North Coast Medium-Duty and Heavy-Duty ZEV Blueprint Plan

November 2023

REDWOOD COAST
EnergyAuthority

The California Energy Commission provided the funding for this project through its Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program, which issued solicitation PON-10-602 to provide funding opportunities for California's diverse regions to develop regional "blueprints" for implementation of medium- and heavy-duty Zero-Emission vehicles and related electric charging and/or hydrogen refueling infrastructure.

PROJECT TEAM

The Redwood Coast Energy Authority was formed in 2003 to develop and implement sustainable energy initiatives that reduce energy demand, increase energy efficiency, and advance the use of clean, efficient, and renewable resources available in the region. The Energy Authority is a local government joint powers agency representing the County of Humboldt, the Cities of Eureka, Arcata, Fortuna, Rio Dell, Blue Lake, Ferndale, and Trinidad, and the Humboldt Bay Municipal Water District.

The Schatz Energy Research Center at Cal Poly Humboldt was founded in 1989 with a mission to promote the use of clean and renewable energy resources. Over the years, SERC has been involved in extensive research, planning, design, and analysis activities for the development and implementation of sustainable energy systems on the North Coast.

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FUEL CELL ELECTRIC DRIVE
7022
ZERO EMISSION

Executive Summary

Redwood Coast Energy Authority (RCEA) and Schatz Energy Research Center (SERC), with funding from the California Energy Commission's (CEC) Clean Transportation Program (CTP), produced this Blueprint to assess the North Coast Region's readiness to deploy medium duty/heavy duty zero-emission vehicles (MD/HD ZEVs). The study region is Del Norte, Trinity, and Humboldt Counties, with a specific focus on Humboldt as a regional economic center. Vehicle types assessed are battery electric and fuel cell electric vehicles (BEV and FCEV).

The need for a Blueprint arises in response to the State of California's ambitious goals to reduce greenhouse gas (GHG) emission from the transportation sector. Those emissions are characterized as Scope 1 (produced by sources within community boundaries) and Scope 2 (produced outside of community boundaries, but still benefitting the community).

Based on data analyzed in this report, the transportation sector in Humboldt County represents 53.2% of total GHG emissions compared with 38% statewide. We expect that this elevated rate of GHG emissions attributed to the transportation sector also holds true in Trinity and Del Norte Counties. Emissions from MD/HD vehicles making up approximately half of these emissions.

To accelerate reduction in GHG emissions the state of California, through the California Air Resources Board (CARB), set targets to reduce greenhouse gases below 1990 levels with a goal of net-zero emissions by 2045. To achieve this CARB has adopted a series of regulatory mandates that will require widespread adoption of Zero-Emission technologies in the transportation sector between now and 2045.

SERC and RCEA conducted quantitative analysis to assess what is needed to meet the mandates within the study region. SERC calculated that the total MD/HD vehicle quantity in the study region approached 19,000 vehicles. This figure, along with RCEA surveys, was used to assess a 15-year timeline for ZEV adoption. Assuming 50% BEVs and 50% FCEVs would lead to an estimated 13% increase in Humboldt County's total electric load; 4.7% and 24% for Del Norte and Trinity respectively, to cover BEV charging needs. This figure also resulted in an estimated

THE TRANSPORTATION SECTOR IN THE STUDY REGION REPRESENTS ROUGHLY 53% OF TOTAL GREENHOUSE GAS EMISSIONS, COMPARED WITH 38% STATEWIDE.

ESTIMATED NUMBER OF MD/HD VEHICLES IN THE STUDY REGION: ~19,000

ESTIMATED FUEL VOLUMES TO SUPPORT MD/HD ZEV TRANSITION:

COUNTY	INCREASED ELECTRIC USE (UP TO)	HYDROGEN (METRIC TONS/YR)
DEL NORTE	4.7%	626
HUMBOLDT	13%	6,612
TRINITY	24%	2,402

annual quantity of 6,612 metric tons of hydrogen/year in Humboldt County, and 626 metric tons and 2402 metric tons in Del Norte and Trinity respectively, to meet FCEV fueling requirements.

To accommodate the nearly 19,000 vehicles in need of ZEV replacement, the infrastructure needed for EV charging stations alone would be 18,000 charging ports, assuming overnight charging by fleet operators. If we consider a 50% FCEV scenario, this number is cut and in half, and to accommodate FCEV fueling, the study region would need 8 small (1000kg/day) and 5 large (5,000kg/day) stations, distributed through the region, to be refueled by 7 hydrogen tanker trucks daily.

Placement of these ZEV refueling stations varies based on fuel type. For FCEVs, size of population center and proximity to other population center decides the location and size of the hydrogen fuel stations. For instance, despite being small population centers comparatively to Eureka, Arcata, and McKinleyville, we find that Crescent City, Weaverville, and Garberville will require large hydrogen stations to account for longer distances between stations.

This Blueprint also discusses significant barriers to achieving these goals including permitting obstacles, workforce development needs, constraints on the electric utility's transmission and distribution system, fleet operator concerns, and cost barriers.

We conclude the Blueprint with potential resources to address barriers to ZEV adoption and proposed regional actions to accelerate ZEV adoption. Our region will need to embrace change and shifting economic conditions to successfully meet the goals of GHG emission reductions from the transportation sector.

This Blueprint edition is a first step as we begin the transition of the MD/HD market sector, and it will need to be a living document to expand and grow in parallel with the ZEV landscape and marketplace.

Project Goals

BACKGROUND

Assembly Bill 118 created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational. Other legislative efforts are in process and reinforce the state's commitment to electric and hydrogen based fueling infrastructure in the next decade and beyond.

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

- Increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable renewable low-carbon fuels and construct related infrastructure.
- Improve the market viability of existing and new light-, medium-, and heavy-duty vehicle technologies.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

The funding for this North Coast Medium-Duty/Heavy-Duty Zero-Emission Vehicle Readiness Blueprint comes from the Clean Transportation Program and was awarded to RCEA in November of 2021.

NEED FOR A BLUEPRINT

The aim of this readiness plan is to prepare the North Coast region (Humboldt, Trinity, and Del Norte Counties), especially in terms of charging and fueling infrastructure, for the deployment of medium-duty and heavy-duty (MD/HD) 100% Zero-Emission vehicles (ZEV). It is anticipated that the MD/HD ZEV fleet will be a mix of battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) that run on clean, renewable hydrogen fuel. Three main driving factors behind the need for a North Coast MD/HD ZEV Readiness Blueprint are:

1) A growing awareness of the need to reduce greenhouse gas (GHG) emissions from the transportation sector.
2) The need on the part of MD/HD fleet owners and operators to comply with the regulatory mandates from California state agencies like the California Air Resources Board (CARB).
3) A proactive and coordinated effort to regionally address complexities such as availability, cost competitiveness, infrastructure, policy support, and operator awareness and training.

This Blueprint covers Del Norte, Trinity, and Humboldt counties, which is the same territory regulated by the North Coast Unified Air Quality Management District. Humboldt County has access to more resources (data, financial, human capacity, expertise, and so on) than Del Norte and Trinity, and as a result is able to generate more data and analyses. These data and the results of these analyses can serve as a proxy for the neighboring counties, and to some degree that is the approach taken in this study though specific analyses were conducted for Del Norte and Trinity counties as well.

This Blueprint is a summary document, and in late 2023 a complementary reference document ("Final Report")[1] will be available with supporting data and discussion.

[1] RCEA's Final Report can be found at: https://redwoodenergy.org/medium-duty-heavy-duty-planning-documents/

GHG Emissions from Transportation

The best local source of GHG emission data is the 2022 Humboldt County Regional Climate Action Plan (CAP). As part of developing Humboldt County's CAP, RCEA inventoried local emissions in the past, present and future. Similar resources are unavailable for Del Norte and Trinity counties.

There are two categories of emissions captured in Humboldt County's GHG inventories:

1) Scope 1 emissions: GHG emissions produced by sources located within the community boundary. For example, transportation is an emissions source since GHGs from vehicle use are produced within the community boundary. For this CAP, the community boundary is the entirety of Humboldt County.
2) Scope 2 emissions: GHG emissions resulting from community activities. For example, emissions from power plants that provide electricity to local homes and businesses are included, even though many of the power plants are located outside of the county.

In 2015, sources and activities in Humboldt County generated the equivalent of 1.5 million tons of carbon dioxide. This compares to a single car driving four billion miles, or roughly a year's worth of carbon sequestration in two million acres of U.S. forests. The 2015 countywide inventory reveals four sectors responsible for the vast majority (83%) of emissions in the region: transportation, livestock, stationary combustion, and electricity consumption. Figure 1 shows the results of the 2015 GHG inventory by category and percentage of the county's emissions.

IN 2015 HUMBOLDT GENERATED CARBON DIOXIDE EQUAL TO A YEAR'S WORTH OF CARBON SEQUESTRATION IN 2 MILLION ACRES OF FOREST.

TRINITY COUNTY IS 2 MILLION ACRES IN SIZE.

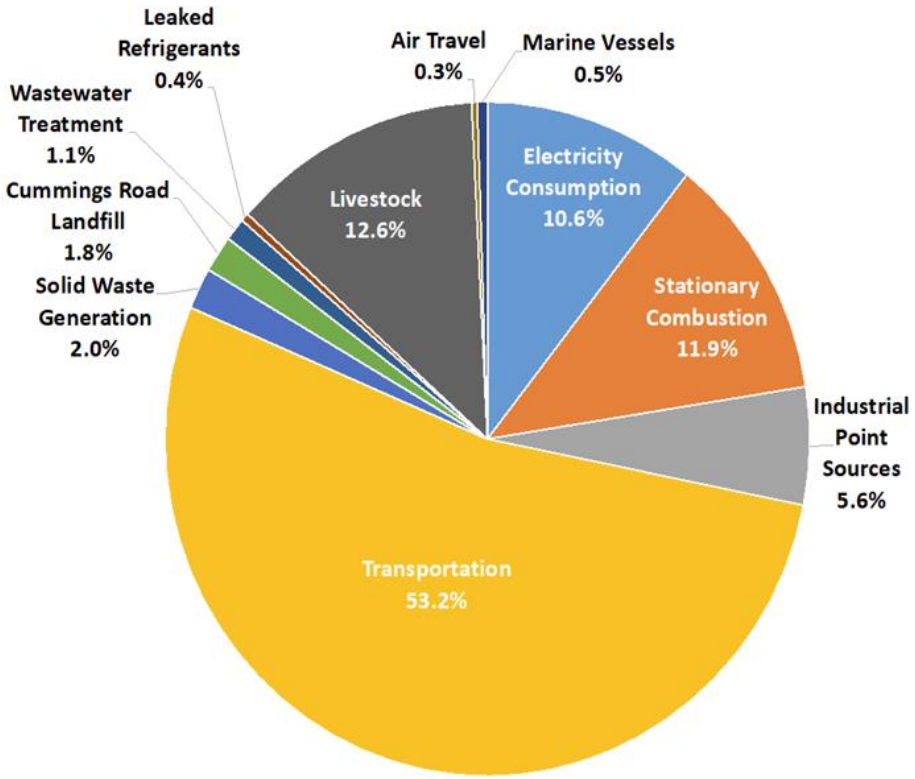


Figure 1: 2015 GHG inventory by source and activity in Humboldt County, including industrial point source emissions. (Source: County of Humboldt)

Transportation accounts for over half of the county's GHG emissions in the 2015 inventory. In 2022 the California Air Resources Board published a report titled "California Greenhouse Gas Emissions for 2000 to 2020 Trends of Emissions and Other Indicators" which shows that statewide transportation accounts for 36.8%; see Figure 2.

Humboldt County's higher fraction of overall GHG emissions from transportation compared to the state is common among rural regions. Contributing factors may include large land areas, dispersed development, long travel distances, and limited options for mass transit compared to urban and suburban communities. Further explanation for higher transportation related GHG emissions in rural counties is reliance on four-wheel-drive/all-wheel-drive vehicles, this is especially true of many Class 2b and

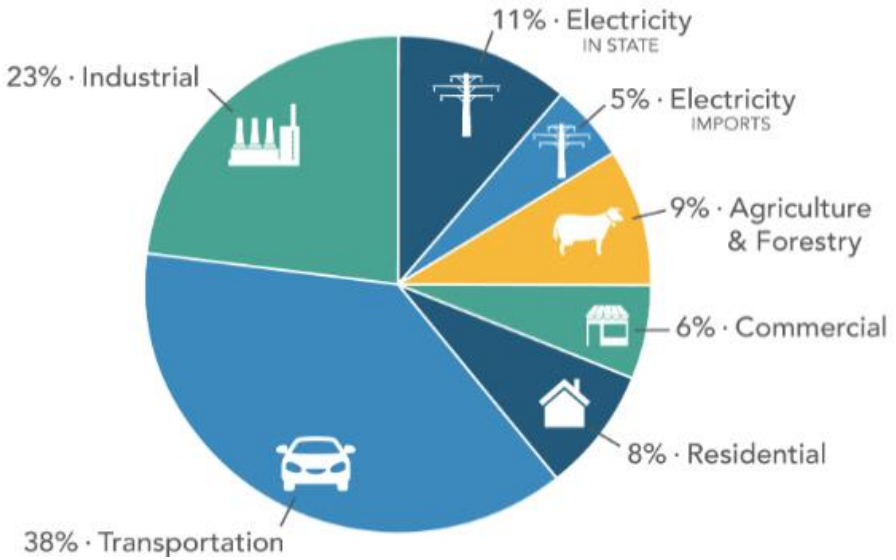


Figure 2: 2020 California greenhouse gas emissions by economic sector (Source: CARB)

Class 3 pick-up trucks. We expect GHG emissions from transportation in Trinity and Del Norte Counties to be similar to Humboldt County and less comparable with statewide emissions.

The Humboldt County 2015 GHG inventory also includes a breakdown of the transportation emissions in Humboldt County by vehicle type; see Figure 3.

To calculate transportation emissions, the Humboldt County CAP relied on a Caltrans' estimate of the total miles traveled by vehicles within Humboldt County in 2015. Emissions vary with vehicle and fuel type, so RCEA also incorporated data on fuel consumption and types of vehicles registered in the county.

This highlights that MD/HD vehicles represent a significant share of transportation emissions in Humboldt County given that most retail and commercial trucks (35.3% of emissions) and many of the off-road vehicles (15.8% of emissions) are MD/HD vehicles. Understanding the contribution to total GHG emissions from the MD/HD fleet of vehicles in rural counties will help us better understand how widespread adoption of MD/HD ZEVs in Del Norte, Humboldt, and Trinity counties can contribute to meeting state and regional GHG emission reduction goals.

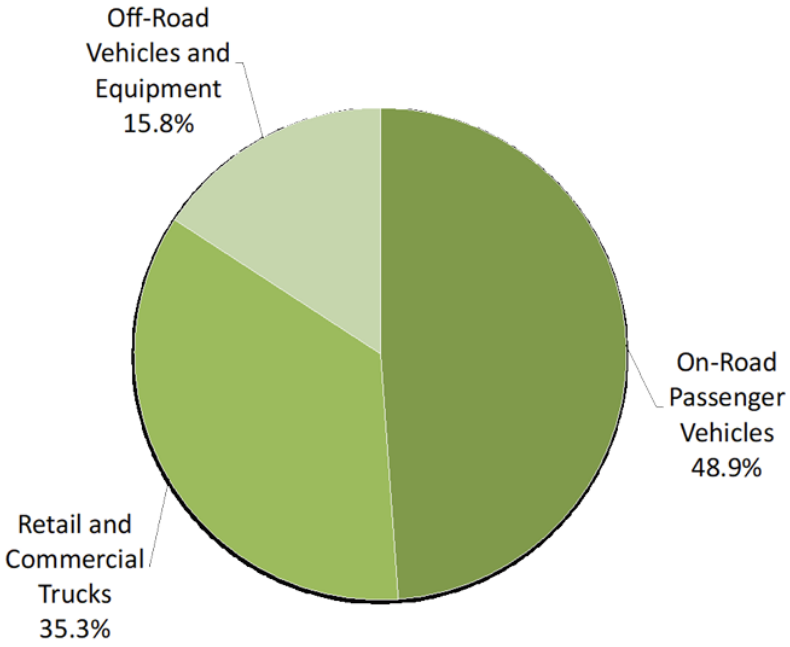


Figure 3: Humboldt County 2015 transportation emissions by vehicle type (Source: County of Humboldt)

California's Air Quality and Climate Targets

California faces challenging mandates to reduce air pollutants to protect public health and to meet state climate change targets, including:

- 40% reduction in GHGs below 1990 levels by 2030 per SB 32;
- 80% reduction in GHGs below 1990 levels by 2050 per Executive Order (EO) S-3-05; and
- Net-Zero-emissions by 2045 per EC B-55-18

Meeting these goals requires a bold transformation in all sectors, including stationary, industrial, residential, and transportation, with significant contributions from public agencies, private businesses, and individuals. In rural counties like Humboldt, Trinity, and Del Norte, the transition of MD/HD vehicle fleets to ZEVs will be a strong contribution to these efforts.

Legislative and Regulatory Mandates

This section identifies statewide legislation and regulations that affect various MD/HD transportation sectors. Each piece of legislation or regulation will affect each transportation sector differently. These mandates are complicated, and this summary conveys the general landscape; specific questions about how these mandates apply to our local fleets can be directed to these organizations:

- For Executive Orders: By email at: https://www.gov.ca.gov/contact/, by mail at: 1021 O Street, Suite 9000, Sacramento, CA 95814, or by phone at: (916) 445-2841
- For CARB regulations: By email at: zevfleet@arb.ca.gov, or by phone at: (866) 634-3735

Executive Order N-79-20

Signed on September 23, 2020, by Governor Gavin Newsom, Executive Order (EO) N-79-20 sets a series of broad, statewide goals for transitioning the state's transportation sector to ZEVs.

To achieve these goals, EO N-79-20 directs the California Air Resources Board (CARB) to develop and propose regulations that will help meet the broad goals of the order. See Figure 4 for an overview of CARB reduction targets by industry sector. For transportation specific goals include:

- Vehicle Sales - Develop passenger and truck regulations requiring increasing volumes of new ZEVs be sold in the state, with a target of 100 percent in-state sales by 2035.
- Fleet Transition – Develop MD/HD regulations requiring increasing volumes of new Zero-Emission trucks and buses be sold and operated in the state, with a target of 100 percent of fleets transitioning to ZEVs by 2045, where feasible, and all drayage trucks being Zero-Emission by 2035.
- Off-Road Vehicles – Achieve 100 percent Zero-Emission from off-road vehicles and equipment operations in the state by 2035 in coordination with other state agencies, the US Environmental Protection Agency, and local air districts.

