing training programs at high schools, colleges, and trade schools. Valley Vision predicted 1,200 total jobs in non-business-related career-technology education (CTE) programs over three years.

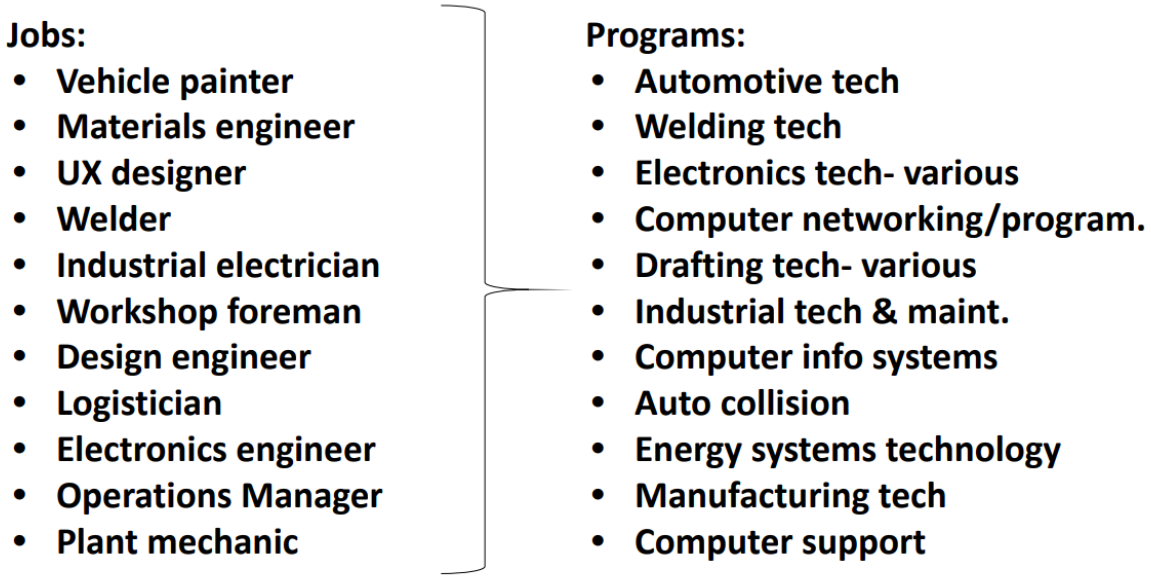


Figure 13: Technical Jobs and Training Programs (source: Valley Vision)

The MD/HD ZEV transition will affect key occupations differently. Roles related to service technicians will require upskilling to incorporate high-voltage electrical safety. ZEV operators or drivers will require basic training to understand the operation and safety differences between a ZEV and an internal combustion engine vehicle (ICE). Customer service occupations, like sales managers, will require training so they understand and can communicate ZEV fundamentals and benefits.

The Brookings Institute created a data visualization tool, Moving Up, that tracks pathways from "sandpit jobs," those with low wages and little upward mobility, to "skyway jobs," those with a trajectory to advancement. Figure 14 shows a potential pathway for a retail salesperson to a skyway, upward mobility job associated with a growing industry and a need for some specialized knowledge like the EV industry represents.

