



Energizing an Ecosystem:

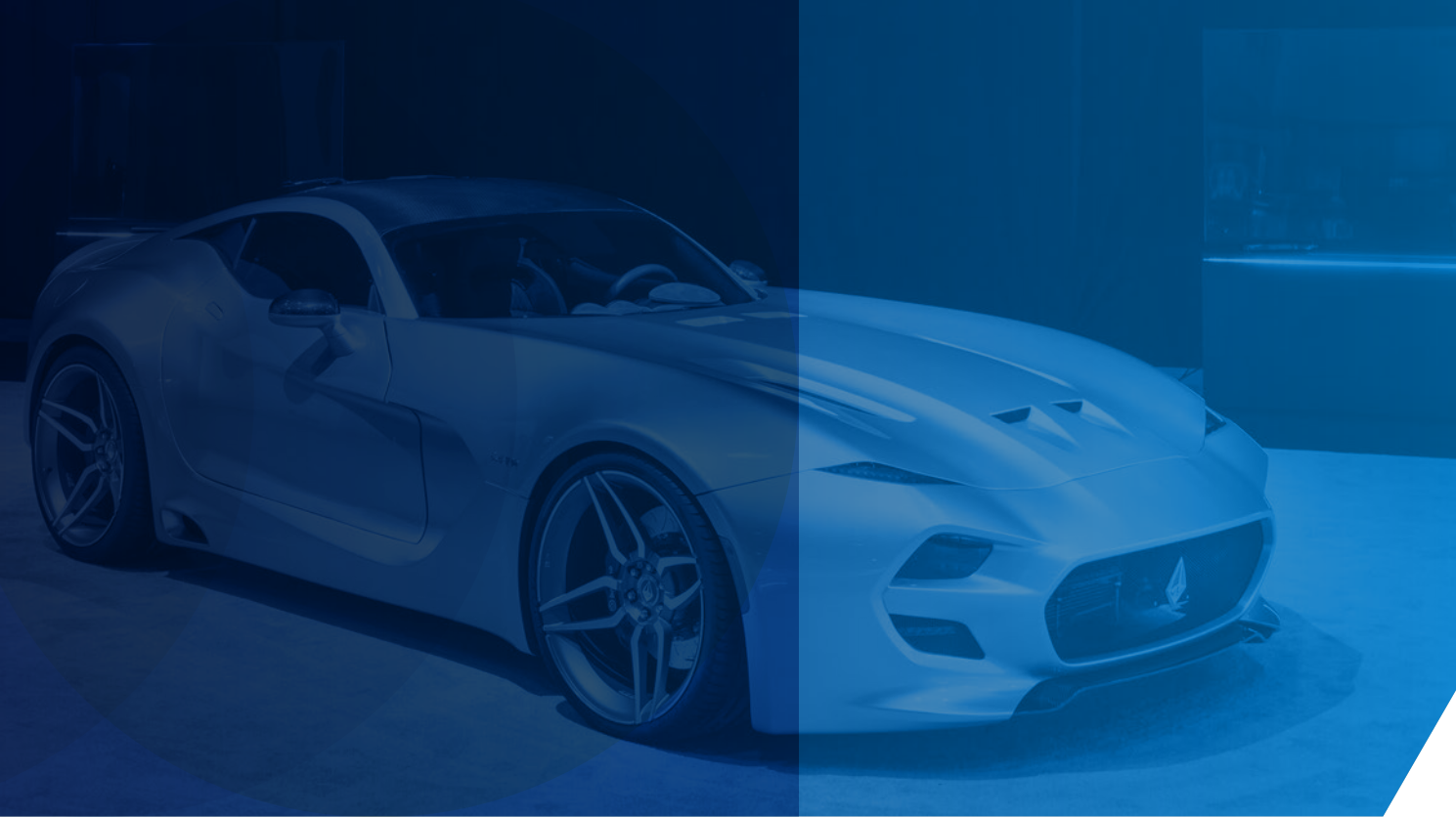
The Electric Mobility Revolution

in Southern California



LOS ANGELES COUNTY
ECONOMIC DEVELOPMENT CORPORATION

Collectively Advancing Opportunity and Prosperity for All



Report Sponsors

This report was commissioned by a partnership of Southern California Edison, the Southern California Association of Governments, the Los Angeles County Metropolitan Transportation Authority, the City of Los Angeles Department of Water and Power, and the South Coast Air Quality Management District.