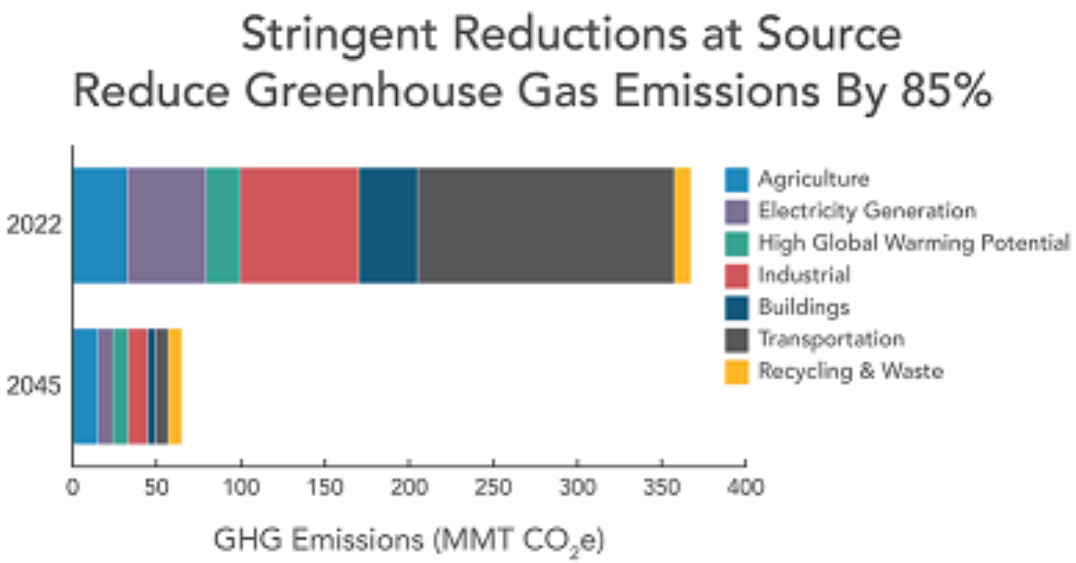


Figure 4: CARB modeled GHG reductions by industry category (Source: CARB)

Innovative Clean Transit

Adopted in December 2018, the Innovative Clean Transit (ICT) regulation requires all public transit agencies to gradually transition to a 100 percent Zero-Emission bus (ZEB) fleet. Beginning in 2029, 100 percent of new purchases by transit agencies must be ZEBs, with a goal of full transition by 2040. The ICT applies to all transit agencies that own, operate, or lease buses with a gross vehicle weight (GVWR) rating greater than 14,000 lbs. For reference, a 40-foot transit bus, capable of holding about 42 passengers, has a GVWR between 33,000 lbs. and 40,000 lbs. The ICT includes the following elements:

- Transit agencies must complete a ZEB roll out plan, approved by its Board, to demonstrate how the agency will complete the transition to Zero-Emission technologies by 2040; large transit agencies must submit a roll out plan by July 1, 2020, and small transit agencies by July 1, 2023.
- A transit agency is considered "large" if it operates at least 100 buses in annual service, in an urbanized area with a population of at least 200,000. All other transit agencies are considered "small".
- The ICT includes ZEB purchases with various exemptions and compliance options to provide flexibility to transit agencies.

Table 1 summarizes the ZEB purchase requirements for large transit agencies (starting in 2023) and small transit agencies (starting in 2026) based on a percentage of new bus purchases each year that must be Zero-Emission.

Table 1: Zero-Emission Bus (ZEB) Purchase Schedule (ZEB% of Total New Bus Purchases)

Year	Large Transit	Small Transit
2023	25%	-
2024	25%	-
2025	25%	-
2026	50%	25%
2027	50%	25%
2028	50%	25%
2029	100%	100%

Advanced Clean Trucks

The Advanced Clean Trucks (ACT) regulation, adopted in March of 2021, is part of the state's approach to accelerate a large-scale transition to Zero-Emission MD/HD vehicles from Class 2b to Class 8. The ACT regulation consists of a manufacturer's ZEV sales requirement and a one-time reporting requirement for large entities and fleets.

- Zero-Emission Truck Sales: Manufacturers who certify Class 2b-8 chassis or complete vehicles with combustion engines would be required to sell Zero-Emission trucks as an increasing percentage of their annual California sales from 2024 to 2035. By 2035, Zero-Emission truck/chassis sales would need to be:
  - 55% of Class 2b – 3 truck sales
  - 75% of Class 4 – 8 straight truck sales
  - 40% of truck tractor sales.
- Company and Fleet Reporting: Large employers, including retailers, manufacturers, brokers and others, are required to report information about shipments and shuttle services. Fleet owners with 50 or more trucks are required to report about their existing fleet operations. This information will help identify future strategies to ensure that fleets purchase available Zero-Emission trucks and place them in service where suitable to meet their needs.

Zero-Emission Airport Shuttle Bus Regulation

The Airport Shuttle Bus (ASB) regulation, adopted in June of 2019, promotes the development and use of ZEV technologies in medium- and heavy-duty airport shuttles that operate on fixed routes at 13 California airports. The ASB regulation requires airport shuttle operators to transition their vehicles to ZEVs beginning in 2027, with a complete transition by the end of 2035. The ASB regulation provides compliance extensions and other flexibilities to ensure service continuity as operators transition to ZEV shuttles. The proposed ACF regulation could include some fleet operators that are also subject to the ASB regulation. Airports within this Blueprint study region do not fall under this regulation.

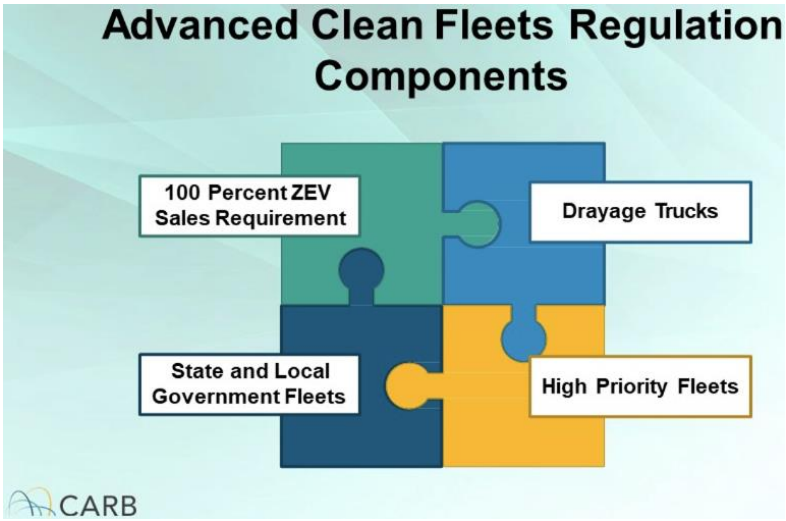
Advanced Clean Fleets

The Advanced Clean Fleet (ACF) regulation, adopted in April of 2023, is part of the California Air Resources Board's effort to accelerate the transition to Zero-Emission medium-duty and heavy-duty vehicles in the state of California. CARB developed the ACF regulation to complement the Advanced Clean Trucks (ACT) regulation, which helps ensure that zero-emission vehicles are brought to market. Compliance requirements differ based on truck type and use. The ACF affects several major classes of regulated fleets:

- Fleets Performing Drayage Operations: Drayage Truck means any in-use on-road vehicle with a GVWR greater than 26,000 lbs that is used for transporting cargo on or through a seaport or intermodal railyard, or transporting cargo that originated from or is destined to seaport or intermodal railyard.
- Fleets Owned by State and Local Government Agencies.
- Federal Fleets.
- High Priority Commercial Fleets: Entities that own operate or direct at least one (1) vehicle in CA and have $50 million in gross annual revenue **or** entities that own, operate, and control a total of 50 or more vehicles (excluding light-duty delivery vehicles).

The ACF regulations include several components that will affect different transportation sectors differently. Below is a summary of some of the major components of the ACF.

- Manufacturer Sales Mandate
  - Manufacturers may sell only Zero-Emission medium-duty and heavy-duty vehicles starting in 2036.
- Drayage Fleets
  - Non-Zero-Emission "legacy" combustion drayage trucks must register in CARB online system before December 31, 2023.
  - Non-Zero-Emission "legacy" combustion drayage trucks will need to be removed from the registry at end of useful life (at least 13 years from engine model year and up to 18 years or 800,000 miles, whichever comes first).
  - Only Zero-Emission drayage trucks may register in the CARB online system beginning January 1, 2024.
  - All Drayage trucks required to be ZEVs by 2035.



- High Priority and Federal Fleets
  - Must comply with the Model Year Schedule or may elect to use the optional ZEV Milestones Options to phase-in ZEVs.
  - Model Year Schedule: Fleets must purchase ZEVs only (100%) beginning in 2024 and starting January 1, 2025, must remove internal combustion vehicles at the end of their useful life.
  - ZEV Milestones Option (see Table 2): Fleets may elect to meet ZEV targets as a percentage of total fleet.

- State and Local Agencies including City, County and Special Districts
  - Must ensure that 50% of vehicles purchased are ZEVs beginning in 2024.
  - Must ensure that 100% of vehicles purchased are ZEVs beginning in 2027.
  - Small fleets (10 or fewer vehicles) and fleets in designated low population counties must ensure that 50% of vehicles purchased are ZEVs beginning in 2027; Humboldt, Trinity, and Del Norte are designated low population Counties.
  - State and local agencies may elect to use ZEV Milestones Option; (see Table 2).

- ZEV Milestone Option –Table 2 summarizes the ZEV Milestone Option in the ACF regulation.

Table 2: ZEV Milestone Table from CARB's Advanced Clean Fleet regulation

Percentage of vehicles that must be Zero-Emission	10%	25%	50%	75%	100%
Milestone Group 1: Box trucks, vans, buses with two axles, yard tractors, light-duty package delivery vehicles	2025	2028	2031	2033	2035 and beyond
Milestone Group 2: Work trucks, day cab tractors, buses with three axles	2027	2030	2033	2036	2039 and beyond
Milestone Group 3: Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042 and beyond

Sectoral timelines

Table 3 summarizes the sectoral timelines described in the various regulations above. There are several overlapping or crossover requirements, and many exemptions and exceptions in the regulations; the table below is only a very high-level summary that cannot account for all fleet characteristics and all regulation requirements.

Table 3: Summary of timelines for transition to Zero-Emission Vehicles by vehicle or fleet sector

Fleet Sector Designation	ZEV Goal/Timeline
Medium-Duty/Heavy Duty Vehicle Manufacturers	100% ZEV sales only by January 1, 2036
Drayage Fleets	100% transition to ZEV by 2035
Transit Operators	100% transition to ZEV by 2040
High Priority Commercial Fleets	100% of purchases to be ZEV by January 1, 2024; full transition to ZEV by 2045
Federal Fleets	100% of purchases to be ZEV by January 1, 2024; full transition to ZEV by 2045
State and Local Government Fleets	50% of purchases to be ZEV by January 1, 2024; 100% of purchases to be ZEV by January 1, 2027; full transition to ZEV by 2045
Small State and Local Government Fleets, Fleets from Low Pop. Counties	50% of purchases to be ZEV by January 1, 2027; 100% of purchases to be ZEV by January 1, 2030; full transition to ZEV by 2045
Airport Shuttle Buses	100% transition to ZEV by 2035

MEETING THE MANDATES

The Schatz Energy Research Center (SERC), under contract to the Redwood Coast Energy Authority (RCEA), developed the following information for the Blueprint:

- Projections for MD/HD ZEV uptake
- Projections for MD/HD ZEV fuel demand
- ZEV uptake and infrastructure timeline

The Schatz team deployed a "top-down" analysis methodology (explained below), where state-level estimates of the regional MD/HD vehicle populations and vehicle miles traveled were used to develop future projections of the MD/HD ZEV uptake, fuel demand and fueling infrastructure needs.

The RCEA team developed a list of regional fleet operators and conducted a fleet survey, which provides some regional fleet information, and a list of fleet operators and locations. This informed the Schatz Center team in determining the expected geographic distribution of needed ZEV fueling infrastructure.

This section:

- Describes the analysis conducted by the Schatz Center and presents the resulting estimates of MD/HD ZEV uptake, fuel demand, and fueling infrastructure needs.
- Presents an infrastructure timeline.
- Proposes a geographic distribution for hydrogen fueling and electric vehicle charging infrastructure.

Study Region Vehicle Population and Vehicle Miles Traveled

Data sources to determine vehicle population and vehicle miles traveled (VMT) include:

- Data from the California Air Resources Board's Emission FACtor (EMFAC) model.
- Local Fleet survey (used for geographic distribution estimates only, and did not inform the quantitative assessment of ZEV uptake, fuel demand, infrastructure needs or infrastructure timeline).

EMFAC Data for Humboldt, Trinity, and Del Norte Counties

The California Air Resources Board's Emissions Factor (EMFAC) Fleet Database was used to determine the MD/HD vehicle population by class for each county (2020 registration year), and to obtain estimates of vehicle miles traveled data by class.

Following CARB's Advanced Clean Fleets Regulation Summary and Advanced Clean Trucks Fact Sheet, CARB regulations primarily cover medium- and heavy-duty on-road vehicles with a gross vehicle weight rating greater than 8,500 lbs. This includes Class 2b through Class 8 vehicles, as shown in Figure 5. These are the vehicle categories included in this study. Two vehicle types not directly included in the analysis are:

- Class 2a vehicles (GVWR = 6,001 to 8,500 lbs): Vehicles in this category include the Ford F-150, RAM 1500 and Chevrolet 1500 pickup trucks, while the Ford F-250, RAM 2500 and Chevrolet 2500 are classified as Class 2b vehicles (GVWR = 8,501 to 10,000 lbs). We did not include Class 2a vehicles in our analysis, but did estimate the fuel demands for this vehicle class. We anticipate that most Class 2a vehicles are owned by private individuals and are not part of a commercial fleet. However, fleet survey and anecdotal data confirm that a significant number of these vehicles are used in fleets.
- EMFAC motorhome vehicle classification: We expect that most of these vehicles are owned by private individuals rather than fleet operators. However, from a weight rating standpoint these vehicles mostly fall into the MD/HD category.

See appendices in the associated Final Report for estimates of vehicle population data, ZEV adoption rates, and the potential fuel demand for the Class 2a and motorhome vehicle categories in our study region.

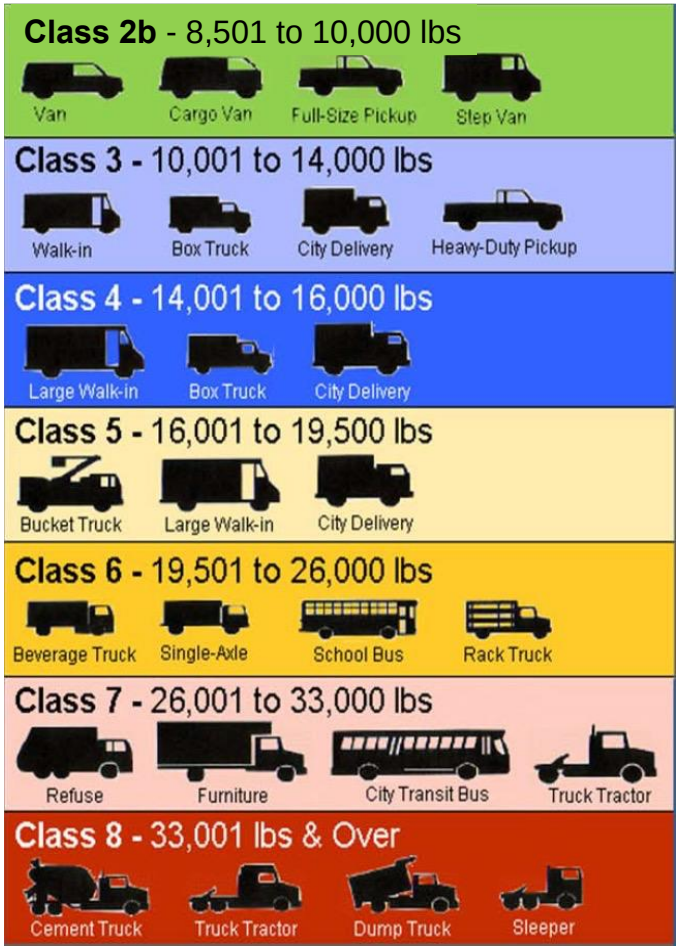


Figure 5: Vehicle classes defined as MD/HD for this study (adapted from U.S. Department of Energy/Oak Ridge National Laboratory)

A summary of the vehicle population estimates and the estimated VMT data obtained from the EMFAC database for this study are shown in Table 4. We note that EMFAC vehicle population and VMT data are specified by EMFAC vehicle class, which is not the same as the vehicle weight classes shown in Figure 5. Except for buses (EMFAC vehicle classes B, BS and BT), the respective GVWRs are shown in Table 4 for each of the EMFAC vehicle classes. Buses fall mainly in Classes 6 and 7.

Table 4: 2020 Vehicle population and VMT by class, Humboldt, Del Norte, and Trinity counties

EMFAC Vehicle Class	Vehicle Pop. Humboldt	Annual VMT per Vehicle Humboldt	Vehicle Pop. Del Norte	Annual VMT per Vehicle Del Norte	Vehicle Pop. Trinity	Annual VMT per Vehicle Trinity
B (All other buses)	108	19,400	23	19,600	8	48,300
BS (School buses)	225	6,600	55	9,700	37	11,000
BT (Urban buses)	82	18,200	13	5,300	10	15,700
T4 (Light-heavy duty trucks, GVWR 8501–10,000 lbs, Class 2b)	9,527	11,400	1780	11,100	1554	15,500
T5 (Light-heavy duty trucks, GVWR 10,001–14,000 lbs, Class 3)	2,019	13,400	306	13,400	244	21,000
T6 (Medium-heavy duty trucks, GVWR 14,001–33,000 lbs, Classes 4, 5, 6 & 7)	1,079	17,200	157	12,400	182	49,100
T7 (Heavy-heavy duty trucks, GVWR >33,000 lbs, Class 8)	1,026	57,500	147	15,100	185	143,100
Total	**14,066**		**2,481**		**2,220**	

Fleet Surveys

For any MD/HD fleet owner or operator, a successful transition to ZEVs must include a detailed and specific analysis of the existing fleet, and conducting a fleet survey is the first step. In rural counties where fleet managers are often tasked with many responsibilities (including driving shifts), conducting a survey often requires a dedicated consultant. This work is often performed by engineering firms at additional cost to the fleet owner/operator and may require its own source of funding.

To gather the data, the fleet survey will require input from the fleet managers or others with detailed knowledge of fleet operations. Data that may be gathered during a fleet survey include:

- Existing vehicle type (make and model)
- Vehicle age or vehicle model year
- Daily vehicle miles traveled (VMT)
- Vehicle Duty Cycle: hours of operation, down time (if any). elevation changes/route data, and domicile location

An example of the fleet survey forms that RCEA administered during our research on this MD/HD ZEV Readiness Blueprint can be found in the Final Report appendices.

Estimates of Appropriate ZEV Adoption Rates (BEV/FCEV)

To develop estimates of MD/HD ZEV sales and fleet adoption rates, we referenced the following State goals, regulations, and guidelines:

- The State's ZEV Action Plan, as well as Executive Order N-79-20 state that we must reach 100% sales of MD/HD vehicles by 2045. These documents also communicate the State's target of transitioning 100% of the MD/HD fleet to Zero-Emission vehicles by 2045.
- CARB's Advanced Clean Truck regulations state that "By 2035, Zero-Emission truck/chassis sales will need to be 55% of Class 2b – 3 truck sales, 75% of Class 4 – 8 straight truck sales, and 40% of truck tractor sales."
- CARB's Advanced Clean Fleet Regulations state that "fleets, businesses, and public entities that own or direct the operation of medium- and heavy-duty vehicles in California must purchase and operate ZEVs to achieve a smooth transition to ZEV fleets by 2045 everywhere feasible, and specifically to reach:
    - 100 percent Zero-Emission drayage trucks, last mile delivery, and government fleets by 2035
    - 100 percent Zero-Emission refuse trucks and local buses by 2040
    - 100 percent Zero-Emission capable utility fleets by 2040.

Based on data in the CARB EMFAC database, we assumed a 15-year vehicle life, resulting in an average annual fleet replacement rate of 6.7% and a 15-year period for the MD/HD fleet to completely turn over. The 15-year vehicle life was determined based on the weighted average MD/HD vehicle age in Humboldt County in the year 2020.