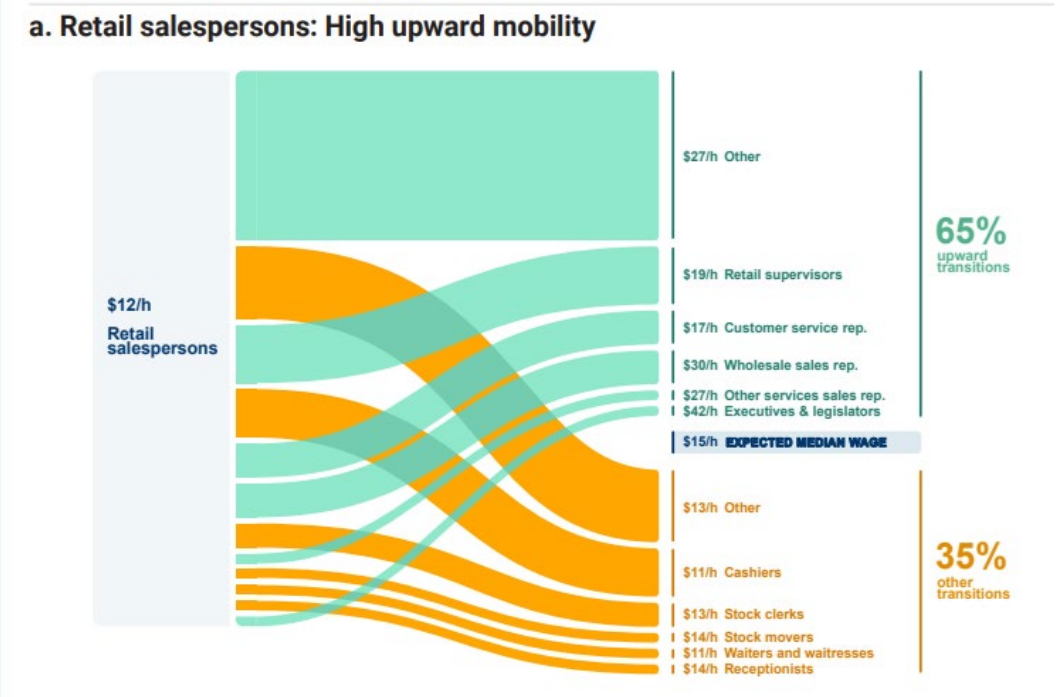
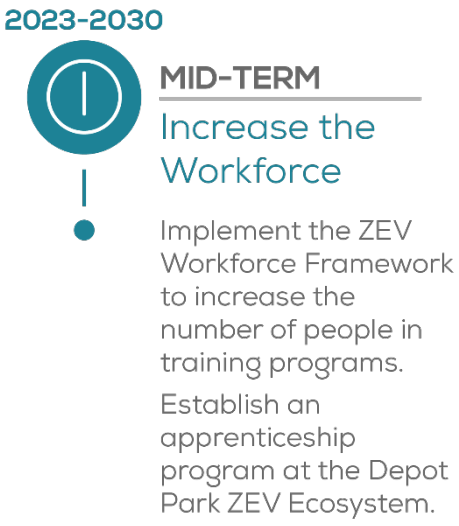


Figure 14: Pathway to Upward Mobility for a Retail Job (source: The Brookings Institute)



The Sacramento area has about 108,000 people employed in the Brookings' categories of sandpit jobs. Education and training for these workers could help fill the hundreds of skyway EV jobs needed in Sacramento in the next few years, and position Sacramento as having an informed and educated base of workers that will help Greater Sacramento Economic Council attract EV-related businesses to the Sacramento area businesses, a G-SAC focus area.[19]

Figure 15 and Figure 16 show CMC's general framework for engaging target communities and providing a framework to transition a person from an entry-level job to a high-wage career.

[19] https://www.greatersacramento.com/business-climate/industries/future-mobility/