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Executive Summary

50 years ago, Los Angeles was on the heels of Detroit in a close competition for the esteemed title of the nation's automotive capital. However, as the cost of production fell in other states and overseas, auto manufacturers one by one began abandoning the Golden State, and the final closure of General Motor's Van Nuys Assembly plant in 1992 led many to believe that L.A.'s auto glory days were over. One telling article from the Los Angeles Times in 1991 encapsulated the general sentiment, reporting that the booming industry was, in fact, "now a memory."¹ Over the years, many have



pointed to California's rigorous clean air standards as a main hindrance to manufacturers. In a perhaps ironic twist, the state's commitments to combating climate change might have aided California in once again finding its footing as a frontrunner in the nation's auto industry. The Golden State's climate goals, government support, and growing resource network are now propelling new auto leaders that find themselves facing the global demand for more efficient vehicles.

The closure of auto plants in the 80s and 90s did little to dampen the Californian fixation on automobile consumption. This extensive market of drivers coupled with the growing demand for clean transportation has provided a vital incentive for manufacturers to make their way back into the state. In the years since the LA Times article, over 60 company headquarters related to the electric vehicle (EV) and charging industry and over 20 manufacturing sites have made California their home. Emerging EV producers have found in the Golden State an eager audience, ready to test, purchase and support the latest electric mobility developments.

Exhibit ES-1: Electric Vehicle Cluster	
Goods Producing	Services Producing
Electrical Equipment Mfg.	Merchant Wholesalers
Electric Power Generation & Transmission	Customer Service & Management
Motor Mfg.	Transit & Ground Passenger Transport
Transport Equipment Mfg.	Insurance & Brokerages
	Software Publishing
	Motor Vehicle & Parts Dealers

From start-ups to industry giants, California and the greater L.A. region have provided and nurtured a new automotive ecosystem. This time, however, the system is poised to meet some the nation's leading climate objectives and ultimately lead the state to accomplish the California Air Resources Board's (CARB) strategy of 100 percent zero emission vehicle (ZEVs) sales as a proportion of automobile sales by 2050.²

For purposes of this report, the Los Angeles County Economic Development Corporation (LAEDC) defines electric vehicles as battery electric vehicles (BEVs, interchangeably referred to as EVs), plug in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs) based upon the state of California's current policies and definition of electric vehicles. This report will focus primarily on three essential industries in the EV cluster: electric passenger vehicles; electric trucks, trams and buses; and charging and alternative fuel networks.

Given the state, national and global interest in electric vehicles, it is no surprise then that the Golden State already hosts a robust, if nascent, electric vehicle cluster. Indeed, the electric vehicle industry has provided thousands of well-paying job opportunities and \$9.6 billion in labor income. In 2018 alone, the EV industry provided 275,600 jobs across a variety of sectors with average annual wages of \$91,300 and \$80,900 in the state and the Southern California region, respectively. The growing EV cluster is heavily concentrated in the Downtown Los Angeles (DTLA), South Bay, and Orange County areas and with the many EV technology and software companies in the Bay Area. The five counties of Southern California (Los Angeles, Orange, Riverside, San Bernardino and Ventura) account for 43.4 percent of EV jobs in the state.

Industry clustering is also supporting geographically concentrated growth in jobs, innovation, and commerce, as suppliers and related businesses locate nearby. For example, the deployment of charging infrastructure will be an essential driver of new employment, as a significant number of workers will be employed in activities related to these charging networks, such as installing and maintaining EV infrastructure. In Southern California alone, over 11,000 public charging outlets have been installed, with hundreds more currently being planned, financed, and installed to meet the state's goal of 250,000 stations by 2025.³ Expanding the EV industry continues to create new opportunities, employing 119,200 workers in the Southern California region.

Accounting for the business and employment environment of the EV cluster in California, combined with state and local goals for EVs as part of the battle against climate change, development of new laws, regulations, incentives and structures are essential for this cluster's long-term success. Legislative action at the local, state and federal levels will be required in some instances, while business, government and education will have to combine their resources and energies in existing and new convening bodies to align priorities and strategies. Working in tandem, EV business leaders and policymakers can work to make California the global center of the research, design, manufacturing and sale of electric vehicles.