ASSUMPTIONS:

- 15-YEAR VEHICLE LIFE
- 6.7% ANNUAL FLEET REPLACEMENT RATE

MD/HD ADOPTION GOALS FOR THE STUDY REGION:

- 100% ZEV VEHICLE SALES BY 2036
- 100% ZEV MD/HD FLEET BY 2045

We used the State goals, guidelines, and regulations stated above, as well as the 15-year replacement assumption to guide our development of a ZEV sales rate profile. Using the State's goals, we established a set of ambitious MD/HD adoption rates for the study region. This includes reaching 100% ZEV vehicle sales in the MD/HD sector by 2036, and a 100% ZEV MD/HD fleet by 2045. Figure 6 shows the assumed annual ZEV sales percentage as a percent of total sales, as well as the percent of ZEVs in the entire MD/HD fleet for Humboldt County through 2045. Figure 7 shows the resulting number of MD/HD annual ZEV sales (series 1) and number of ZEVs in the overall fleet (series 2) for Humboldt County, again through 2045. An analogous approach was used for Del Norte Trinity Counties. See tables in the Final Report appendices for ZEV sales assumptions and cumulative ZEV fleet projections for Del Norte and Trinity.

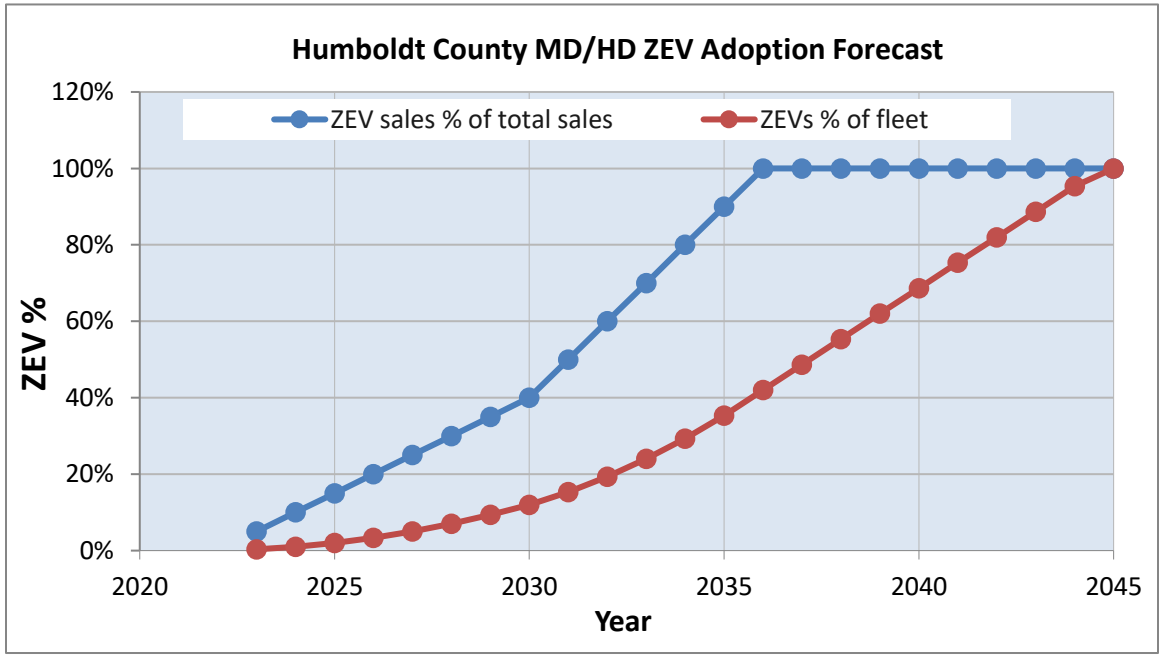


Figure 6: Assumed Humboldt County MD/HD ZEV adoption rates through 2045.

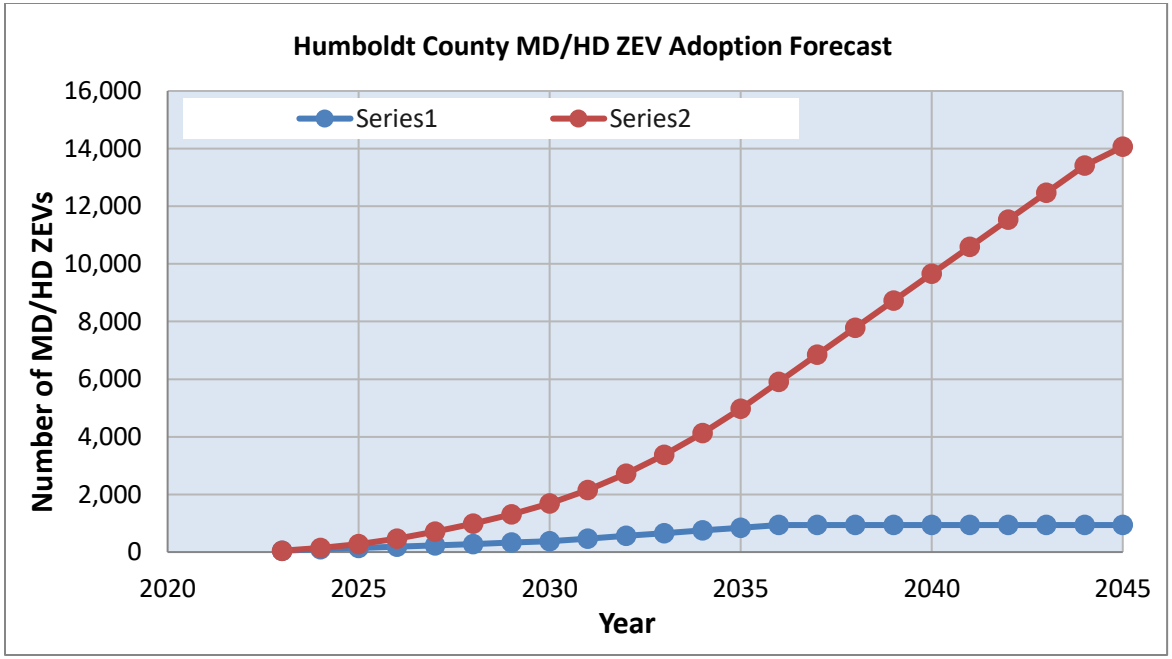
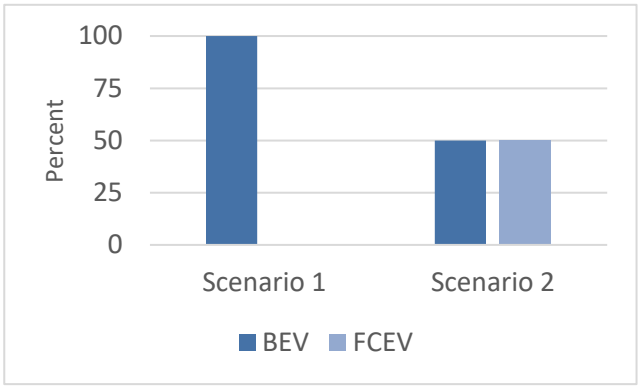


Figure 7: The number of ZEVs sold annually and the total ZEVs in the fleet by year for Humboldt.

Estimated Annual ZEV Fuel Demand Profiles – Electricity and Hydrogen

Using the estimates of annual ZEVs in the MD/HD fleet, we estimated the MD/HD ZEV energy consumption by class, including estimates of electricity consumption for charging battery electric vehicles (BEVs), and hydrogen consumption for fueling fuel cell electric vehicles (FCEVs). For this analysis, we used ZEV fuel economy estimates (kWh/mi or kg/mi) from various sources, including real data from demonstration projects, information from research studies, and manufacturer specifications. The ZEV fuel economy assumptions, along with a list of references, are shown in the associated Final Report appendices.



To estimate the ZEV energy consumption by vehicle class, we started with a percentage of BEVs and FCEVs. Our anticipation is that BEVs will likely dominate the MD/HD vehicle population, with potential for substantial penetration of FCEVs. We estimated ZEV energy consumption for the following two scenarios.

- Scenario 1: MD/HD vehicle population is 100% BEV.
- Scenario 2: MD/HD vehicle population is 50% BEV and 50% FCEV.

The 100% BEV assumption provides an upper range for increased electrical demand, and we think that the 50% FCEV scenario provides a reasonable estimate of maximum potential hydrogen fuel demand. Below are the equations used to estimate the annual fuel consumption for the forecasted ZEV population by vehicle class, either in kWh of electricity or kg of hydrogen.

Scenario 1: MD/HD vehicle population is 100% BEV.

- We used the following equation to calculate the electricity consumption used to charge the MD/HD BEVs:

  kWh/yr = (100% MD/HD vehicle population) * (VMT/vehicle/yr) * kWh/mi

Scenario 2: MD/HD vehicle population is 50% BEV and 50% FCEV

- We used the following equation to calculate the electricity consumption that will be used to charge BEVs:

  kWh/yr = (50% MD/HD vehicle population) * (VMT/vehicle/yr) * kWh/mi

- We used the following equation to calculate the amount of hydrogen that will be required to fuel FCEVs:

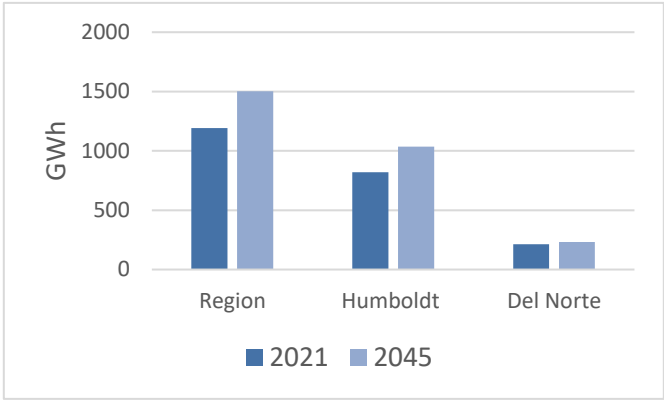
  kg/yr = (50% MD/HD vehicle population) * (VMT/vehicle/yr) * kg/mi

Using the above formulas, we calculated the energy consumption (both electricity and hydrogen) by year for each county for both scenarios. Tables showing the annual GWh required for BEV charging and the annual kg of hydrogen required for hydrogen FCEVs are presented below, with results shown for each of the three counties through the year 2045. This information can be used to assess the amount of fueling infrastructure needed to support the projected MD/HD ZEV fleets.

Scenario 1 energy requirement: 100% BEV

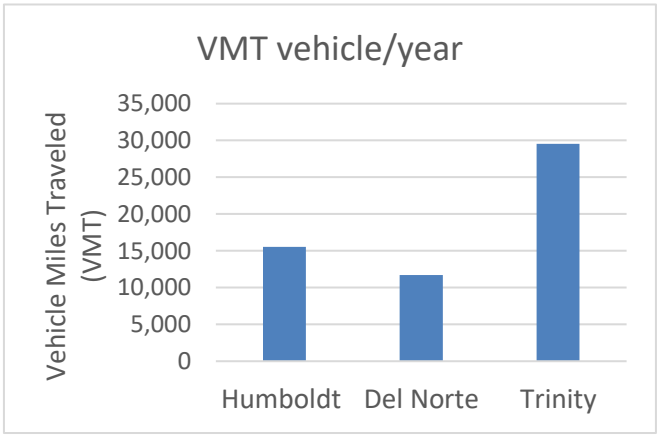
Table 5 shows the total GWh per year required to charge the MD/HD BEVs for Scenario 1 (100% BEV) for all three counties, and Figure 8 presents the results graphically for Humboldt County only. For scale, we compare the total annual GWh required for BEV charging to the total annual GWh consumed in each county in the year 2021. Total electricity consumption in 2021, including both residential and non-residential loads, for the three counties[2] are:

- Humboldt – 821 GWh
- Del Norte – 212 GWh
- Trinity – 159 GWh



When the entire MD/HD fleets have converted to BEVs in Humboldt County by 2045, the electricity for charging results in a 26% increase compared to the county's 2021 total electric load. For Del Norte County the increase is 9%, and for Trinity County is 49%. Notably, this is the change associated with MD/HD fleet uptake alone. During the same period, it is anticipated that there will also be significant uptake of BEVs in the light-duty fleet as well as electrification of energy loads such as water and space heating. Preparing for this increase in total electricity demand as well as the shifts in load shape associated with that demand must be a key energy planning priority in the coming decades.

There are large differences between the counties in terms of the estimated electricity consumption growth rates associated with MD/HD BEV charging. One explanation for this is the correspondingly large differences in the estimated average vehicle miles traveled for MD/HD vehicles in each of the three counties. The county with the largest increase in electricity use is Trinity, which also has the greatest weighted average VMT at 29,537 miles/vehicle/year. The high VMT for Trinity County is likely due to the diffuse population compared to the other two counties in the study. For comparison, Humboldt has a weighted average VMT of 15,519 miles/vehicle/year, and Del Norte has a weighted average VMT of 11,720 miles/vehicle/year.



The number of MD/HD fleet vehicles in Del Norte and Trinity Counties are nearly the same (Trinity County at 2,220, Del Norte County at 2,480). However, the energy consumption for ZEVs in Trinity County is about 4 times the energy consumption for ZEVs in Del Norte County, and this also seems to be tied to the high VMT value for the MD/HD fleet in Trinity County.

[2] From: California Energy Commission Energy http://www.ecdms.energy.ca.gov/elecbycounty.aspx

Table 5: Electricity requirements by year for MD/HD BEV charging (100% BEVs)

Year	Humboldt		Del Norte		Trinity	
	Annual BEV Charging (GWh)	% of 2021 county electric load	Annual BEV Charging (GWh)	% of 2021 county electric load	Annual BEV Charging (GWh)	% of 2021 county electric load
2023	0.7	0.1%	0.1	0.03%	0.3	0.2%
2024	2.1	0.3%	0.2	0.1%	0.8	0.5%
2025	4.2	0.5%	0.4	0.2%	1.6	1.0%
2026	7.0	0.9%	0.7	0.3%	2.6	1.6%
2027	11	1.3%	1.0	0.5%	3.9	2.4%
2028	15	1.8%	1.4	0.7%	5.5	3.4%
2029	20	2.4%	1.8	0.9%	7.3	4.6%
2030	25	3.1%	2.4	1.1%	9.3	5.9%
2031	32	3.9%	3.0	1.4%	12	7.5%
2032	41	5.0%	3.8	1.8%	15	9.5%
2033	51	6.2%	4.7	2.2%	19	12%
2034	62	7.5%	5.8	2.7%	23	14%
2035	75	9.1%	7.0	3.3%	28	17%
2036	89	11%	8.3	3.9%	33	21%
2037	103	13%	9.6	4.5%	38	24%
2038	117	14%	11	5.2%	43	27%
2039	131	16%	12	5.8%	48	30%
2040	145	18%	14	6.4%	53	34%
2041	159	19%	15	7.0%	54	37%
2042	173	21%	16	7.6%	64	40%
2043	187	23%	18	8.3%	69	43%
2044	201	25%	19	8.9%	74	47%
2045	211	26%	20	9.3%	78	49%

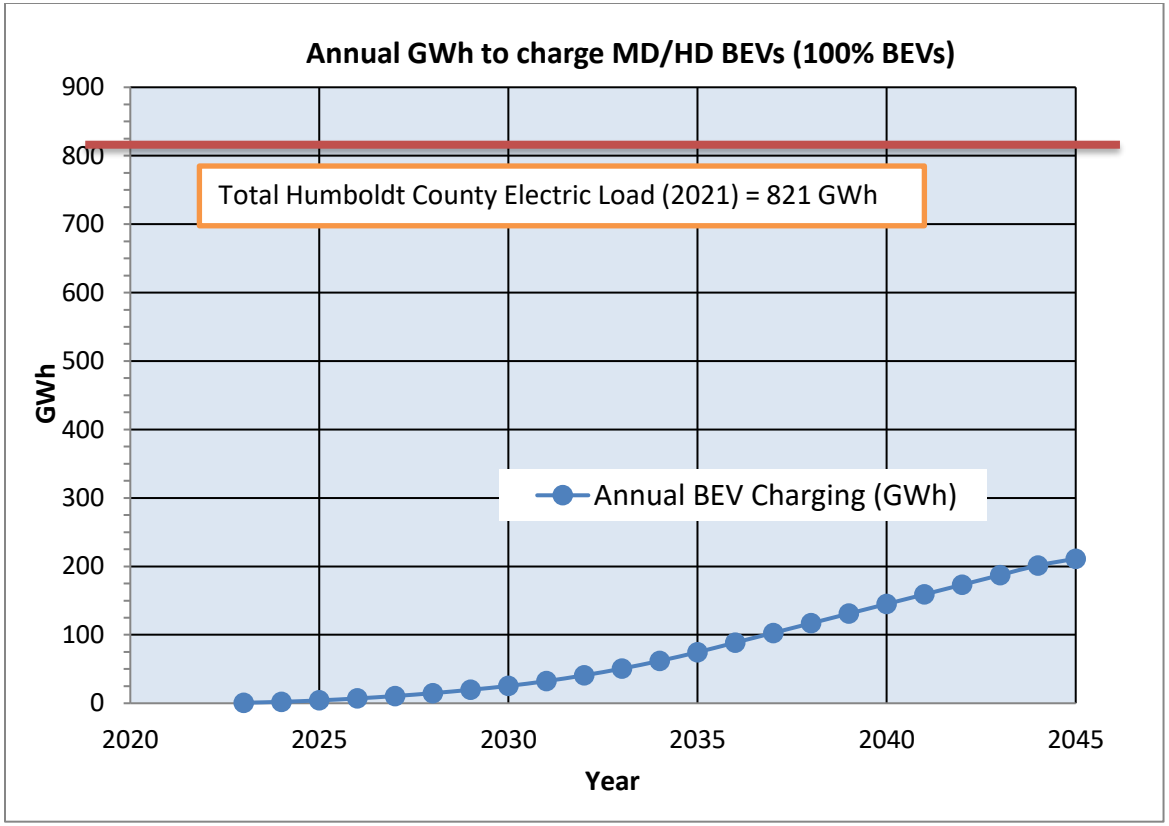


Figure 8: Humboldt County Projected Annual GWh to Charge MD/HD BEVs

Scenario 2 energy requirement: 50% BEV/50% FCEV

The results for Scenario 2 (50% BEV, 50% FCEV) for all three counties are presented in Table 6, with a graphical presentation for Humboldt County provided in Figure 9, showing total GWh of electricity needed (series 1) and total kg of hydrogen needed (series 2).