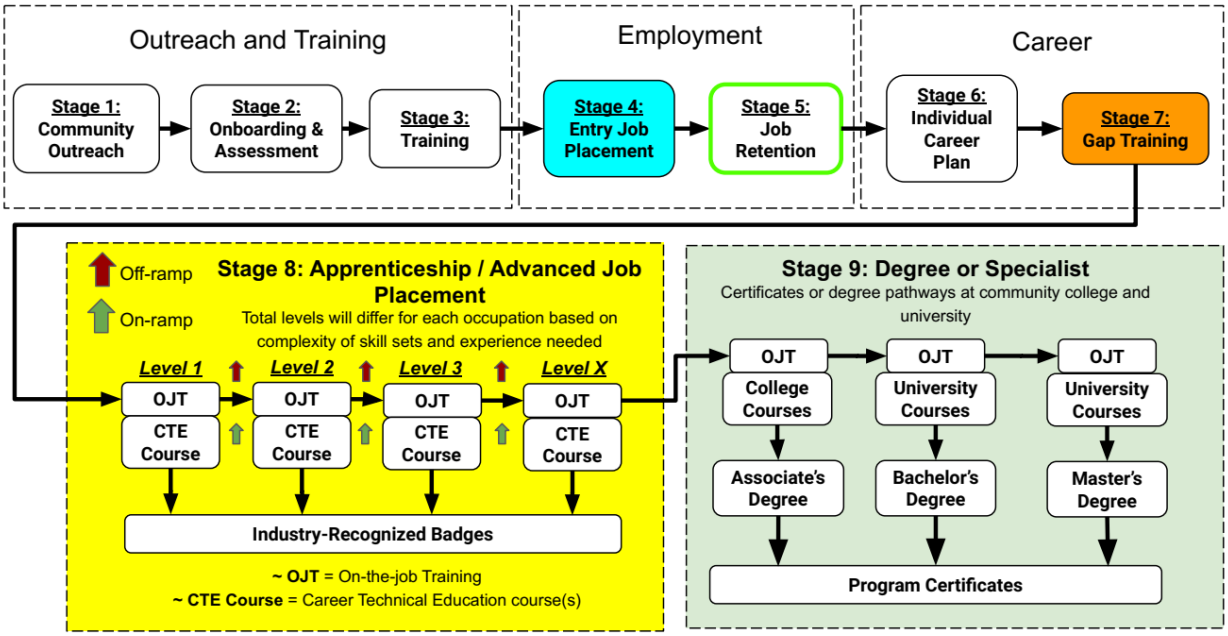


Figure 15: Career Pathways Pipeline Model/Framework (source: CMC)

Figure 16: Wage Range of Job Types (source: CMC)

Job training needs to be more accessible and productive for targeted populations that include:

- People for whom training programs are a financial hardship
- People with limited or no English comprehension
- People with criminal histories
- People who do not read or write at least at a 9th grade level
- People who are full-time caregivers for others
- People with limited or no transportation
- People with mental and physical health problems, including addiction
- People who had a poor experience with school
- People who are in low-income households
- People who are homeless or in transitional housing

Each of these groups has unique needs to access training programs, may need more time and support to complete training, and then may need a longer on-ramp to transition to a job. The California Mobility Center is partnering with 15 community groups and training programs to give trainees the individual support they need to enroll in programs and stick with them.

The project team further identified challenges and opportunities (in Table 5) for workforce training that also apply to outreach on the transition to ZEVs.

Table 5: Workforce Opportunities and Challenges

Challenge	Opportunity
Many people from target communities have financial hardships and anxiety. Inclusion in a new industry or career with high-wage potential may not be enough to overcome the hardships and fear.	Events like career fairs, focus groups, info sessions, and workshops that require less than a day (or evening), use gift cards, raffles, and refreshments to encourage attendance. Longer courses, technical panels, and training programs should consider financial incentives like stipends or scholarships so there is no need for participants to forego income to attend.
Technical verbiage, even when assumed to be simple, is not easy for people to understand, particularly those for whom English is a second language or have limited reading skills.	Use storytelling and associations to help people understand basic concepts. For example, descriptive phrases such as "electric vehicle *like a Tesla*," helps people draw the link between technology and a consumer product. Avoid unfamiliar acronyms, like ZEV and EVSE, which are meaningless for most people.
Potential students and ZEV owners need to see the trade-off between a today's investment and a higher income that may take months or years to materialize. Participants need factual information, not promises.	Materials need to clearly articulate the duration of a training program, the risks involved, the starting wage and potential wage cap for a job, the reliability of vehicles, etc.
People in the ZEV industry do not look like the people we are trying to recruit.	Identify people who are either employed in a direct or related ZEV job, an early ZEV adopter, and/or actively participated in a training or employment program as ambassadors. When they reflect the culture of the community, ambassadors are the most effective method to recruit people into a new or unfamiliar industry.

Challenge	Opportunity
Many people in target communities struggle with reading. Outreach and training materials tend to be heavy with text, either in print or online. Additionally, some programs require that applicants pass a written test or submit applications and reports in English and sometimes in Spanish.	Collateral and course materials should use more images and incorporate video. Short video clips that are quick to watch have a major impact on comprehension. Others include 1) using members of the community to translate materials into other languages, like Russian, Farsi, and Hindi, and ensure that the materials are culturally appropriate for the target audiences. 2) Offering physical and interactive activities or experiences so that people can imagine themselves in a ZEV career or operating a ZEV. Interactive activities also help reduce the stigma that ZEVs are inaccessible and complicated.
Every participant's journey is different, and they all have unique barriers and roadblocks to workforce development and employment. A broad-brush approach to barriers benefits few people.	Establish an ecosystem so that activities, education, and outreach provided to the community will first be validated by the network of community partners. Program managers, coaches, social workers, counselors, and educators can participate in a series of workshops designed to educate about the scope of the ZEV industry and the many career options exist. The workshops will be combined with site visits to further illustrate the operational side of the occupations (how the job functions are applied in reality). An optimal site visit will be one that has an ambassador working there. This requires strong relationships to be established with business and division executive leaders.