Exhibit ES-2 EV Industry in Southern California, 2018	
Employment	119,200
Total Charging Stations	2,427
Total Registered Electric Vehicles	200,400

Source: CA DMV, U.S. Dept. of Energy; Estimates by LAEDC

¹ Baker, Bob. "L.A.'s Booming Auto Industry Now a Memory". 20 July 1991. The Los Angeles Times. <https://www.latimes.com/archives/la-xpm-1991-07-20-mn-2136-story.html>

² "Mobile Source Strategy." California Air Resources Board. May 2016. Pg. 36.

³ "Zero-Emission Vehicles." 2020. California Public Utilities Commission. <https://www.cpuc.ca.gov/zev/>.

1. INTRODUCTION

“California has emerged as the nation’s EV industry frontrunner.”



1. Introduction

As electrification changes the landscape of transportation globally, California leads the nation in design, manufacturing, and adoption of electric vehicles. As ACCESS Magazine stated in 1993, “the economic and human resources for an electric-car industry are already in place in Southern California.”⁴ In the 25 years since this observation, California has emerged as the nation’s EV industry frontrunner. Home to nearly half of the nation’s electric cars; 24 percent of the nation’s charging stations; the most electric vehicle incentives in the United States; and the nation’s largest vehicle market, California’s influence in the future of the automotive and transportation industry is undeniable.

Innovative companies such as Tesla, Canoo, Fisker Inc., Hyperion Motors, and Ampere Motors began their journey in California. Inspired by the Golden State’s rich automotive history and forward-looking environmental policies, these companies drive the future of electric vehicles.

California’s EV Market

California already accounts for nearly half of EV sales in the United States and is spearheading new transportation policies that transcend the rest of the nation’s standards.

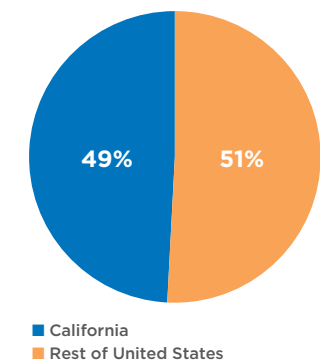
Currently, state goals set by former Governor Edmund G. Brown are pushing for five million automobiles on the road to be zero-emission vehicles by 2030, along with 250,000 charging stations for support.⁵ As of late 2018, there were only 435,000 ZEVs on California’s roads. However, California vehicle data lends some reasons for optimism regarding the state’s goal. The average yearly increase of new registered ZEVs between 2007 and 2018 of 82 percent suggests consumers

are eager to switch to EVs and adoption is making its way towards Southern California Edison’s (SCE) ambition of reaching 7.5 million EVs on the road by 2030, which SCE believes necessary to achieve California’s climate goals.

According to California’s registration data, 2018 marked the first year in which pure battery electric vehicle (BEVs) registrations surpassed that of plug-in hybrid electric cars (PHEVs), resulting in over 22,000 more BEVs than PHEVs on California’s roads. This is a market signal that California consumers view pure battery electric vehicles favorably, particularly in the Bay and Southern California areas.

ZEVs are also contributing to a large and growing share of California’s exports. In 2019, transportation equipment exports – which includes motor vehicle manufacturing as a subcategory – accounted for 13 percent, or \$22.7 billion, of the state’s global exports in 2019. Moreover, these exports grew 18 percent from 2018.⁶

Exhibit 1-1: Share of United States Electric Vehicle Population



⁴ Scott, Allen. “Southern California: The Detroit of Electric Cars?” Fall 1993. Access Magazine. <http://www.accessmagazine.org/fall-1993/southern-california-the-detroit-of-electric-cars/>

⁵ Zero-Emission Vehicles. 2019. California Public Utilities Commission. <https://www.cpuc.ca.gov/zev/>

⁶ State Export Data. 2020. International Trade Administration, U.S. Department of Commerce. <http://tse.export.gov/tse/tsehome.aspx>

Introduction

ZEVs - including BEVs, PHEVs and FCEVs - have also made up an increasing share of new vehicle registrations in California since 2010. In 2018, ZEVs made up 5.4 percent of new vehicle registrations, up from only 0.1 percent in 2010. A linear trend based upon this current rate of adoption suggests almost 2.8 million ZEVs on the road by 2030 with ZEVs accounting for 58.4 percent of new registrations by the end of the decade. However, as **Exhibit 1-2** shows, additional action will be needed to address the large gaps between state goals and actual deployment. Using forecasted sales data by electric vehicle consultant Loren McDonald combined with California Department of Motor Vehicle registration data, the LAEDC estimates state goals can only be met if ZEVs increase by an average of 25 percent each year over the next decade.