Table 6: Electricity and hydrogen requirements by year for 50/50 BEVs/FCEVs

	Humboldt			Del Norte			Trinity		
	Annual GWh	Annual FCEV Fueling (metric tons H2)	% of 2021 county electric load	Annual GWh	Annual FCEV Fueling (metric tons H2)	% of 2021 county electric load	Annual GWh	Annual FCEV Fueling (metric tons H2)	% of 2021 county electric load
2023	0.4	22	0.04%	0.03	2.1	0.02%	0.1	8	0.08%
2024	1.1	66	0.1%	0.1	6.3	0.05%	0.4	24	0.2%
2025	2.1	132	0.3%	0.2	13	0.1%	0.8	48	0.5%
2026	3.5	220	0.4%	0.3	21	0.2%	1.3	80	0.8%
2027	5.3	331	0.6%	0.5	31	0.2%	1.9	120	1.2%
2028	7.4	463	0.9%	0.7	44	0.3%	2.7	168	1.7%
2029	10	617	1.2%	0.9	58	0.4%	3.6	224	2.3%
2030	13	793	1.5%	1.2	75	0.6%	4.7	288	2.9%
2031	16	1,014	2.0%	1.5	96	0.7%	6.0	368	3.8%
2032	20	1,278	2.5%	1.9	121	0.9%	7.5	464	4.7%
2033	25	1,587	3.1%	2.4	150	1.1%	9.3	576	5.9%
2034	31	1,940	3.8%	2.9	184	1.4%	11	704	7.2%
2035	37	2,336	4.5%	3.5	221	1.6%	14	498	8.7%
2036	44	2,777	5.4%	4.1	263	2.0%	16	1,009	10%
2037	51	3,218	6.3%	4.8	305	2.3%	19	1,169	12%
2038	59	3,659	7.1%	5.5	346	2.6%	22	1,329	14%
2039	66	4,100	8.0%	6.1	388	2.9%	24	1,489	15%
2040	73	4,541	8.8%	6.8	430	3.2%	27	1,649	17%
2041	80	4,981	10%	7.4	472	3.5%	29	1,809	18%
2042	87	5,422	11%	8.1	513	3.8%	32	1,969	20%
2043	94	5,863	11%	8.8	555	4.1%	34	2,129	22%
2044	101	6,304	12%	9.4	597	4.4%	37	2,290	23%
2045	106	6,612	13%	9.9	626	4.7%	39	2,402	24%

In Scenario 2 we assume that 50% of the MD/HD fleet are BEVs (rather than the 100% assumed in Scenario 1), so the total annual GWh of electricity consumed is precisely half of Scenario 1. For the estimated hydrogen consumption of the 50% MD/HD fleet that are FCEVs, estimated annual quantities of hydrogen consumed by county at full build-out in 2045 are:

- Humboldt – 6,612 metric tons/year
- Del Norte – 626 metric tons/year
- Trinity – 2,402 metric tons/year

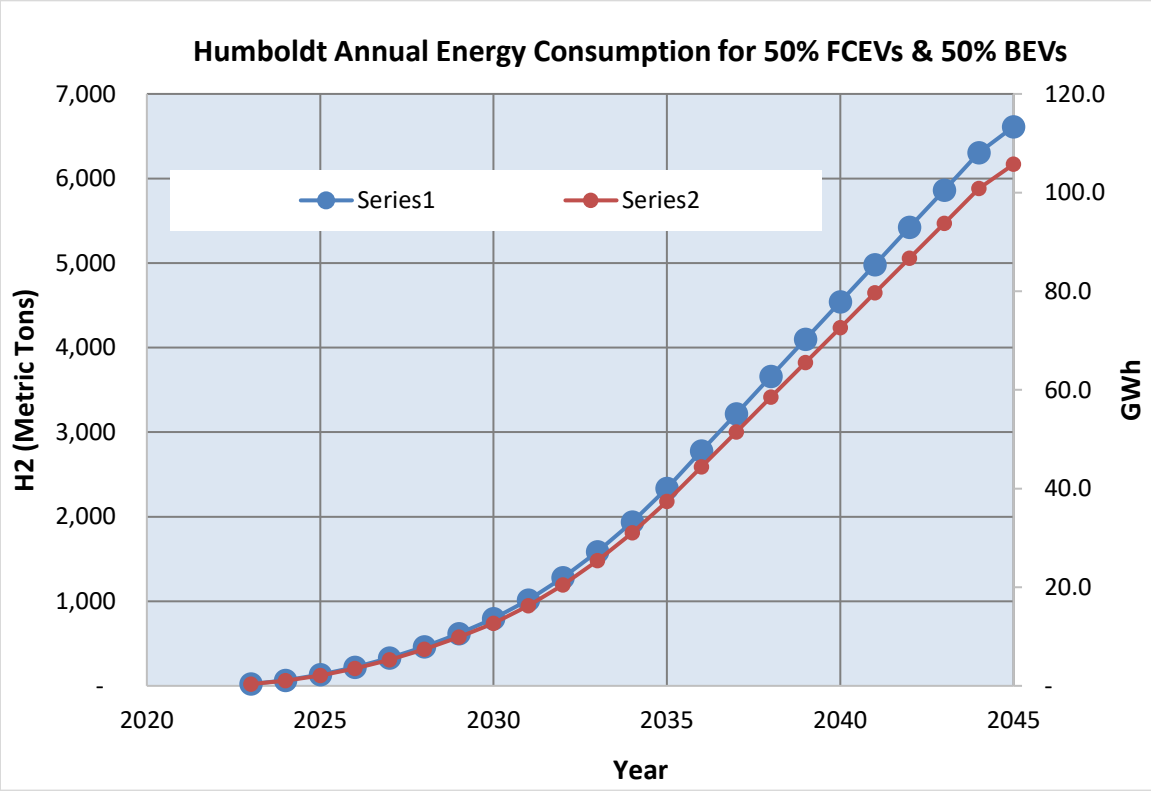


Figure 9: Humboldt County Annual GWh (series 1) to Charge MD/HD BEVs and Kg hydrogen (series 2) to fuel FCEVs (assumes 50% BEVs and 50% FCEVs for MD/HD ZEV fleet)

PROJECTED CHARGING/FUELING INFRASTRUCTURE

Using the fuel demand projections from the previous section, this section evaluates the infrastructure needed to support electric and hydrogen fueling for the MD/HD fleet within the study region.

Need for EV Charging Stations

Electric vehicle charging infrastructure can largely be treated like any other electrical appliance, and located virtually anywhere there is electrical service as long as there is sufficient capacity on the electric grid at key locations. Because Level-2 and DC Fast Chargers that are needed in the MD/HD sector use more power (19 kW-350 kW) than a typical appliance, electric grid capacity is a crucial factor when installing these chargers. Fleet operators generally should be able to install charging infrastructure at their own facilities to meet their charging needs, much of which is likely to occur overnight. They will need to:

- Assess their electrical service infrastructure to see if it can handle the added load, including the capacity of their utility service.
- For required upgrades, estimate costs, and required process to move projects forward.
- Consult with their electrical utility for incentives or related programs.

For regional planning for EV fleet charging infrastructure, local planning entities can work with and support local fleet operators to determine their needs.

This study employs a very high-level assessment of the potential need for EV charging infrastructure to support the regional MD/HD BEV fleet. Assuming that the MD/HD ZEV fleet will be 100% BEV, we can estimate the greatest added electrical load and greatest need for infrastructure. In 2045, with full adoption of ZEVs in the MD/HD fleet, we expect approximately 18,800 BEVs. If we assume that each fleet vehicle will need to charge daily, likely overnight, then over 18,000 new EV charging ports are needed to serve the regional fleet, and these chargers will mainly reside at the fleet operators' base locations where the vehicles return each day.

In terms of charger capacity and charging times, the 18,800 vehicles are expected to require 309 GWH of charging energy annually. On average, this is approximately 45 kWh/day for each BEV. If vehicles recharge nightly with a 19.2 kW Level 2 charger, they will charge for about 2.5 hours. If

they are set for a full charge in 8 hours, it will require an average charge rate of 5.6 kW. Alternatively, if vehicles have adequate range and can charge every other day, then only 9,400 chargers would be needed. In this case, each charger would be required to provide 90 kWh of charge in an overnight session, requiring about 5 hours at 19 kW, or 8 hours at 11 kW.

These numbers are approximate and generalized and each fleet and vehicle will have their own use cases and charging needs. Nonetheless, these high-level numbers provide a sense of what EV charging infrastructure might be needed to support a 100% MD/HD BEV fleet. If 50% of the fleet is FCEV and 50% is BEV, the electrical energy and charging needs will be reduced by half.

There may also be a need for fast chargers in key locations for fleet drivers to quickly recharge vehicles. This could be a planned charging strategy where high-powered, fast EV chargers are located along key day-time routes and/or at key destinations for one or more fleet operators. Operators could then complete a fast charge during the day before making a return trip to their base location at the end of the day. In these situations, siting needs to consider the vehicle size to support adequate pull-through or turning radius.

Need for Hydrogen Fueling Stations

To gain a sense of scale for hydrogen consumption, we examined the fueling capacity for planned hydrogen stations for AC Transit in the San Francisco East Bay Area and for Humboldt Transit Authority in Eureka, CA. AC Transit has operated FCEV buses and their own hydrogen fueling facilities for more than 15 years. Currently they operate 36 FCEV buses, and their planned and pending hydrogen fueling stations will be designed to deliver approximately 5,000 to 6,000 kg/day[3].

Humboldt Transit Authority is currently working to build a new hydrogen fueling station in Eureka, CA that will support 11 FCEV buses. This project is expected to be operational in 2025. The fuel demand for the HTA station in year 10 is expected to be about 800 kg/day.[4] We have rounded this up to 1,000 kg/day.

Based on this information, we modeled two different sized hydrogen fueling stations that could provide hydrogen fuel for a MD/HD FCEV fleet that serves the study region. The modular sizes for a small and large hydrogen fueling station are shown in Table 7.

[3] AC Transit Zero-Emission Transit Bus Technology Analysis, Volume 4, December 14, 2022., https://www.actransit.org/sites/default/files/2023-01/0430-22%20Report-ZEBTA%20v4_FNL_012423.pdf.

[4] Humboldt Transit Authority Projection, Aug. 2023

Table 7: Modeled hydrogen station capacities

Size	H2 throughput capacity	Example station
Small	1,000 kg/day	HTA Hydrogen Station
Large	5,000 kg/day	AC Transit Hydrogen Station

Based on the estimated fuel demand in 2045 for a 50% FCEV fleet scenario, the number of stations required throughout the region is estimated to be 8 small (1,000 kg/day) and 5 large (5,000 kg/day) stations. These numbers also allow for an adequate geographic distribution of hydrogen fueling stations throughout the region.

We also estimate that if the required volume was trucked into the region as liquid hydrogen, it would require on average about 7 cryogenic hydrogen tanker trucks/day (assuming a typical hydrogen tanker carries 4,000 kg of hydrogen). Table 8 provides an estimate of the number of hydrogen fueling stations needed throughout the region at a five-year interval starting in 2030 and achieving full build out of 8 small and 5 large stations by 2045.

Table 8: Estimated number of hydrogen stations needed in the region from 2030 through 2045.

Year		
2030	kg/day	3,167
	# of 1000 kg/day stations	3
	# of 5000 kg/day stations	1
2035	kg/day	9,332
	# of 1000 kg/day stations	5
	# of 5000 kg/day stations	2
2040	kg/day	18,137
	# of 1000 kg/day stations	6
	# of 5000 kg/day stations	4
2045	kg/day	26,411
	# of 1000 kg/day stations	8
	# of 5000 kg/day stations	5

WHERE TO PLACE FUELING INFRASTRUCTURE

To determine the regional distribution of the required fueling infrastructure, our analysis determined the expected geographic distribution for the fuel demand and then placed EV charging stations and hydrogen fueling stations accordingly. Numerous population and retail business metrics were assessed to estimate the desired geographic distribution, including:

- Population distribution (2020 US Census)
- Distribution of retail sales (2020 US Census)
- Distribution of transportation and warehousing receipts/revenue (2020 US Census)
- Distribution of existing gasoline/diesel fueling stations (Google Maps)
- Distribution of fleet operators (Redwood Coast Energy Authority)

Using these indicators, a high-level evaluation determined where the greatest fueling activity is likely. We also examined fueling capacity needs in outlying areas, where interregional vehicles are likely to fuel and are key to connectivity for intra-regional activities. While economic indicators such as population and retail sales may be low in these boundary locations, we think that placing fueling infrastructure in these locations will be critical in the study region.

Table 9 shows the population and economic indicators in the rows 1-5, with the indicator percentages for each region in rows 6-10. Row 11 shows the proposed percentage breakout for fueling infrastructure. The four population centers around Humboldt Bay (Eureka, Arcata, McKinleyville and Fortuna) represent 60% of the proposed fueling infrastructure capacity in Humboldt County. In comparison, the demographic and economic indicators for the same four population centers are: population = 41%, transportation and warehousing receipts = 49%, retail sales = 65%, and fleet operators = 66%.

The maps in Figures 10 through 12 graphically present population data, existing gasoline/diesel fueling station data, and fleet operator data summarized in Table 9. We note that the existing gasoline/diesel fueling station data are uncertain estimates that were derived from an analysis using Google maps.

Nonetheless, the fueling station data collected agree well with data available from the California Energy Commission's California Retail Fuel Outlet Annual Reporting (CEC-A15)[5].

Table 9: Population and Economic Indicators as Surrogates for Expected Fueling Activity

Row		Fortuna CA	Eureka, CA	Arcata, McKinleyville CDP, CA	Rest of Humboldt County	Del Norte County	Trinity County
1	Population (April 2020 census)	12,516	26,512	35,119	136,463	27,743	16,112
2	Transportation and warehousing receipts/revenue, 2017 ($1,000)	2,635	29,292	22,537	100,662	7,641	2,587
3	Retail sales, 2017 ($1,000)	167,549	1,008,010	376,607	2,055,468	229,945	98,220
4	Existing gasoline stations	84				13	18
5	Fleet operators	46	243	139	555	72	23
6	Population (April 2020 census) (%)	7%	15%	19%	35%	15%	9%
7	Transportation and warehousing receipts/revenue, 2017 (%)	2%	26%	20%	42%	7%	2%
8	Retail sales, 2017 (%)	7%	42%	16%	21%	10%	4%
9	Existing gasoline stations (%)	73%				13%	18%
10	Fleet operators (%)	7%	37%	21%	20%	11%	4%
11	**Proposed % breakout for fueling infrastructure**	**10%**	**30%**	**20%**	**Rest of Humboldt County + Del Norte and Trinity Counties 40%**		

[5] https://www.energy.ca.gov/data-reports/energy-almanac/transportation-energy/california-retail-fuel-outlet-annual-reporting

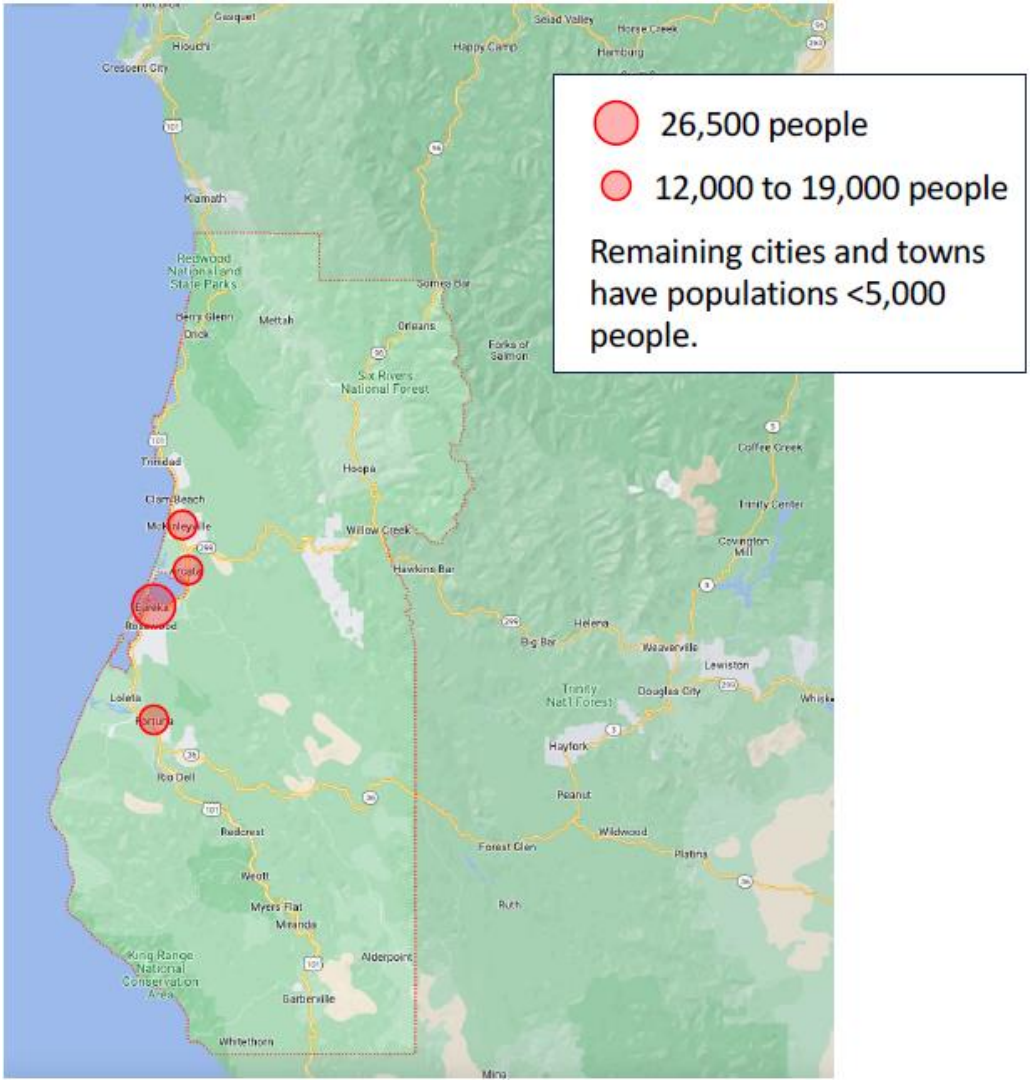


Figure 10: Population Distribution Map for Study Region (Source: 2020 US Census)

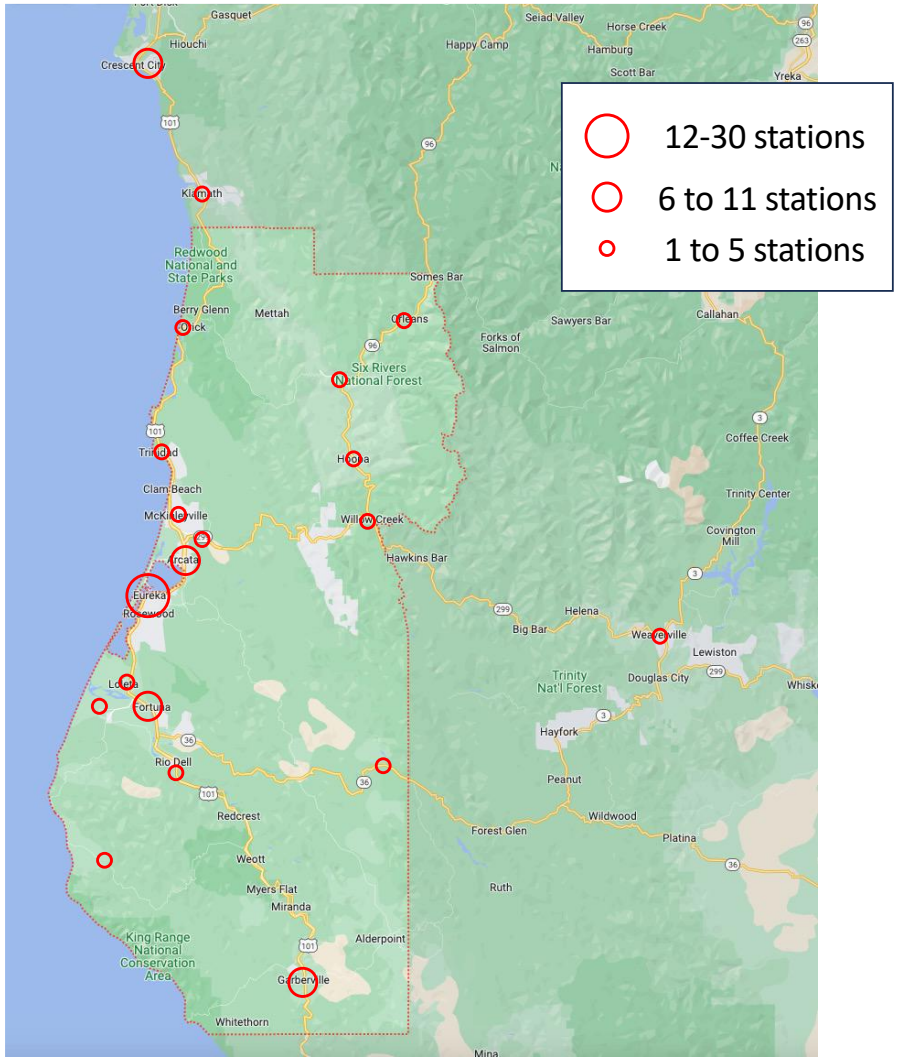


Figure 11: Existing Gasoline/Diesel Fueling Station Map for Study Region (Source: Google Maps)