Challenge	Opportunity
Community engagement events are often a hard sell for recruitment or participating in a program. Individuals are asked to commit on the spot, which often sets them up for failure when unexpected financial hardships, a loss in the family, drug abuse or addiction-related relapse, and other issues arise, and the participant lacks a ready support system to help them through it.	Position career fairs, focus groups, info sessions, and workshops to educate and inspire rather than to recruit. The ZEV industry needs people that are motivated and illustrate initiative. Once the participant expresses interest the role of community partners, training providers, and employers should be to fuel that interest until it becomes a passion. It also helps to establish a strong support system within the community, the program, and a potential employer to help the participant weather life's storms.
Like many other technical trades, a career as an electrician requires frequent use of mathematics like algebra and trigonometry. Many adults in target communities are not able to satisfy a 9th grade equivalent level of proficiency in math skills. Furthermore, the effect of COVID has reduced the level of math competency for youth graduating in 2022 and beyond.	Align math proficiency goals with interactive activities that are fun, engaging, and relatable to the target communities' perspective. Rather than leading with learning math, lead with an engaging activity that emphasizes and gamifies the use of mathematics. An additional tactic is to expand and enhance personal financial literacy training. This will solve the issue with math skill gain and prepare people to navigate the job market (wage and benefits), manage their debt obligations, and increase their savings. With the increased comfort of math, more people from priority communities will at least be eligible for more technical careers.

EVITP

People in the jobs that involve installing charging stations are already trained to manage high voltage electricity but may be prohibited from doing so due to EVITP.

California's Assembly Bill 841 (Ting, 2020) added Public Utilities Code (PUC) section 740.20 that requires Electric Vehicle Infrastructure Training Program (EVITP) certification to install State-funded electric vehicle charging infrastructure and equipment. Currently, it requires that at least 25% of the workforce on a job site must be EVITP-certified.[20]

In August 2022, California has about 33,000 licensed electricians[21] and the EVITP website showed 174 EVIT-certified electricians statewide and 12 in the greater Sacramento area.[22] SMUD has identified that the requirement for EVITP certification will soon be a deployment bottleneck, which will potentially worsen with the National Electric Vehicle Infrastructure (NEVI) program and as new information for V2X is introduced.

EVITP was collaboratively created by industry stakeholders and is operated by Powering Michigan's Future, a non-profit associated with the National Electrical Contractors Association (NECA). The way that EVITP is implemented presents three barriers to achieving California's goals for EV deployment and will be exacerbated if NEVI requires that all electricians are EVITP certified:

1. EVITP is limited to journeymen electricians (those with 8,000 hours of paid work). Similar training is not available for other jobs that are essential to accurately and safely installing charging stations. In an interview, Bernie Kotlier, the national co-chair of EVITP, said that EVITP will be available only to journeymen electricians.
2. It takes years to become a journeyman electrician and initially wages are low. It limits many groups of people from participating in EV charger installation.
3. EVITP is managed by a small staff and a network of industry volunteers to update curriculum and proctor certification tests, which limits the ability to expand the program. Online training became available in August 2022, but the in-person

[20] https://ww2.arb.ca.gov/2020-assembly-bill-841-ting-philip-electric-vehicle-infrastructure-training-program-and-energy
[21] https://data.ca.gov/organization/california-department-of-industrial-relations
[22] https://evitp.org/california

exam is only in Los Angeles and San Francisco and offered about four times a year.

To ensure that electrician certification is not a barrier to EV charging station deployment:

- EVITP could license their content to State-approved training programs to increase the number of trainers, training locations, and testing options. Alternatively, regulations could refer to EVITP and similar State-approved certification programs.
- EVITP content should be available to apprentices, estimators, designers, installers, and other support positions, potentially with a credential that demonstrates competency, yet is clearly distinguished from certification.
- EVITP content should be integrated into electrician training programs at community colleges to capture growing interest in EV charging and encourage more people to become electricians.
- NECA and Powering Michigan's Future need to start now to integrate V2X content into the certification program and incorporate training for AHJs.

Considering how EVITP-style training can be part of a career roadmap can help California meeting the demand for charging station design, installation, and commissioning and create a pathway to engage people to become a journeyman electrician.