This forecast is presented in **Exhibit 1-3**. The result from this pace of electric vehicle adoption would be 7.2 million ZEVs on California roads by 2030.

Action by the state and local municipalities are largely responsible for increasing the momentum in consumers looking to switch to EVs. Further action at all government levels will be necessary to foment the growth in EV adoption necessary to accomplish state and local climate goals. Strong adoption will also continue to fuel the state's existing ecosystem of vehicle innovation, design, manufacturing, and supporting services. As such, this report is broken into four sections covering several elements of vehicle electrification in California and especially the Southern California region. First, a landscape analysis is presented covering the institutions and companies supporting and building this mobility revolution. This analysis covers all classes of vehicles, light-, medium- and heavy-duty. Additionally, organizations involved in developing chargers and charging technology are presented. Second, externalities, especially emissions and health benefits, are presented as they pertain to ZEVs. Thirdly, a workforce analysis and forecast is presented for electric vehicle-related employment in the state and Southern California region. This analysis covers not only employment numbers but also

entry-level education and experience requirements. Moreover, a set of occupational targets are presented in the interest of discerning future workforce training and the demand for upskilling. Finally, a set of state and local policy recommendations are presented as a prelude to more concerted and tangible actions to implement state and local environment goals.

Exhibit 1-2: Annual New ZEV Registrations to Meet California's Goal (in Millions)