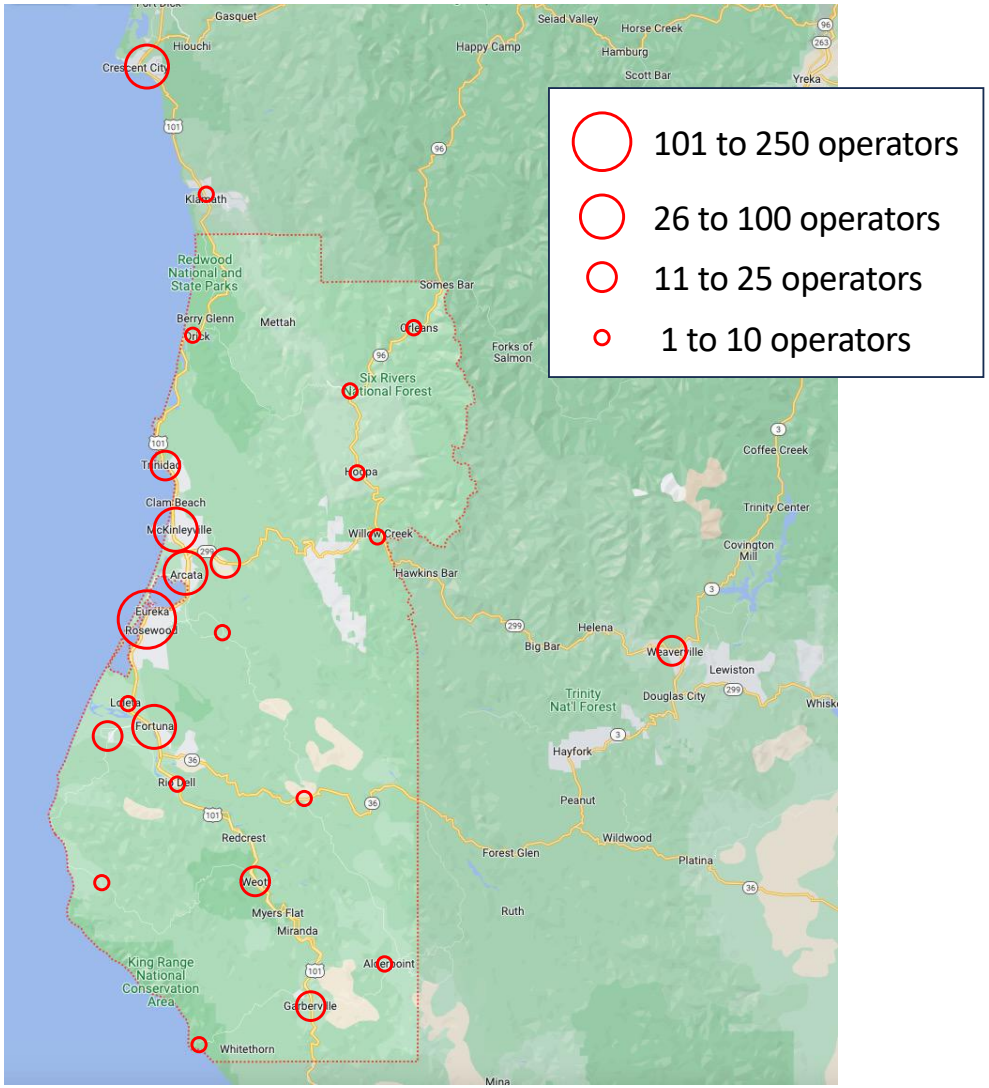


Figure 12: Fleet Operator Map for Study Region (Source: Redwood Coast Energy Authority)

Locating Hydrogen Fueling Station Infrastructure

Using the population and economic indicators described above, this section proposes the number and placement of hydrogen fueling stations needed by year; see Table 10. A map of the proposed hydrogen fueling stations at full buildout in 2045 is presented in Figure 13.

Table 10: Proposed Number of Hydrogen Fueling Stations by Location, Year and Size

Year	Parameter	Fortuna, California	Eureka, California	Arcata + McKinleyville, California	Rest of Humboldt, Del Norte & Trinity Counties
2030	kg/day	317	950	633	1,267
	# of 1000 kg/day stations	1	1	1	0
	# of 5000 kg/day stations	0	0	0	1
2035	kg/day	933	2,799	1,866	3,733
	# of 1000 kg/day stations	1	3	1	0
	# of 5000 kg/day stations	0	0	1	1
2040	kg/day	1,814	5,441	3,627	7,255
	# of 1000 kg/day stations	2	3	1	0
	# of 5000 kg/day stations	0	1	1	2
2045	kg/day	2,641	7,923	5,282	10,564
	# of 1000 kg/day stations	3	3	1	1
	# of 5000 kg/day stations	0	1	1	3

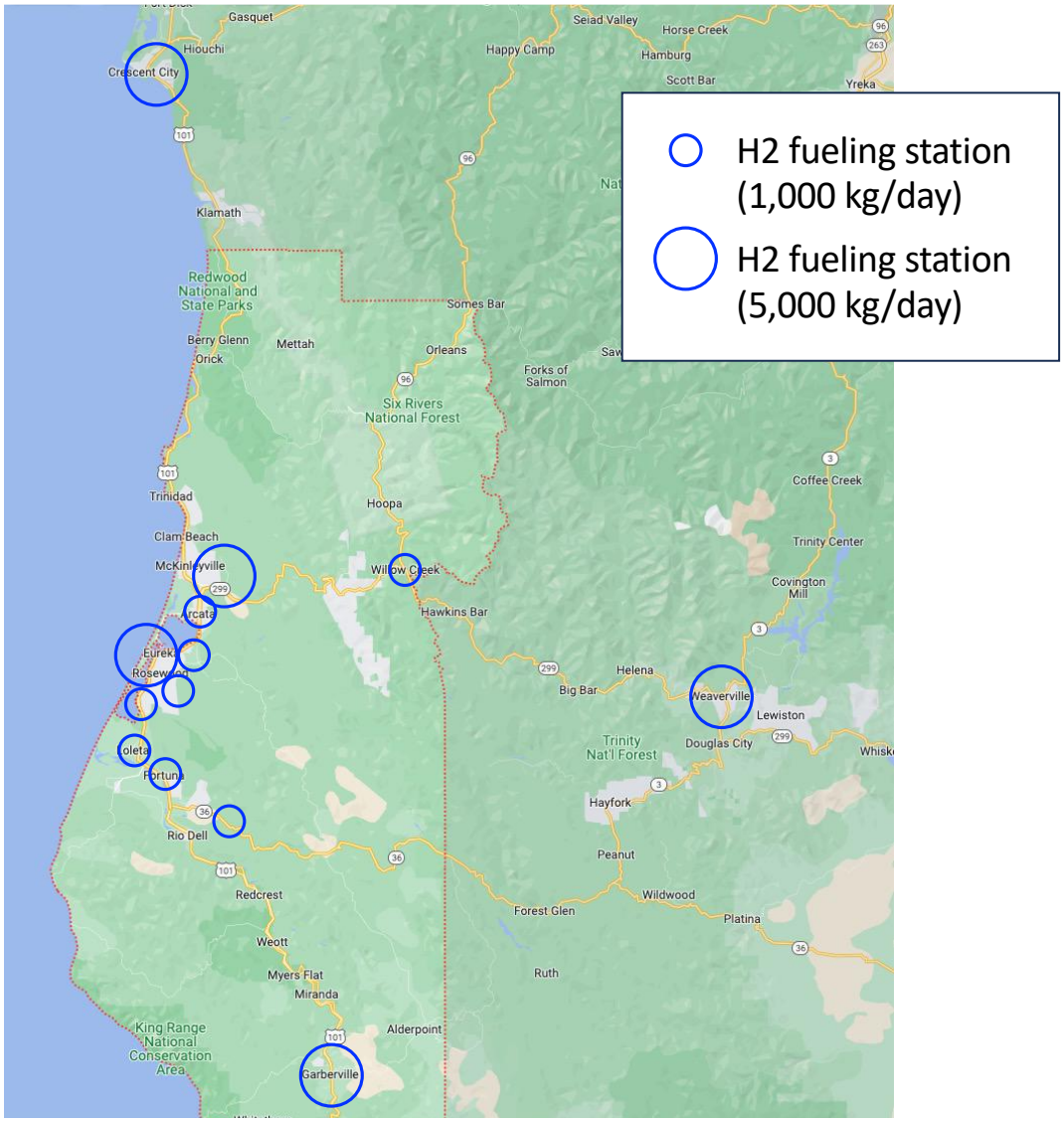


Figure 13: Proposed Hydrogen Fueling Station Map for Study Region for Full Buildout in 2045

Figure 14: Proposed Freight EV corridor in study region

Locating Electric Vehicle Charging Infrastructure

For Scenario 1 where the MD/HD ZEV fleet will be 100% BEV, we will need about 18,800 EV charging ports. We expect that the distribution of EV charging infrastructure should be similar to the distribution of fleet operators (Figure 12: Fleet Operator Map for Study Region (Source: Redwood Coast Energy Authority)). If we use the same geographic distribution parameters that we used for the hydrogen fueling infrastructure, that will lead to a distribution of EV charging stations around the region in the proportions shown in Table 11. If 50% of the MD/HD ZEVs were FCEV and 50% were BEV, we would need half as much infrastructure.

Table 11: Possible distribution of EV charging infrastructure percentages in 2045 to support 100% BEV MD/HD Fleet (assumes daily charging)

	Eureka	Arcata/ McKinleyville	Fortuna	Rest of Humboldt, Del Norte and Trinity Counties
% of infrastructure	30%	20%	10%	40%
# fleet EV chargers	5,630	3,750	1,880	7,510

In 2023, the Federal Highway Administration introduced the designation of Freight EV corridors, and California nominated 14 additional segments including Highway 101 from Santa Rosa to the Oregon border[6]. This increases potential funding for EV charging for north-south routes; see Figure 14.

[6] "California's Deployment Plan for the National Electric Vehicle Infrastructure (NEVI) Program", California Energy Commission; https://dot.ca.gov/-/media/dot-media/programs/esta/documents/nevi/2023-ca-nevi-plan-update-final-a11y.pdf

A local planning entity could work with the local electric utility to determine potential regional electrical distribution infrastructure upgrades and placement. One set of tools that could be useful in this effort are PG&E's Distributed Resource Planning data and maps[7], including their Integration Capacity Analysis (ICA) Map and their Distribution Investment Deferral Framework (DIDF) Map. These resources provide maps of the distribution system and identify approximate available capacity on the existing electrical grid. In the example map shown in Figure 15: green lines have 1.5-2.0 MW of load hosting capacity, yellow have 1.0-1.5 MW of load hosting capacity, orange have up to 1 MW of load hosting capacity and red has 0.0 MW of load hosting capacity.

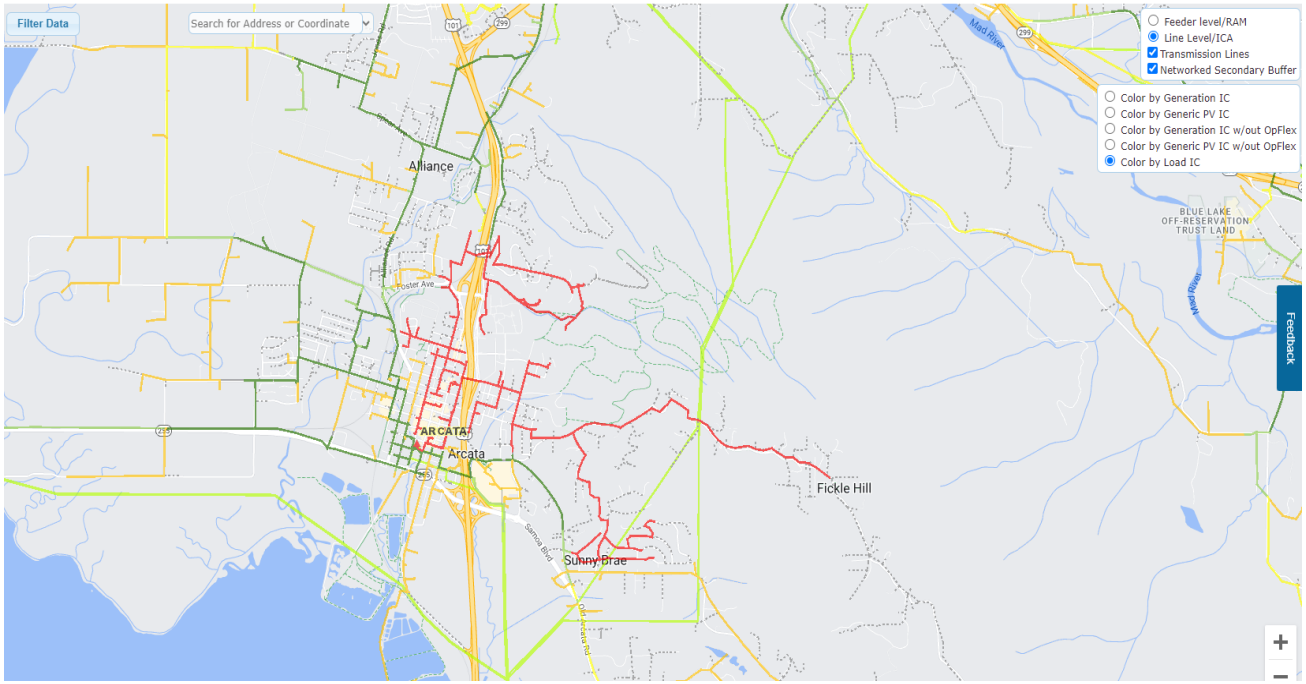


Figure 15: Screen shot of the ICA map for the Arcata area showing load hosting capacity.

[7] https://www.pge.com/en_US/for-our-business-partners/distribution-resource-planning/distribution-resource-planning-data-portal.page

Early-Adopter Placement

Although this blueprint focuses on general region-wide infrastructure placement, this section outlines several initial build-out siting opportunities for both electric and hydrogen infrastructure.

Electric charging hubs

Electricity is generally universal near populated areas, but interconnection capacity may be an issue along with limited space options for access by large vehicles. Remote locations may have more available space, but connection to the grid is limited or very costly. Placing initial charging infrastructure is a balance of finding MD/HD capable physical locations with cost-effective grid connection, or where onsite generation is a viable option for truly remote locations.

Arcata Transit Center

The Arcata Transit Center is a bus terminal in downtown Arcata that serves six fixed-route local and intercity transit services, including service to Crescent City and Amtrak connections in Martinez, CA. This site is also the northern terminus for Greyhound Lines to San Francisco. This site can support local and regional Level 3 charging.

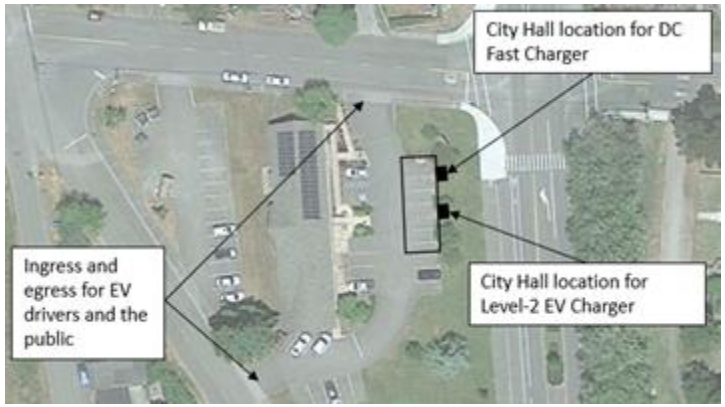
RCEA has applied to the U.S. Department of Transportation for discretionary funds[8] to establish DC fast charging capacity at this site, and should we receive the award any additional funds will provide match dollars or expand capacity.

Eureka City Schools

Eureka City Schools (ECS) are a regional early adopter of electric buses. ECS has received several HVIP vouchers for new buses to be delivered between December of 2023 and December of 2025, and RCEA assisted ECS staff with an associated Energiize grant application for new electric vehicle charging stations.

City of Rio Dell

Located in southern Humboldt, Rio Dell provides a strategic refueling location either for heading further south from the populous Humboldt Bay region, or after traveling north through a long stretch of Highway 101 with limited services; see Figure 16. RCEA has applied to the U.S. Department of Transportation for discretionary funds [IBID] to establish DC fast charging capacity at this site, and should we receive the award any additional funds will provide match dollars or expand capacity.



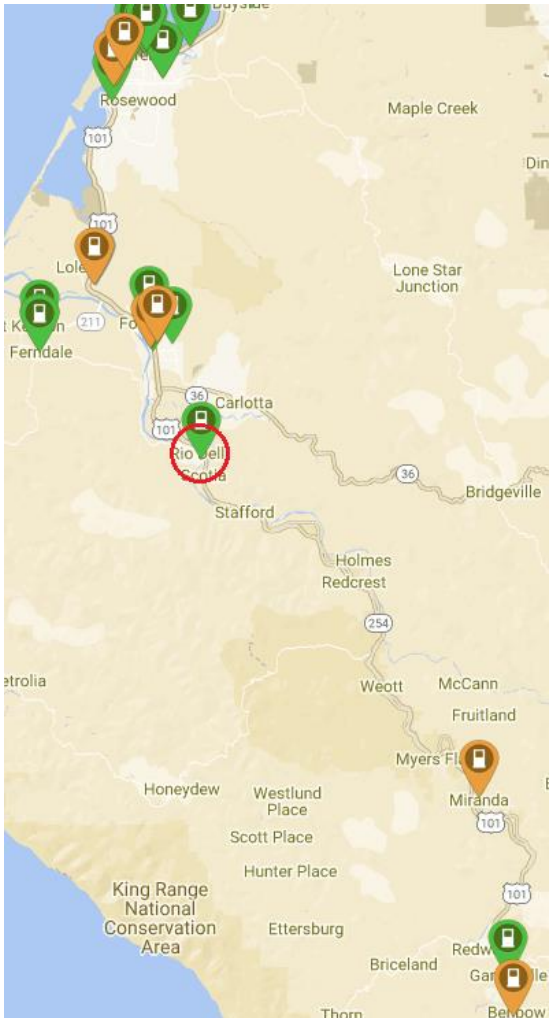


Figure 16: Strategic value of Rio Dell for fast charging along Highway 101.