9 The Human Side of the MD/HD ZEV Transition

Sacramento is a hub for goods movement because of its proximity to north/south and east/west interstates and highways. Figure 17 shows the highways in dark grey lines and the relationship between traffic routes and disadvantaged communities.

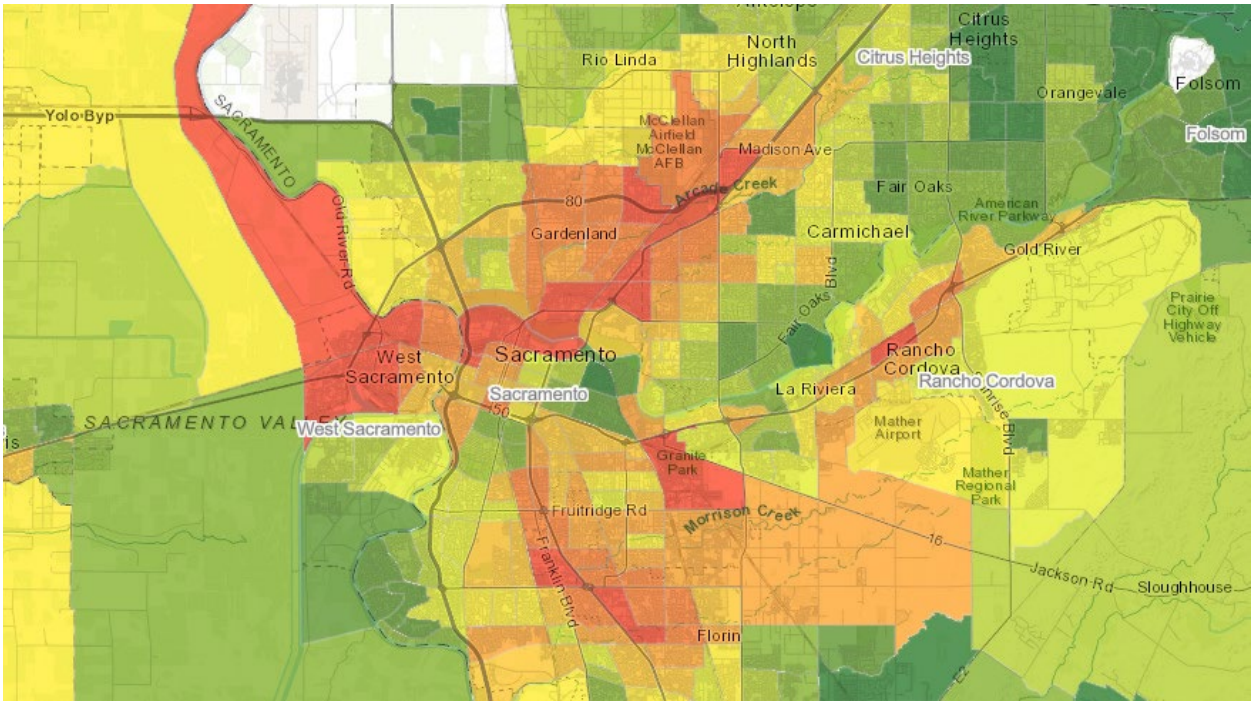


Figure 17: Sacramento Highways and Disadvantaged Communities (source: CalEnviroScreen 4.0)

Deborah Archer, who has researched and writes on the inequity of America's interstate system stated, "(The) construction of the interstate highway system contributed to the residential concentration of race and poverty, and created physical, economic, and psychological barriers that persist."[23]

In Sacramento, construction of Interstate 80 ran through the center of West Sacramento, effectively separating the West Sacramento into two halves, and cleaved the White neighborhood in downtown and the largely Asian community near Broadway. Highway 99 divided Oak Park and Curtis Park, and I-5 separated the Pocket Area from Meadowview.

Businesses that serve traffic and freight naturally grew along the freeways and left some areas behind. West Sacramento's once-thriving entertainment district along West Capitol Avenue became blight. Little Saigon on Stockton Blvd. and the Del Paso Business District went from thriving to dying when people took the highway instead of the main thoroughfares.

[23] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3539889

We intend the ZEV Blueprint to benefit the people who live and work close to freeways and industrial zones, but more importantly, work with the community members to understand barriers that are uniquely theirs, listen to their hopes and worries, and then seek opportunities within the project to fulfill their aspirations and ensure the project doesn't spawn unintended consequences.