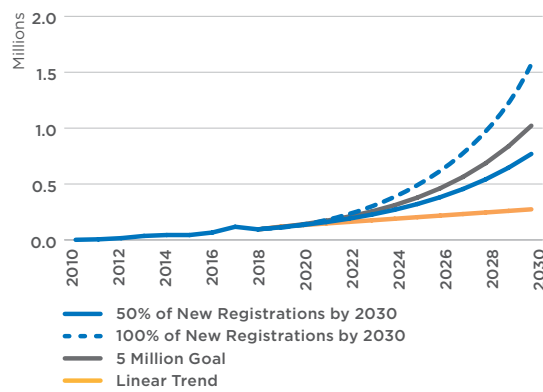
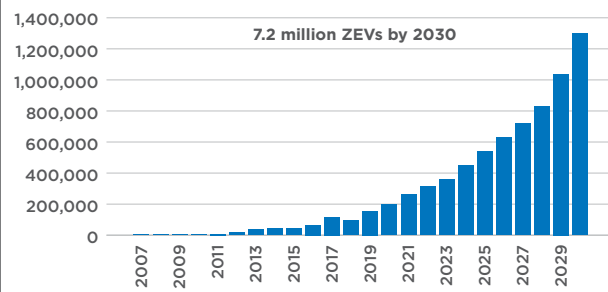
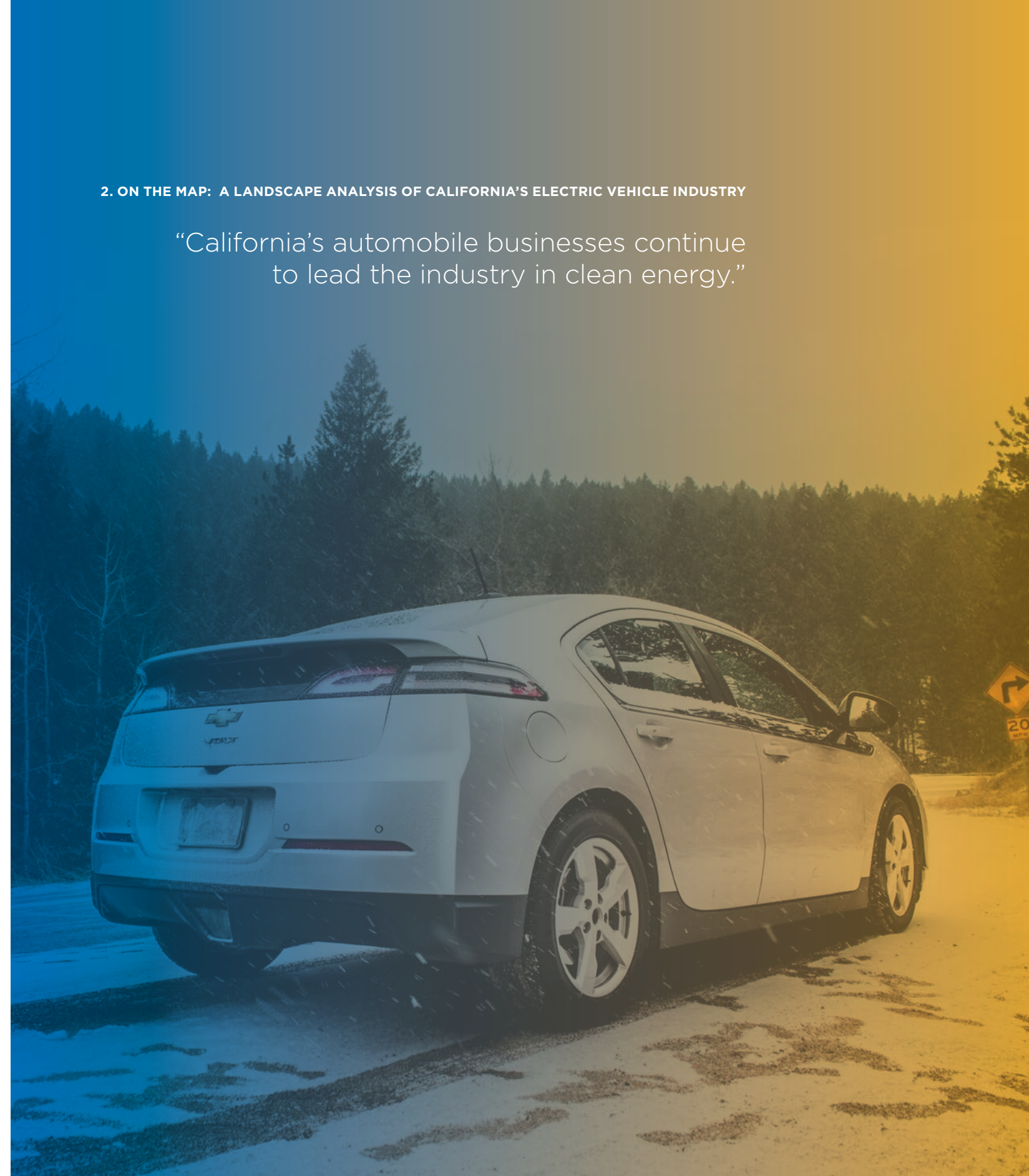


Exhibit 1-3: Forecasting New EV Registrations to 2030



2. ON THE MAP: A LANDSCAPE ANALYSIS OF CALIFORNIA'S ELECTRIC VEHICLE INDUSTRY

“California’s automobile businesses continue to lead the industry in clean energy.”



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2. On the Map: A Landscape Analysis of California's Electric Vehicle Industry

California's car culture coupled with its deep commitment to environmentalism create a unique position for the state to serve as a leader on implementing clean vehicle technologies. Traditional auto companies have accepted California's climate goals as a challenge to ramp up their research and design capabilities in the state. Startups throughout the state are finding innovative ways to collaborate with local governments in providing Californians with efficient mobility solutions. Leaders in engineering and data science are breaking ground on the opportunities that clean vehicles present to exploring alternative power sources, smart grid capabilities and artificial intelligence. Manufacturers and local governments are collaborating on fleet conversion operations to ensure that traditionally large greenhouse gas emitters are among the first to find cleaner power sources.

Consistently willing to set global standards for ingenuity, California's automobile businesses continue to lead the industry in clean energy, design and research and development. As a result, California is gaining national and global competitive advantage in this space. The LAEDC has identified businesses and programs throughout the state that are working on transforming the state's vehicle market, fleet system, charging capabilities, and other mobility sources and emerging technologies.

To assist and support the emerging industry, Southern California has a variety of programs that are striving to address workforce development needs, grid and infrastructure expansion and incentive policies designed to encourage residents and businesses to make the shift to electric transportation. Some of the region's most impactful organizations and their programs dedicated to bolstering the EV industry are listed below.