[8] U.S. Department of Transportation, Federal Highway Administration Charging and Fueling Infrastructure Discretionary Grant Opportunity (Notice of Funding Opportunity 693JJ323NF00004)

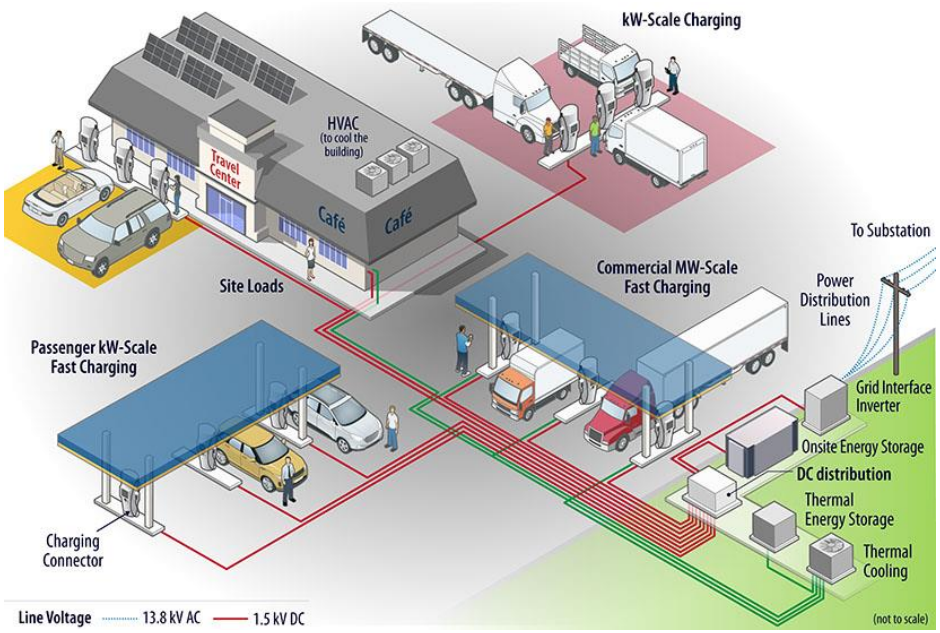


Illustration by Al Hicks, NREL

EV charging and energy storage

The National Renewable Energy Laboratory (NREL) is currently researching options to develop charging hubs that can manage reliable, high-power charging at the 1-megawatt level or higher. Goals are to advance interoperable, reliable, and fast charging systems using a high-power DC charging hub integrated with the electric grid. Onsite energy storage and integration with other site loads are also considered.

An emerging opportunity exists to site EV charging with energy storage systems (ESS). ESS infrastructure provides ancillary electrical services where the grid experiences reliability issues, and one useful application is to offset power peaks on specific grid nodes to defer expensive transmission line upgrades. Depending on their siting, an ESS may be able to offer a secondary role as EV charging depots. Transmission and distribution capacity concerns exist across the study region and RCEA is in discussion with one utility regarding potential ESS siting.

Potential hydrogen sites

In 2019 RCEA completed a CEC grant to for fuel cell EV readiness in the north coast region[9]. The outcome includes a request for information regarding possible sites for local utility-scale solar energy projects. Although the emphasis is on light-duty vehicles as the perceived early adoption market, it helps to inform parallel efforts in the MD/HD sector.

[9] https://redwoodenergy.org/fuel-cell/

Humboldt Transit Authority

The Humboldt Transit Authority is currently acquiring 11 hydrogen buses and is working with a bus manufacturer to develop equipment that can tackle rural route characteristics, including expanded range, temperature, and elevation capacity. As an early adopter in a remote area, HTA serves as an excellent anchor tenant to promote hydrogen fueling infrastructure and is open to business models that allow public use.

Figure 17: Early draft concept of redesigned HTA Administration and Maintenance Facility; illustration courtesy of HTA

State Agency Depot

State fleets have the potential to accelerate FCEV adoption across the state by creating fuel demand to catalyze private investment in fueling infrastructure and creating the opportunity for communities not originally targeted in state planning (rural, disadvantaged community) to adopt FCEVs. The California Department of General Services can take several steps to promote this concept:

Figure 18: AC Transit HyROAD Fueling Station, Emeryville; image courtesy Google Maps

- Proactively communicate planned FCEV purchases to the California Fuel Cell Partnership, car manufacturers and station developers. Coordinate with station developers to enable state fleet managers to place FCEVs where they make sense. This expressed demand will open investment opportunities.
- In more rural areas on major transportation corridors, host fueling stations (fleet-only access or public retail) on state-owned property centrally located relative to multiple government fleets (local, state, and federal).
- In more rural areas with potential for near-term public demand[10], consider prioritizing public retail access by incorporating "shared-over-the-fence" fueling station equipment[11]. This will enable local community fueling, long distance and destination travel, and interstate connectivity.

Caltrans: in 2019 Caltrans District 1, in coordination with the state-level DOT team, indicated that they are interested in hydrogen fueling infrastructure conveniently located for Caltrans fleet, but to date is unavailable to serve as site host for public access. Legislation could help establish policies for state agencies to develop public-private projects that advance state goals.

[10] See CARB CHIT model results at http://californiaarb.maps.arcgis.com/apps/webappviewer/index.html?id=99be905d3127405e81851fd60b19cda2

[11] For an example of "over-the-fence" public access, see the AC Transit Emeryville station located at 1172 45th St, Emeryville, CA 94608.

California Department of Fish and Wildlife (CDFW): Although outside of the study region, the CDFW facility in Yreka, Siskiyou County could serve several state and federal fleets including CalTrans, CDFW, the California Highway Patrol, U.S. Forest Service, and others. It is also located on Hwy 5 near the Oregon border and could serve interstate travel. This site could have potential for high daily volume demand. See Figure 19.

Truck stop options: Private developers are showing interest in potential locations to create truck stops that can include hydrogen fueling. There are no active truck stops within the study region, so this effort would require new development. The potential hydrogen siting map in Figure 13 shows possible real estate acquisitions to investigate as a next step, specifically for locations with sufficient footprints such as along the outskirts of towns and cities.

Figure 19: CDFW, 1625 S. Main Street, Yreka; courtesy Google Maps

Barriers to ZEV Adoption

California sets an ambitious goal to transition MD/HD fleets to ZEVs by 2045. Successfully installing ZEV fueling infrastructure is necessary to advance the state's goals for widespread adoption of MD/HD ZEVs in rural Humboldt, Del Norte and Trinity Counties.

This section lays out the major barriers to ZEV transition and some of the strategies and programs that are available to support our region in overcoming those barriers:

- Permitting ZEV fueling infrastructure.
- Workforce development to build and maintain ZEV fueling infrastructure and to operate and maintain vehicle fleets.
- Utility collaboration and infrastructure upgrades to facilitate electricity refueling.
- Concerns expressed by fleet operators regarding the cost and logistics of owning and operating a ZEV MD/HD vehicle fleet.

Vehicles or infrastructure first?

In the debate about whether Zero-Emission vehicles or the fueling infrastructure should come first, in our study region's rural context, *robust and secure ZEV fueling services will be required prior* to widespread ZEV adoption to enable successful adoption and operation of MD/HD ZEVs.

PERMITTING

RCEA's research identifies some major issues with permitting related to installing ZEV fueling and charging infrastructure.

Barriers to Permitting

General categories of barriers to the permitting process are:

1. Lack of local knowledge and understanding of current codes and standards for ZEV fueling infrastructure.
2. Failure to enforce current codes and standards by local permitting agencies and Authorities Having Jurisdiction (AHJs).
3. Lack of on-line permitting process for most local permitting agencies and AHJs in the study region.
4. Need to coordinate permitting process with both local permitting agencies/AHJs and the local utility providers of transmission and distribution services (Pacific Gas & Electric in Humboldt County, Trinity Public Utilities District in Trinity County, and Pacific Power and Light in Del Norte County).

5. Lack of available electrical capacity from transmission and distribution utility providers.
6. Concerns around safety and standards for hydrogen transportation, storage and fueling.

Efforts to Streamline Permitting

Two main California legislative bills address Electric Vehicle Charging Station (EVCS) permit streamlining for cities and counties: Assembly Bill (AB) 1236 (Chiu, 2015), and AB 970 (McCarty, 2021).

AB 1236 requires all California Cities and Counties to develop an expedited, streamlined permitting process for EVCS. Under AB 1236, cities and counties must adopt a streamlining ordinance and permitting checklist, and jurisdictions are required to limit EVCS project review to health and safety requirements.

AB 1236: ALL CALIFORNIA CITIES AND COUNTIES TO DEVELOP AN EXPEDITED, STREAMLINED EVCS PERMITTING PROCESS.

AB 1236 led to the creation of an EVCS Permit Streamlining Map: https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/; see Figure 20. AB 1236 also led to the creation of a Permitting EVCS Scorecard: https://business.ca.gov/wp-content/uploads/2020/01/Permitting-Electric-Vehicle-Charging-Stations-Scorecard_Updated_8-12-2022.pdf. The scoring criteria are:

- Streamlining Ordinance for Expedited EVCS Permit Process
- Permitting Checklists Online for L2 & DCFC
- Administrative Approval of EVCS
- Approval Limited to Health & Safety Review
- Electronic Signatures Accepted
- EVCS Not Subject to Association Approval
- One Complete Deficiency Notice if Application is Incomplete

RCEA continues to work with Humboldt County jurisdictions to reach compliance.

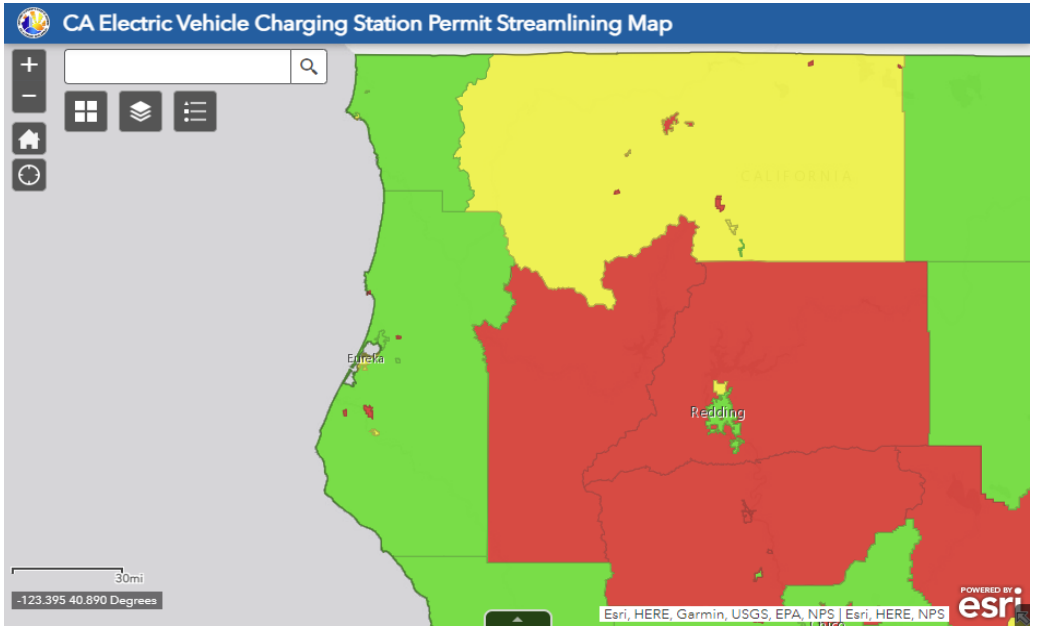


Figure 20: Map showing study region jurisdictions with AB 1236 streamlined EVCS permitting in green, in progress in yellow, and those without a streamlined process in red.

AB 970: SETS SPECIFIC TIME LIMITS FOR JURISDICTIONS TO PROCESS EVCS PERMIT APPLICATIONS.

IEA (2022), Grid Integration of Electric Vehicles, IEA, Paris https://www.iea.org/reports/grid-integration-of-electric-vehicles, License: CC BY 4.0

AB 970 builds on AB 1236 by adding specific binding timelines to the permit review process based on number of EVCS. To comply with AB 1236 requirements and AB 970 timelines, jurisdictions are to provide one complete set of comments detailing any application deficiencies. The review periods are determined based on the size of the proposed project.

AB 1236 and AB 970 apply to all charging station installations, including Level-1, Level-2 and DC Fast Charging; public and private charging stations; and light-, medium-, and heavy-duty EVCS. All cities and counties, including charter cities, in California are required to comply with AB 1236 and AB 970. AB 970 will become operative on January 1, 2022 for all counties and cities with population greater than 200,000 residents and on January 1, 2023 for all counties and cities with a population less than 200,000 residents.

EVCS Permit Timelines under AB 970

1-25 EVCS at a single site:

- An EVCS permit application will be considered complete after **5 business days** if the jurisdiction has not either (1) found the application to be complete or (2) issued a written deficiency notice.
- If not already approved or denied, the application will be deemed approved **20 business days** after it was deemed complete if (1) the jurisdiction has not made a finding of adverse impact to health or safety, (2) the jurisdiction has not required the applicant to apply for a use permit or (3) an appeal has not been made to the planning commission.

26 or more EVCS at a single site:

- An EVCS permit application will be considered complete after **10 business days** if the jurisdiction has not either (1) found the application to be complete or (2) issued a written deficiency notice.
- If not already approved or denied, the application will be deemed approved **40 business days** after it was deemed complete if (1) the jurisdiction has not made a finding of adverse impact to health or safety, (2) the jurisdiction has not required the applicant to apply for a use permit or (3) an appeal has not been made to the planning commission.

Status of Streamlining in Humboldt, Del Norte, and Trinity Counties

Within the study region, Table 12 shows the status of streamlining efforts at the county level and Table 13 shows the streamlining status for incorporated cities. Figure 20 (above) shows the

California Electric Vehicle Charging Station Permit Streamlining Map with the status of incorporated cities in each county; there are no incorporated cities in Trinity County.

Table 12: Summary of streamlining status for Counties of Humboldt, Del Norte, and Trinity.

Streamlining Element	Humboldt County	Del Norte County	Trinity County
Ordinance	Yes	Yes	No
Checklist	Yes	Yes	No
Admin Approval	Yes	Yes	No
Health & Safety	Yes	Yes	No
e-Signature	Yes	Yes	No
No Association	Yes	Yes	No
One Notice	Yes	Yes	No

Table 13: Streamlining status for incorporated cities in Humboldt, Del Norte, and Trinity Counties.

Streamlining Element	Arcata	Blue Lake	Eureka	Ferndale	Fortuna	Rio Dell	Trinidad	Crescent City
Ordinance	Yes	No	Yes	No	No	Yes	No	Yes
Checklist	No	No	No	No	No	No	No	No
Admin Approval	Yes	No	Yes	No	No	Yes	No	Yes
Health & Safety	Yes	No	Yes	No	No	Yes	No	Yes
e-Signature	Yes	No	Yes	No	No	Yes	No	Yes
No Association	Yes	No	Yes	No	No	Yes	No	Yes
One Notice	Yes	No	Yes	No	No	Yes	No	Yes

WORKFORCE DEVELOPMENT

The successful MD/HD ZEV transition requires education programs to retrain existing, and grow new, workers on emerging technologies, equipment and procedures.

Crucial segments of the MD/HD vehicle workforce for retraining will be vehicle operators, fleet maintenance staff, and charging and fueling technicians. Existing personnel hold extensive institutional knowledge and are an essential part of new technology rollouts since they can ease, or stall adoption based on how they embrace the effort and confront challenges.

- Fleet Operators
  - Facilities must accommodate a new fueling system while maintaining existing technology through the transition period.
  - ZEVs and infrastructure require upfront additional capital and require budget adjustments to fleet replacement schedules.
  - Operations need to manage multiple fueling sources and a mixed fleet until fossil fuel-based equipment is decommissioned.
- Vehicle Operators
  - ZEVs are a new type of technology that operate differently than their internal combustion counterparts. Understanding these differences can help maximize ZEV range and reliability.
  - Operating characteristics will affect route planning and schedules.
- Fleet Maintenance Staff
  - Maintaining ZEVs poses challenges to existing fleet maintenance staff who have long histories and extensive training on gas and diesel engines.
  - New diagnostic equipment will also be needed to assess maintenance needs on BEVs and FCEVs.
- Charging and Fueling Technicians
  - MD/HD fleet operators will need to understand the charging needs and limitations of the BEVs that are in their fleets and size their electric vehicle charging stations to provide the correct rate of charge that is compatible with the vehicles charge control system. The charging port configuration on the vehicle will need to match the charging port configuration on the charging stations.

- Charge management systems will need to be put in place that will ensure that all vehicles in a fleet are charged and ready for service each day, but it will not be advantageous or even possible to charge all vehicles at one time.
- Hydrogen fueling infrastructure is a very new technology and not every MD/HD fleet operator will have the need for or the ability to provide hydrogen fueling infrastructure for their vehicles.
- Those that do have a need for hydrogen infrastructure on site will need to develop an understanding of technical requirements and safety requirements of storing and dispensing hydrogen fuels.

Workforce development resources

There are many state, federal, and private resources available for workers and workforce development and training entities, summarized below. Helping to inform pending local needs, the Humboldt Transit Authority provides a course list in their fleet transition planning documentation at: http://hta.org/wp-content/uploads/2023/06/HTA-Zero-Emission-Bus-Rollout-Plan-V1.0.pdf

California Energy Commission's Clean Transportation Program

The California Energy Commission's (CEC) Clean Transportation Program provides funding to support innovation and to accelerate the development and deployment of advanced transportation and fuel technologies. They offer resources and funding for employers to assist in updating the skills of their workers that lead to good paying, long term jobs through their partnership with the Employment Training Panel (ETP): https://etp.ca.gov/.

The California Energy Commission also partners with California Community Colleges to support the Advanced Transportation and Logistics (ATL) Program. The ATL program represents an array of clean energy technologies that form a critical part of California's strategy for reducing its climate change impact while growing the green economy by providing training resources for a skilled and clean workforce: https://atleducation.org/.

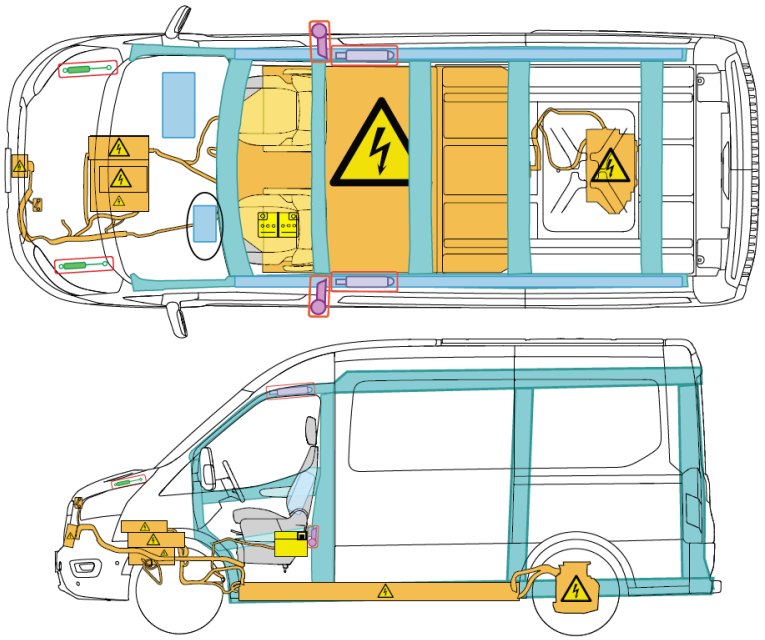
California Air Resources Board's Adult Education & Vocations School Zero-Emission Vehicle Technology Training Project

The California Air Resources Board (CARB) makes grant funding available to support California-based, accredited, non-profit adult education or vocational schools that provide ZEV and electric vehicle charging and fueling equipment education and workforce development:

https://ww2.arb.ca.gov/our-work/programs/adult-education-vocational-school-zero-emission-vehicle-technology-training/about.