Small businesses and independent owner/operators are worried that vehicle electrification will put them out of businesses. They are also worried about today's high fuel costs and the negative impacts of inflation, and the supply chain slow down unleashed by the COVID-19 pandemic. Their business is based on day-to-day cash flow, not air quality and climate change. To benefit from ZEVs, small business and independent owner/operators need to see the immediate economic advantage of charging or hydrogen fueling. A 10-year return on investment, while informative, is insufficient on its own to compel action.

Studies show that 40% of new truck drivers are recent immigrants.[24] In the Sacramento area, we interviewed truck drivers who speak Russian, Spanish, Hindi, Cambodian, Punjabi, and Farsi often with the help of a translator. Many of the terms we used were difficult or impossible to translate and it was challenging to communicate concepts of vehicle electrification and explain rebates and incentives. As ZEVs roll out, it will be crucial to engage business owners, drivers, and all workers in the languages and styles that they use.

The project team had very low response to surveys. In interviews, about 25% of participants were unwilling to share information about their driving, fueling, and parking habits. People were hesitant about giving out information for a variety of reasons. The built-in data collection of EVs and charging stations elicits concerns, and reporting requirements for some incentive programs are a major deterrent.

[24] https://www.forbes.com/sites/andyjsemotiuk/2022/08/31/foreign-immigration-could-relieve-us-trucker-shortage/?sh=40e30cab1839

10 Estimated Greenhouse Gas Reduction

Using data from Guidehouse and NREL, we forecasted the growth of the MD/HD vehicle population through 2050 and then estimated the percentage of vehicles that would likely be ZEVs, shown in Figure 18. Guidehouse projected ZEVs would comprise 26% of the MD/HD vehicles on the road in 2041 (24% battery electric and plug-in hybrid and 2% fuel cell electric). For 2050, NREL projected ZEVs would comprise 80% of the MD/HD vehicle population – 66% BEV and 14% FCEV—with a corresponding decline in GHG emissions by 69% when compared to 2019.[25]

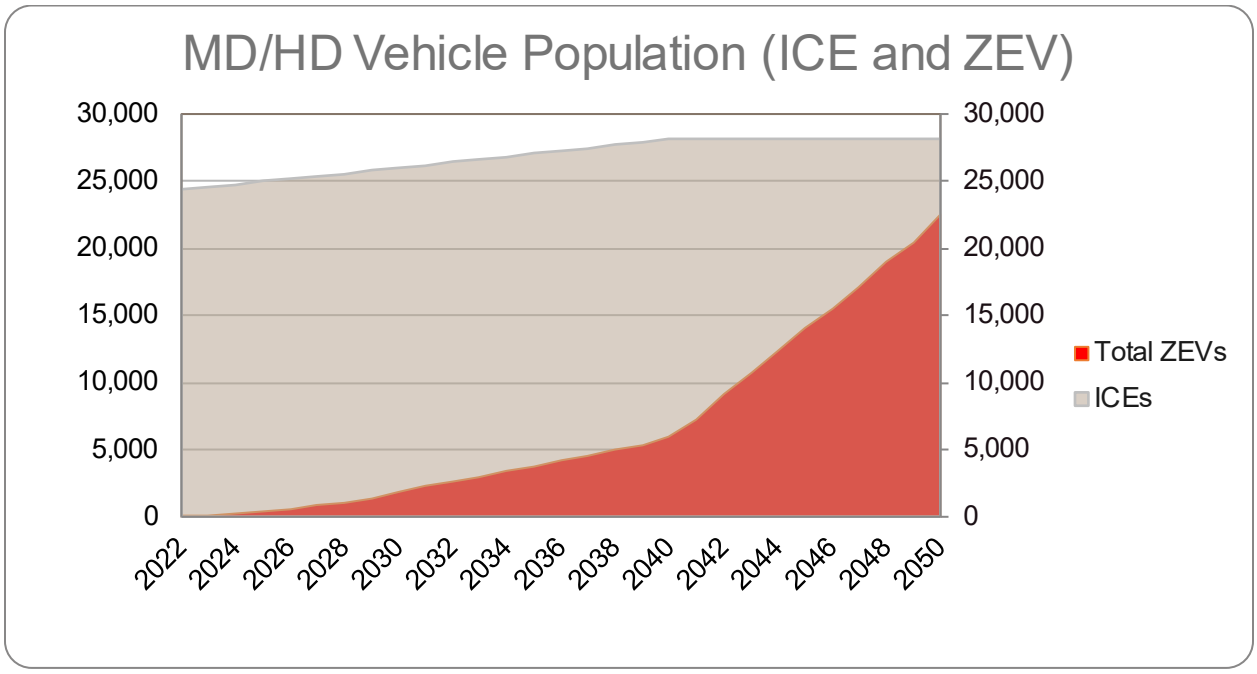


Figure 18: MD/HD Vehicle Projections (source: Frontier Energy)

The project team used Argonne National Lab's AFLEET tool to calculate emissions using a single-unit short-haul truck with a California mix of diesel operating 16,500 miles a year as the representative vehicle. AFLEET calculates a resulting 165 metric tonnes of CO2 per year of operation.

We assume that all ZEVs are new vehicles. Because current emphasis is on using renewable electricity and hydrogen for ZEV fueling, we used AFLEETs renewable pathways. and will use 100% renewable electricity for charging and 100% renewable hydrogen for fuel cells and, therefore, will have zero GHG emissions. Figure 19 shows the estimated tonnes of CO2 that will be avoided through 2030, cumulatively, according to projections of ZEV adoption.

[25] https://www.nrel.gov/docs/fy22osti/82081.pdf

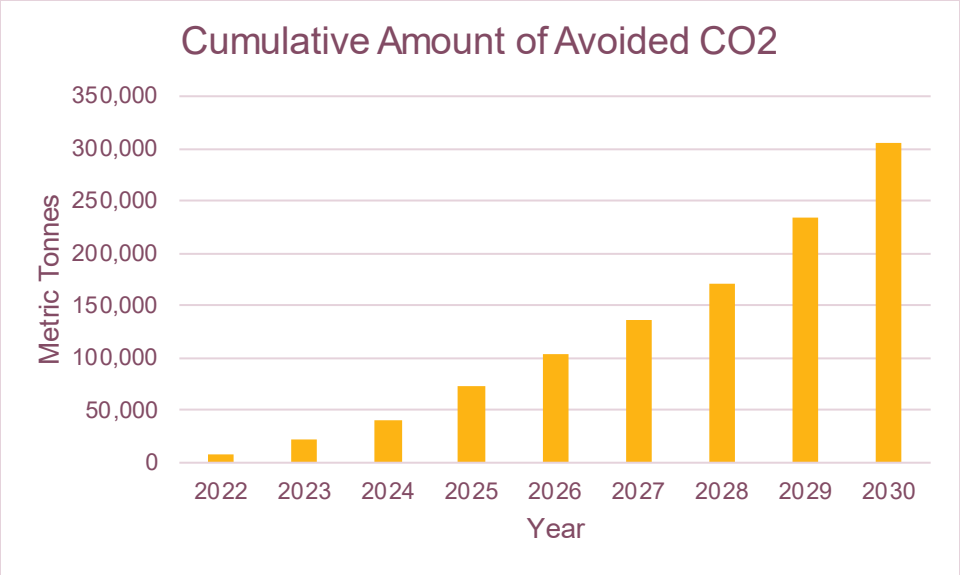


Figure 19: Avoided GHG Emissions by ZEV Vehicles (source: Frontier Energy)

11 Next Steps and Actions

Implementing the strategies in this blueprint can accelerate the adoption of ZEV MD/HD vehicles and increase GHG savings, which is vital to stabilizing the effects of climate change and improving the quality of life in Sacramento.

Many of the items in this plan require funding and long-term investments, and one outcome is the need for participants to support various initiatives that cross geographic boundaries and utility service areas. In the coming years, the project team members will coordinate on funding opportunities to achieve this blueprint and try to not compete for the same project dollars.

SMUD and the project team identified near-, mid-, and long-term actions.

Many of the near-term actions were either initiated while working on this blueprint or accelerated due, in part, to the findings uncovered by the project team. For example:

- SMUD launched a commercial light-duty V2G pilot program with bidirectional capability that leverages SMUD's own fleet vehicles, including Nissan Leaf and Ford F-150 Lightning models once delivered.