Environmental Protection Agency's Workforce Development and Training Resources

The United States Environmental Protection Agency has a very useful website dedicated to workforce development and training (https://www.epa.gov/cleanschoolbus/workforce-development-and-training-resources) which provides several useful resources for workforce development and training. For General Electric Vehicle and Electric Vehicle Supply Equipment Training, they offer:



- Electrification Professional Development (SAE International): Introduction to hybrid and electric vehicle battery systems, safety on high voltage battery systems. https://discover.sae.org/professional-development-electrification-fb#Featured-Courses
- Battery Electric Bus Familiarization (Transit Training Network): Battery electric bus overview, high voltage safety considerations, battery charging approaches. https://www.transittraining.net/courseware/details/battery-electric-bus-familiarization
- Electric Vehicle Training (Federal Energy Management Program): EVSE infrastructure, EV financial considerations, driving EVs, utility partnerships for fleet electrification. https://www.transittraining.net/courseware/details/battery
- First Responder Safety Training (National Fire Protection Association) https://www.nfpa.org/EV

For Vehicle Operation Training, they offer:

- Driver and Technician Training (Alternative Fuels Data Center): EV operation and charging, EV features, important dashboard indicators, charging best practices. https://afdc.energy.gov/vehicles/electric_school_buses.html#driver-training

Under the topic of Installation, Maintenance, and Repair for EVs and EVSE they offer:

- Transportation Electrification (Institute of Electrical and Electronics Engineers): Basic concepts of electric motors, fuel cells, electric drive trains, and battery systems. https://iln.ieee.org/Public/ContentDetails.aspx?id=A9E334131FB046819D77B07AA8ACCD53&gclid=EAIaIQobChMIpv39kMvI-wIVhrrICh2wgQyJEAAYAiAAEgLztfD_BwE
- Electric Vehicle Infrastructure Training Program: Comprehensive training for installation of EV charging equipment. https://evitp.org/training/

Department of Energy Trainings

The United States Department of Energy (DOE) provides training resources for electric vehicles online here: https://www.energy.gov/femp/electric-vehicle-training. The DOE offers a series of training videos at this same website that cover the following topics that can help fleet operators, EV drivers and maintenance technicians:

- EV Technology Overview
- EV Financial Considerations
- EVSE Infrastructure
- Driving Electric Vehicles

Fleet and facility managers interested in developing expertise in fleet electrification can enroll in the Federal Energy Management Program's (FEMP): fleet management training courses: https://www.wbdg.org/continuing-education/femp-courses?field_topics_tid_selective=307&field_education_type_value_selective=OD

The Department of Energy's Electric Vehicle (EV) Champion Series is a four-part course developed by the National Renewable Energy Lab and the Federal Energy Management Program fleet team. People who complete all four webinars can earn continuing education units and a training certificate: https://www.wbdg.org/continuing-education/femp-courses/fempodw109.

Electric Vehicle Infrastructure Training Program

The Electric Vehicle Infrastructure Training Program (EVITP) provides training and certification for electricians installing electric vehicle supply equipment (EVSE). Many state and federal granting and funding agencies require that grant funded EVSE are installed by EVITP certified electricians or electrical contractors: https://evitp.org/.

Redwood Coast Energy Authority currently provides a reimbursement process for Humboldt County electricians to get EVITP certified: https://redwoodenergy.org/contracting/#1678742833581-533f847d-0a9b.

Community Colleges

In Humboldt County and Del Norte Counties, the College of the Redwoods offers an Associate of Science Degree in Automotive Technology and a Certificate of Achievement in Automotive Maintenance and Light Repair. Within both programs they offer classes in "Electrical and Electronics Installers and Repairers for Transportation Equipment" and "Electronic Equipment Installers and Repairers for Motor Vehicles". They do not yet offer specialized degrees or certificates for electric vehicle maintenance or repair: https://redwoods.elumenapp.com/catalog/2022-2023/program,automotive-technology-fall-2022#mainContent.

In Trinity County, the Shasta College satellite campus in Weaverville offers an "Associate of Science Degree in Automotive Technology" and a "Certificate of Achievement in Automotive Technology". Within both programs they offer classes in Vehicle Electrical Systems and Introduction to Hybrid and Electric Vehicle Technology. They do not offer specialized degrees or certificates for electric vehicle maintenance or repair: https://www.shastacollege.edu/academics/programs/automotive/.

UTILITY COLLABORATION

Each county in the study region is served by different electric utility service providers:

- In Humboldt County electric transmission and distribution (T&D) services are provided by Pacific Gas and Electric (PG&E).
- In Del Norte County the electric utility provider is Pacific Power.
- The majority of Trinity County receives electric utility service from the Trinity Public Utilities District (TPUD), but the eastern and southern portions of Trinity County are served by PG&E.

The Redwood Coast Energy Authority (lead author of this Blueprint) also serves as a Community Choice Aggregator in the study region and provides electric generation content to 93% of residents in Humboldt County. However, PG&E provides the transmission and distribution services that govern the interconnection and planning process for new Electric Vehicle (EV) charging infrastructure, so this blueprint focuses on PG&E's programs and policies.

General best practices

Some best practices for utility collaboration are to:

- Plan for Fleet Electrification: Factors for fleet electrification planning include:
  - The type and number of vehicles in the fleet,
  - A timeline for transitioning to ZEVs,
  - Daily vehicle miles traveled,
  - ZEV charging locations,
  - ZEVs charging schedules.
- Submit construction permit applications early: Permits from the city or county (or other authority having jurisdiction) will take time and permit details are often required for utility service applications.
- Apply for dedicated metered electric service for EVCS: Electric needs of EVCS often exceed existing facility electrical service capacity. An alternative to upgrading the existing electric service is to install a dedicated metered electric service for EVCS.
  - PG&E and Pacific power have programs to pay for infrastructure related to a dedicated service (see details in Utility Programs below).

ELECTRIFICATION FLEET PLAN:

- ☐ Vehicle type and number
- ☐ Transition timeline
- ☐ Daily VMT
- ☐ Charging locations
- ☐ Charging schedules

AS OF 2023, ELECTRIC EQUIPMENT, INCLUDING TYPICAL STOCK ITEMS SUCH AS METER SOCKETS AND PEDESTALS, CAN HAVE LEAD TIMES OF 12 MONTHS OR LONGER.

  - A dedicated metered electric service also allows customers to designate an EV charging rate, which typically lowers the cost for EV charging compared to standard commercial building electric rates.
  - Separating the new load also helps to avoid expensive demand charges on existing electric accounts.
- Submit Utility Interconnection Applications Early: Applications for new and or upgraded electric service connections can take between 9-24 months in these regions. In addition, equipment lead times for utility compliant switch gear, transformers and meter panels can delay projects.
- Apply for Commercial EV Charging Rates: Commercial EV charging rates typically offer a lower cost option for EV charging when compared to standard commercial electric rates, with off-peak and super off-peak EV rates being the lowest cost option for EV charging. PG&E's BEV rate does not include demand charges, which can account for a large increase in the cost of EV charging.
- Use Utility Providers Tools: Some utilities provide useful online tools to help planning for ZEV infrastructure installations.
  - PG&E offers the Integration Capacity Analysis (ICA) mapping tool to help identify available capacity on their electric grid: https://www.pge.com/en_US/for-our-business-partners/distribution-resource-planning/distribution-resource-planning-data-portal.page.
  - PG&E also provides a link to an EVCS charger selection guide developed by Southern California Edison, the Charge Ready Approved Product List Selection and Rebate Tool: https://app.powerbi.com/view?r=eyJrIjoiZWE0Mjg4MjctNjZiYi00MjhmLWFiYWEtMzBiODM2YTFhZTdlIiwidCI6IjViMmE4ZmVlLTRjOTUtNGJkYy04YWFlLTE5NmY4YWFjYjFiNiIsImMiOjZ9.

- Use Utility Provider Programs: Both Pacific Power and PG&E offer programs dedicated to electric vehicle service connections.

- In Del Norte County, Pacific Power offers the California Electric Vehicle Infrastructure Line Extension program. Pacific Power's Electric Vehicle Infrastructure Rule 24 will pay for and coordinate the design and deployment of service extensions from their electrical distribution line facilities to the service delivery point for separately metered EVCS; see Figure 21.
- In Humboldt County and parts of Trinity County, PG&E offers Rule 29 EV Infrastructure Planning Rule. Under this program, PG&E will cover the costs of utility-side electric distribution infrastructure supporting separately metered EV charging. Figure 23 (next page) shows a breakdown of utility and customer owned infrastructure under the PG&E program.
- In Humboldt and parts of Trinity County PG&E also offers the EV Fleet Program. Similar to the Rule 29 EV Infrastructure Rule, PG&E will cover the costs of utility-side electric distribution infrastructure supporting separately metered EV charging. In addition to covering the cost of "to-the-meter" infrastructure, the EV Fleet Program provides various funding levels for behind-the-meter; see Figure 22.

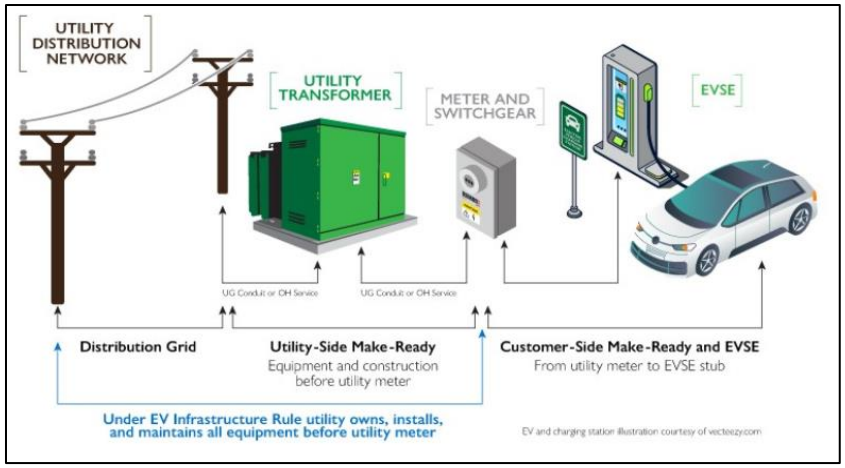


Figure 21: Breakdown of utility and customer owned infrastructure under the Pacific Power program

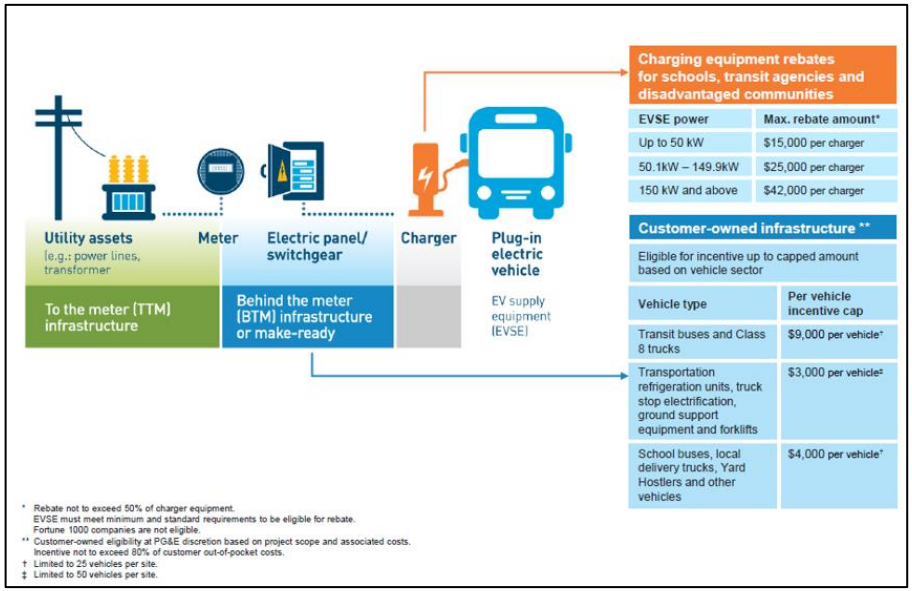


Figure 22: Breakdown of utility and customer owned infrastructure and additional incentives under the PG&E Fleet Program

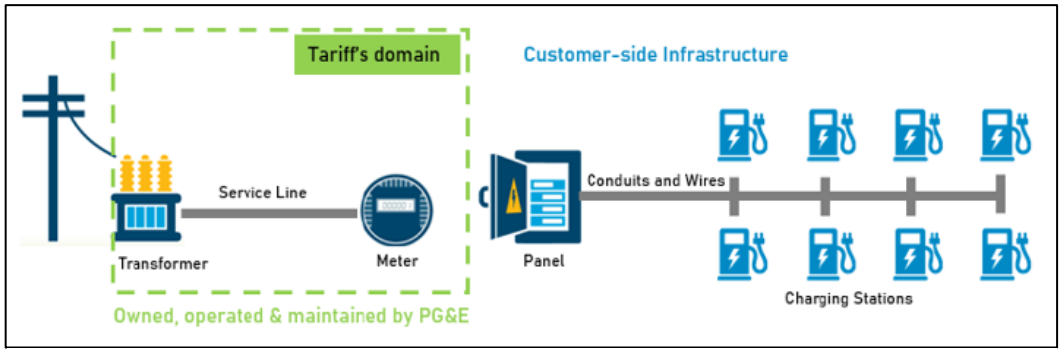


Figure 23: Overview of PG&E Infrastructure Planning Rule Program ownership

Accelerate utility interconnection timelines

For EV charging infrastructure the electric grid is an essential factor for rapid deployment. Current challenges for new infrastructure projects include:

- MD/HD charging infrastructure is typically larger than most utility connections, and utilities need time to work out these more complex projects. [12]
- New projects are currently experiencing 18-24 months to receive utility connection, and delays may last for 5 years or more in congested areas.
- A scarcity in electrical equipment components, mostly from a lack of specialized steel. In 2023 material order times have gone from weeks to months, and in some cases exceeding a year to procure.

Some ideas to help reduce future delays:

- Conduct dedicated grid planning to identify necessary infrastructure upgrades to support a fully built-out fleet. One example is the two-year study of electric trucking charging needs in the Northeast to develop a 20-year demand forecast for over 100 potential charging sites in the region[13].
- Assess if new infrastructure is upstream or downstream of major transmission grid loads.
- If a new substation is probable in key locations, start planning early since it can take up to five years or longer to build.

[12] "I-5 Electric Truck Charging Sites Mapped Out by Electric Utilities"; https://westcoastcleantransit.com/resources/WestCoastCleanTransitNewsRelease-Website.pdf

[13] https://www.utilitydive.com/news/national-grid-electric-trucking-charging-needs-study/696668/

FLEET OPERATOR CONCERNS

There are significant challenges that MD/HD fleet owners and operators face when making the transition to ZEVs. This blueprint identifies five major areas of concern expressed by fleet operators/managers regarding the transition to ZEVs:

- Vehicle Availability
- Vehicle Cost
- Vehicle Range Limitations
- Availability of Charging and Fueling Infrastructure
- Vehicle Maintenance

These resources are currently available to partially address the concerns:

- ZEV TruckStop is a one-stop website provided by CARB and provides a range of resources including information about vehicle availability, vehicle incentives, and infrastructure funding. The site can be accessed here: https://ww2.arb.ca.gov/our-work/programs/truckstop-resources/zev-truckstop
- Cal Fleet Advisor, also a CARB resource, provides guidance to California trucking fleets owners and operators at no cost, including referrals to products, services, and funding opportunities. The site can be accessed here: https://calfleetadvisor.org/
- Zero-Emission Truck Loan Pilot Project, a collaborative effort from CARB, the CEC, and the California Pollution Control Financing Authority, provides loan funding assistance to small business owners that are transitioning to Zero-Emission heavy-duty vehicles. Program information can be found here: https://ww2.arb.ca.gov/our-work/programs/zero-emission-truck-loan-pilot
- Commercial Clean Vehicle Federal Tax Credit provides tax credits up to $40,000 to businesses and tax-exempt organizations that buy a qualified Zero-Emission vehicle. More information can be found here: https://www.irs.gov/credits-deductions/commercial-clean-vehicle-credit
- California's Hybrid Zero-Emission Truck and Bus Voucher Incentive Program (HVIP) provides point-of-sale vouchers to help discount the cost of ZEVs. They offer a range of resources including a vehicle catalog, dealer lists and funding updates. Program information can be found here: https://californiahvip.org/

- Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE Commercial Vehicles) provides incentives for electric vehicle charging infrastructure and hydrogen fueling infrastructure for California commercial fleet operators. They offer a range of funding opportunities; more program information can be found here: https://www.energiize.org/

Beyond program resources, truck, bus and other medium- and heavy-duty vehicle manufacturers also provide these sources for trucks, buses, and equipment:

- Blue Bird Electric School Buses: https://www.blue-bird.com/buses/electric-school-buses
- Lion Class 8: https://thelionelectric.com/en/products/electric_truck_class8
- Lion Electric School Buses: https://thelionelectric.com/en/products/electric_school_bus
- Freightliner Electric Trucks: https://www.freightliner.com/trucks/#category=Electric
- Freightliner eM2 Delivery Truck: https://www.freightliner.com/trucks/em2/specifications/#tab-6
- Mack LR Electric: https://info.macktrucks.com/refuse-revolution?utm_source=google&utm_medium=cpc&utm_content=mack%20semi%20truck&utm_campaign=20188275807&gad=1&gclid=EAIaIQobChMI3NDxi4etgAMVAgitBh0y2gz2EAAYASABEgJeyvD_BwE
- Mack Truck MD Electric: https://www.macktrucks.com/trucks/md-electric/
- Peterbilt Electric Vehicles: https://www.peterbilt.com/electric-vehicles
- Volvo Electric Trucks: https://www.volvotrucks.us/trucks/vnr-electric/specifications/
- Volvo Electric Construction Equipment: https://www.volvoce.com/united-states/en-us/products/electric-machines/

Cost Barriers Are a Primary Concern

While some fleet operators recognize environmental benefits, total cost of ownership (TCO) remains a central decision tool. Although ZEVs benefit from lower operating costs, up-front costs cause hesitation particularly for operators with limited working capital. As one recent

article observes, “This industry is very, very old-school, very, very conservative. You’ll see pushback from them until TCO becomes positive operating the vehicles.”[14]

Reducing the upfront costs will help to achieve parity with traditional vehicles and enable a smoother transition to ZEVs. The same article highlights that once total cost of ownership becomes positive, ZEVs become a preferred choice.

Potential Cost Solutions

The West Coast Clean Transit Corridor Initiative summarizes that to date, “electric utility infrastructure programs that support MD/HD EVs have primarily focused on fleets that charge at a single location (usually their home base). Expanding these programs to support charging for fleets that travel along corridors and rely on public fueling stations could further accelerate electric truck adoption.” See Figure 17 for an example at an AC Transit station in Emeryville, CA.

Site infrastructure costs remain difficult to predict, with variables such as location characteristics, electric circuit capacity, utility upgrades, permits, and labor and equipment costs. Since sites require targeted, detailed assessments, technical assistance funding can provide preliminary screening and create an inventory of shovel-ready projects. By using grant funding, this sunk cost can be distributed across a portfolio rather than borne on a project-by-project basis.

CARB is currently offering $83 million in incentives for smaller fleets seeking to buy Classes 2b-8 electric trucks[15]. CARB is also proposing changes to its Low Carbon Fuel Standard to create a provision to support medium and heavy-duty Zero-Emission vehicle (ZEV) refueling infrastructure[16].

Policy makers can accelerate market adoption and transformation through subsidies, a familiar topic for California decision-makers. To help ease the transitions, mandates, and regulations it is

> “COMMERCIAL EVS HAVE BEEN ON THE JOB FOR YEARS NOW, AT DOZENS OF COMPANIES, IN JUST ABOUT EVERY CONCEIVABLE USE CASE, AND THEY’VE PROVEN THAT THEY CAN DO THE JOB BETTER, QUIETER, MORE SAFELY AND ABOVE ALL, CHEAPER.”[14]

[14] Clearing the roadblocks to electrification of heavy-duty trucks; https://chargedevs.com/features/vehicle-features/clearing-the-roadblocks-to-electrification-of-heavy-duty-trucks/

[15] https://ww2.arb.ca.gov/resources/fact-sheets/innovative-small-e-fleet-pilot-program

[16] https://ww2.arb.ca.gov/sites/default/files/2023-09/lcfs_sria_2023_0.pdf

crucial that fleet operators can benefit from incentives and rebates to balance real and perceived challenges of shifting toward clean fleets.