- SMUD was awarded funds under the CEC's BESTFIT grant to launch an MD/HD V2G pilot program in partnership with Twin Rivers Unified School District (TRUSD), Ford Pro, and Cadmus. The program involves up to 57 electric buses from a mix of vendors plus other light-duty vehicles. The goal of the project is to test and demonstrate Advanced Load Management, V1G and V2G capabilities in phases. Construction at TRUSD's Grant Avenue bus yard was completed in summer 2022 with an anticipated project completion date of Q3 2024. SMUD aims to expand the BESTFIT program to additional school districts.

- SMUD is exploring potential V2G pilot opportunities that will include MD/HD trucks operated by commercial fleets.

- SMUD identified the need for the open architecture eFleet platform that would accommodate disparate fleet management solutions. It would also enable a unified view of fleet energy consumption through a single fleet management. The dashboard would provide visibility and control of energy flows across the entire utility system. SMUD will seek avenues for developing this "eFleets of eFleets" management tool, including potential grant funding sources.

The action defined as mid-term must be started now by seeking grants, developing business cases, starting new training programs, addresses the needs of residents and smaller businesses, and/or collaborating with projects like SACOG's Megaregion plan.

The long-term actions must also be started now. They are largely about pilot projects, education, outreach, relationship building, and planning. They are "no-regrets" actions that will avoid stranded assets and missing out on the road not taken. They are the plans

for a zero-emission future that evolve with the technology and the way that people and goods move throughout the region.

A lot can change in 30 years. In 1992, 30 years from today, the Internet was in its infancy. No one was shopping online, and Amazon had not been founded. The country was emerging from a major recession and unemployment approached 8%. With globalization, much of the job loss came from manufacturing plants closures and the U.S. started the swing from an exporter of goods and products to an importer. Home foreclosures were at record levels nationwide and hit California particularly hard. Goods movement dramatically changed because of these events.

It is changing again. The U.S. is on the cusp of a surge in local manufacturing and demand for U.S.-produced agriculture is growing. The first autonomous vehicles are in testing and companies are looking at driver-less delivery options. It's reasonable to think about a future in which the U.S. is once again a net exporter of finished goods, drones are normal for last-mile delivery, and that shared mobility is more common than personal vehicles.

The SMUD MDHD Blueprint prepares Sacramento County and West Sacramento for actions that lead us to a zero-carbon future no matter how our goods move from port to doorstep.

12 Appendix A: Summary of Actions

Near-Term	2023-2025
Support the Megaregion	Transfer the lessons learned about grid analysis to the region-wide project
	Leverage the Blueprint partnerships for funding and operation models.
Support Early Adopters	Provide technical support and funding assistance to the 42 private fleets that will need to comply with Advanced Clean Fleet.
Expand West Sacramento's Curbside Project	Coordinate with West Sacramento and PG&E to increase the number of MD/HD curbside charging locations with consideration for constrained grid capacity.
Accelerate Planned Public Stations	Support planned charging hubs, Trucks-as-a-Service offerings, and hydrogen stations with technical support, expertise, and community education.

Mid-Term	2023-2030
Increase the Workforce	Implement the ZEV Workforce Framework to increase the number of people in training programs.
	Establish an apprenticeship program at the Depot Park ZEV Ecosystem.
Support V2X	Pursue software to provide visibility to and streamline interconnection processes and to enable managed charging and V2X.
	Update and standardize interconnection guidelines to address V2X
	Provide AHJ training for V2X installations.
Increase Public Stations	Encourage cardlock stations to add DCFC and/or hydrogen dispensing.
	Launch a pilot program for loading dock charging with direct billing.
	Identify locations for shared charging/hydrogen for regional transit buses.

Long-Term	Through 2040
Plan for Capacity	Explore and evaluate advanced technologies and software that can reduce grid load of charging.
	PG&E needs to increase transformers and substations West Sacramento.
Produce Green Hydrogen	Explore hydrogen gasification with the private landfill at the Depot Park ZEV ecosystem.
	Coordinate with Kiefer Landfill and Regional San to produce hydrogen from bio-methane.
Start a Transactive Energy Pilot	Collaborate with DOE and National Labs to launch a pilot with at the Depot Park ZEV ecosystem that includes a microgrid, long-duration energy storage, and hydrogen production.
Create "No-Depot" Charging Locations	Identify locations at which owner/operators park overnight and coordinate funding for charging stations and EV truck purchases.