Availability of Refueling Infrastructure

Fleet operators recognize ZEV mandates but raise questions on when and how infrastructure will be deployed to support operations:

- Address property owner role in deploying fueling infrastructure: Many fleets lease rather than own their properties, which limits their ability to perform site modifications. This requires landowners to consider the cost and responsibility to install charging infrastructure.
- Evaluate EV charging as primary use: As of 2023 EV charging is rarely the primary use of a property. A next step is to develop zoning codes at the municipal level to prepare for higher-density, higher-speed charging infrastructure.
- Need for standards: Standards can support electrification by establishing consistent practices for safety, fuel dispensing, interoperability, training, data management, and so on. This creates a predictable fueling experience for all participants.

Actions to Accelerate ZEV Adoption

This section summarizes barriers identified throughout this blueprint along with potential actions, followed by discussions of several broad considerations such as electric grid capacity and economic changes in the region. Along with industry-wide barriers, rural stakeholders also need to address issues around isolation and distance from major markets.

- Permitting
  - Finalize AB 1236 permitting compliance.
  - Train staff on AB 970 requirements and establish compliance metrics.
  - Work with state policymakers to address challenges around lack of enforcement.
  - Secure funding to develop on-line permitting processes for regional agencies.
  - Seek state-level safety and other standards for hydrogen transportation, storage, and fueling.
- Workforce Development
  - Host a working group for operators and managers to share information, voice concerns, obtain support, and advance shared interests within the region.
  - Develop regionally accessible curriculum and programs at regional institutions from high school through university level.
  - Establish training stipends to compensate existing operators for time away from work.
  - Host technology workshops on ZEV operations, maintenance, route planning, and refueling methods.
  - Encourage manufacturers to reinvest in regional authorized repair facilities and associated training, potentially using rural economic development funds.

"ALTHOUGH HEAVY-DUTY TRUCKS ACCOUNT FOR ONLY 5 PERCENT OF THE VEHICLES ON US ROADS, THEY CONTRIBUTE A DISPROPORTIONATELY HIGH 23 PERCENT OF ALL TRANSPORTATION EMISSIONS."

West Coast Clean Transit Corridor Final Report

- Seek opportunities to align workforce development goals with other regional industry efforts such as grid resilience and port revitalization.
- Conduct ZEV first responder training.

- Infrastructure Siting and Placement
  - Conduct an in-depth study of physical siting opportunities using the Blueprint station placement maps.
  - Secure funding for key demonstration sites to "lead by example"; see "Early-Adopter Fleet and Fueling Placement" for example projects.
  - Establish a technical assistance fund to support site design and engineering, utility feasibility studies, and related deliverables to create shovel-ready projects.
  - Develop a portfolio of shovel-ready sites and pursue implementation grant funding.
  - Identify early adopter locations, particularly for public/private collaborations.
  - Promote and identify potential public off-takers for the pending Humboldt Transit Authority hydrogen fueling station.
  - Seek state agency collaborative opportunities to host hydrogen fueling stations (fleet-only access or public retail) on state-owned property centrally located relative to multiple government fleets (local, state, and federal).
  - To stimulate private investment, encourage the California Department of General Services to communicate planned FCEV purchases to the California Fuel Cell Partnership, car manufacturers and station developers.
- Utility Collaboration
  - Work with utilities to investigate options for rapid, low-cost site screening for new electrical loads at existing facilities.
  - Prepare a North Coast grid infrastructure plan that identifies infrastructure upgrade requirements for a fully built-out MD/HD fleet.
  - Identify any locations with surplus grid capacity, such as former mill sites, that could host local hydrogen production.
  - Identify energy storage system locations that could serve as high-power charging hubs in parallel with transmission and distribution capacity needs.

"MOST UTILITIES IN CALIFORNIA, OREGON AND WASHINGTON HAVE ENOUGH CAPACITY IN URBAN AREAS ALONG I-5 TO SUPPORT INTERCONNECTIONS WITH THE MEDIUM-DUTY CHARGING SITES. RURAL AREAS ARE MORE OF A CHALLENGE AND NONE OF THE RURAL AREAS CURRENTLY HAVE CAPACITY TO SERVE HEAVY-DUTY SITE DEVELOPMENT."

- Total Cost of Ownership
    - Evaluate opportunities for public-private infrastructure siting, such as "over the fence" public refueling at government agency facilities that can serve as anchor sites.
    - Secure and provide technical assistance funds and project management to provide preliminary site screening and reduce sunk costs for prospective infrastructure sites. Screening may include siting characteristics, electric circuit capacity, utility upgrades, permitting, and projected labor and equipment costs. This is a preferred option since it provides busy fleet operators with temporary skilled labor for short-term planning efforts.
    - Alternately, provide subsidies to cover targeted activities needed to meet upcoming mandates and regulations.
- Market Acceptance
    - Host regional vehicle expos and ride-and-drive events.
    - Provide scholarships for regional operators to attend west coast events such as the Advanced Clean Transportation Expo.
    - Distribute a fleet electrification handbook to guide operators through the various steps from planning to implementation.
    - Conduct fleet electrification workshops to introduce principles and walk through example projects. Preferably include fieldtrips as early sites become available.
    - Promote technology advances for equipment that can tackle rural route characteristics, including expanded range, temperature, and elevation capacity.
- General Market Initiatives
    - Develop model zoning codes at the municipal level to prepare for higher-density, higher-speed charging infrastructure (EV charging as primary use).
    - Develop incentives for landowners to install charging infrastructure for fleet tenants.
    - Monitor progress on West Coast Truck Charging and Fueling Corridor and promote similar concept for feeder routes.
    - Establish industry standards for safety, fuel dispensing, interoperability, training, data management, and so on.
- Secure funding to provide technical assistance for fleet analysis and infrastructure plans.

IN A NOVEL CONCEPT, WattEV IS DEVELOPING A "TRUCKS AS A SERVICE" MODEL. THIS REMOVES DEVELOPMENT RISK FROM THE TRANSPORTERS FOR BOTH THE ZEV AND CHARGING INFRASTRUCTURE.

IN OCTOBER 2023, MACK TRUCKS ANNOUNCED A LEASING OPTION THAT BUNDLES CHASSIS AND BODY, CHARGING, INCENTIVES, INSURANCE AND MAINTENCE INTO A "PAY AS YOU GO" OFFERING BASED ON MILES DRIVEN. IT ALSO OFFERS ASSISTANCE FOR CHARGING INFRASTRUCTURE DESIGN, CONSTRUCTION, AND OPERATING SOFTWARE.

- Hold a regional vehicle expo, preferably as part of a broader west coast tour.
- To maximize equipment uptime and avoid costly repair delays, develop, and incentivize quality standards to emphasize quality over initial cost.
- Promote technical design for cost-effective field repairs and maintenance.
- Establish regional supply depots.

The electric grid is a mature market, but also includes decades of maintenance and upgrade issues. The Department of Energy cites that we may need to triple new electrical load capacity as transportation and buildings shift away from fossil fuels[17]. As MD/HD ZEVs add new load they will compete with all other decarbonization efforts. Finally, climate change is heavily testing the aging electric grid and forcing an increased focus on redesign, hardening, and monitoring to adapt to evolving conditions. Options to address these challenges:

- Identify opportunities to combine local energy generation and storage with vehicle charging infrastructure.
    - This is particularly useful to reduce demand charges and peak times of day since batteries can charge during lower-cost periods and top off vehicles as needed.
    - Onsite generation such as solar adds resilience when the grid is down or unstable by ensuring at least a minimum electrical resource every day.
    - Combining these technologies sets the stage for future resilience options through vehicle-to-building integration.
- Conduct a feasibility study to determine existing capacity and additional requirements for electric infrastructure upgrades.
- Secure funding to upgrade the electric grid to support MD/HD EV charging requirements.
- Assess fleet facilities for self-generation and storage opportunities.

As a new fueling technology lacking the ubiquity of the electric grid, hydrogen adoption would benefit from targeted activities such as to:

"INDEPENDENT ESTIMATES INDICATE THAT WE NEED TO EXPAND ELECTRICITY TRANSMISSION SYSTEMS BY 60% BY 2030, AND MAY NEED TO TRIPLE IT BY 2050 TO MEET THE COUNTRY'S INCREASE IN RENEWABLE GENERATION AND EXPANDING ELECTRIFICATION NEEDS."
U.S. Department of Energy

[17] https://www.energy.gov/articles/biden-administration-launches-25-billion-fund-modernize-and-expand-capacity-americas-power

- Work with manufacturers to broaden technical capacity beyond initial market opportunities such as flat, limited-range urban routes. For example, the Humboldt Transit Agency is working with one manufacturer to redesign their buses to cope with the broader range, temperature and terrain requirements typically found in rural regions.
- Work to ensure that rural regions receive infrastructure funding to ensure a fully functional freight network beyond just major freight lines.

Although some of these efforts can be solved by private business, others require dedicated government funding to avoid exacerbating equity gaps in rural regions.

Capture other sectors

This blueprint provides a pathway forward for a sizeable share of transportation-related emissions, but there are several other economic sectors that need attention including:

- Offroad vehicles: The study region includes extensive state and national land ownership. This increases the percentage of offroad vehicles contributing to emissions as CARB and other efforts improve on-road transportation. See Figure 24 for an example of extensive state land ownership in Del Norte County.
- Non-drayage maritime: offshore short sea shipping, fishing, and research activities will increase in their proportional share of GHG emission as terrestrial sources diminish.

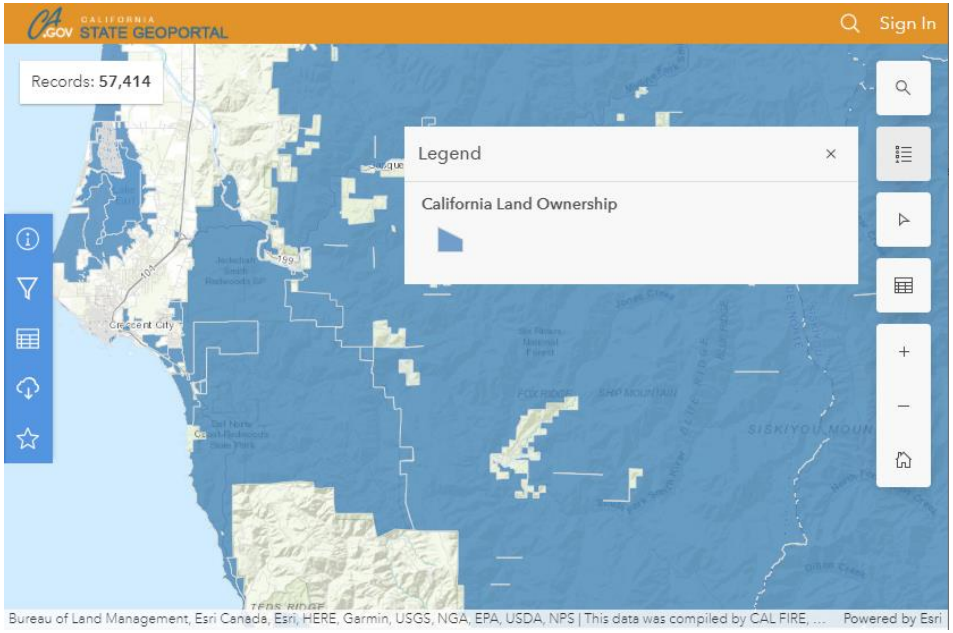
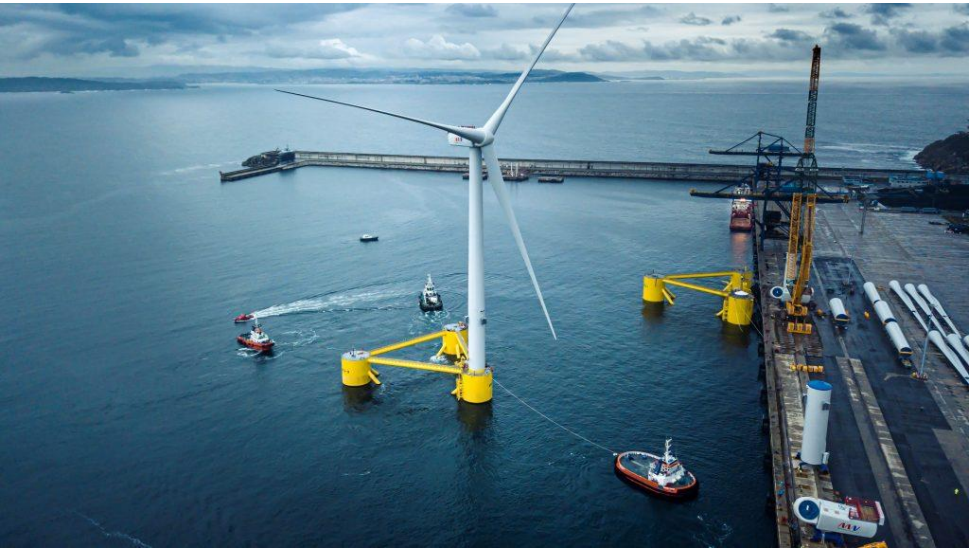


Figure 24: Del Norte County state land ownership



Prepare for economic development

This blueprint focuses on existing needs of the study region, but the north coast holds potential for dramatic growth in heavy industry as home to a world-class offshore wind resource. As an unobstructed deep-water port, Humboldt Bay is well suited to serve as a western seaboard offshore wind industry. Plans are underway at the local, state, and national level to unlock the potential of this renewable energy resource.

One consequence is an initiative to revitalize the Port of Humboldt Bay into a heavy-lift terminal for deploying ocean-based energy resources along the coast. This has major implications for MD/HD inventories and will add new categories of vehicles for drayage, construction, quayside support. A blueprint update will be necessary as the offshore wind industry gains momentum.

ZEV workforce development shares many attributes with other clean energy initiatives. As the home to a Community Choice Aggregator, Humboldt County stands to benefit from efforts to grow local renewable energy and storage projects and to improve local energy resilience and reliability. Given the regional isolation, it is essential to develop and sustain a local skilled workforce to build robust and knowledgeable communities and minimize downtime. Actions to support ZEV workforce development are to:

- Inventory projected jobs and associated skills for various clean transportation roles.
- Secure funding to develop and conduct targeted workshops and certification programs.
- Work with local labor experts to identify career transition requirements and goals for existing transportation workers.
- Work with existing community colleges and universities to develop vocational and university programs in clean transportation careers.

In parallel with offshore wind developments along the western seaboard, Del Norte will likely experience increased port activities such as tug and maintenance services for offshore wind facilities best served out of Crescent City Harbor. The Humboldt County port revitalization will also likely bring economic benefits to Trinity County such as through freight movement and associated services along highway 299.

AN ECONOMIC ASSESSMENT FOUND THAT REVITALIZING THE PORT OF HUMBOLDT BAY COULD GENERATE AS MANY AS 830 LOCAL JOBS AND MORE THAN $130 MILLION IN INDUSTRY OUTPUT OVER A FIVE-YEAR PERIOD.

Change is a constant

Our transportation system is at a crossroad where it must cope with ongoing uncertainties of climate change while simultaneously transforming primary fueling sources and methods. This complex situation requires flexibility and patience to recognize and adapt to factors such as:

- Autonomous vehicles: some form of vehicle autonomy is likely in the next decade, and will have a direct impact on road design, operator behavior, refueling, and so on.
- Rapidly evolving fuel technology: the hydrogen fueling industry is still in its infancy, and the best applications remain uncertain as manufacturers evolve their fueling and power delivery system design and markets identify viable applications for each.
- Grid capacity: shifting from fossil fuel will place considerable strain on the national electric grid as myriad economic sectors migrate to electric power.
- New labor skills required: zero-emission vehicles require new skills to maintain and service emerging powertrains, braking systems, sensors, energy storage, and so on.
- Mixed fleet assets: fleet operators and managers will face extra complexity while they handle a mix of internal-combustion and ZEV assets for the next decade.

Closing Thought

Transportation systems are by nature an interconnected web and require systematic planning and investment across a broad network of routes, fueling, and supply and repair services. Although remote settings often have small communities and limited services, they deliver essential connectivity for intrastate and interstate commerce.

In our national economic system, it may be simpler to conduct transformational work in a setting with abundant capital, skilled workers, and resources, but overall progress requires extra attention to build and sustain rural capacity. With limited ability to attract and retain private enterprise, rural regions will require heightened state-level investment to ensure that the transportation system transitions as a whole.

Photo Credits: All vehicle images - the respective manufacturer; cover page Ford Motor Company; Table of Contents Volvo FE Truck; page iv Humboldt Transit Agency; page 2 Freightliner eCascadia dashboard image; page 3 Clean Transportation Program; page 5 AdobeStock; page 12 Lion C school bus; page 14 Mack LR Truck; page 16 Volvo FE dump truck, page 17 freightliner em2, page 20 General Motors BrightDrop, page 26 ChargePoint EV Charging stock photo; page 27 AdobeStock hydrogen fleet fueling; page 29 AdobeStock fleet charging; pages 38, 39, 42, 43 Google Maps; page 43 Freightliner em2; page 48 Thomas School Bus; page 50 Ford Motor Company; page 52 Pierce Manufacturing Volterra Firetruck; page 53 Freightliner em2 bucket truck; page 57 Thomas School Bus dashboard image; page 58 Nikola AT 7503 dashboard image; page 60 Thomas School Bus; page 61 Freightliner eCascadia; page 67 Nikola BEV/FCEV Port Hero; page 68 Caltrans; page 71 Volvo FEV Truck; and back cover - RCEA.

GLOSSARY

Term/ Acronym	Definition
AB	Assembly Bill
AC	Alternating Current, Flow of electricity that constantly changes direction between positive and negative sides
ACF	Advanced Clean Fleets
ACT	Advanced Clean Trucks
ASB	Airport Shuttle Bus
BEV	Battery Electric Vehicle
Caltrans	California Department of Transportation, responsible for the design, construction, maintenance, and operation of California State Highway System
CAP	Climate Action Plan
CARB	California Air Resources Board, the state agency responsible for protecting the public from harmful effects of air pollution and developing programs and actions to fight climate change
CEC	California Energy Commission, the state agency responsible for energy policy
CTP	Clean Transportation Program, formerly known as Alternative and Renewable Fuel and Vehicle Technology Program
CBO	Community Based Organization
DC	Direct Current, a charge of electricity that flows in one direction and is the type of power that comes from a battery
EMFAC	California Air Resources Board's **Em**issions **Fact**or database
EO	Executive Order
EV	Electric Vehicle

Term/ Acronym	Definition
EVCS	Electric Vehicle Charging Station
FCEV	Fuel Cell Electric Vehicle
GHG	Greenhouse Gas Emissions
GVWR	Gross Vehicle Weight Rating, the maximum loaded weight of a vehicle, including passengers, cargo and the vehicle itself
GW	Gigawatt
GWH	Gigawatt-Hour
HCAOG	Humboldt County Association of Governments
HD	Heavy-Duty
HTA	Humboldt Transit Authority
ICE	Internal Combustion Engine
ICT	Innovative Clean Transit
MD	Medium-Duty
MT	Metric Tons
MW	Megawatt
MWH	Megawatt-Hour
NCUAQMD	North Coast Unified Air Quality Management District
NREL	National Renewable Energy Lab
OPR	Governor's Office of Planning and Research, the State's comprehensive planning agency
OEM	Original Equipment Manufacturer
PG&E	Pacific Gas and Electric
RCEA	The Redwood Coast Energy Authority
RTP	Regional Transportation Plan

Term/ Acronym	Definition
SB	Senate Bill
SERC	Schatz Energy Research Center
TCO	Total Cost of Ownership
TPUD	Trinity Public Utilities District
US EPA	United States Environmental Protection Agency
V	Volt
VMT	Vehicle Miles Traveled
ZEB	Zero-Emission Bus
ZEV	Zero-Emission Vehicle

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