Los Angeles County Economic Development Corporation

LAEDC's **e4 Mobility Alliance** is a robust, dynamic, and unique industry council focused on growing business of the future while meeting quarterly around issues such as market trends, forecasting, tech development, and the workforce of the future. Additionally, e4 convenes experts for policy workshops and tech-to-market roundtables with an agenda focused on accelerating the growth businesses.

Southern California Edison (SCE)

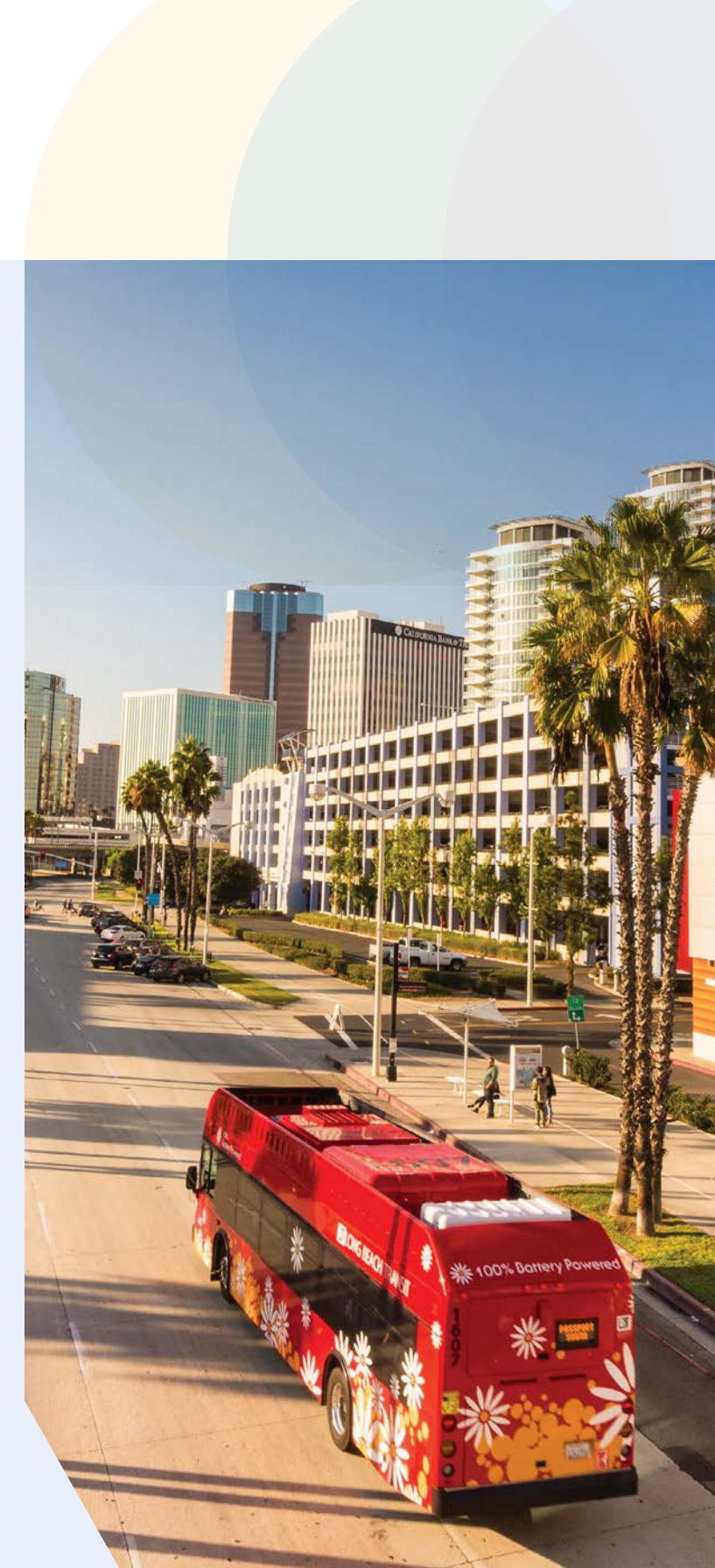
Through its **Charge Ready** program, SCE has been partnering with community stakeholders to install and maintain increased numbers of EV charging stations and infrastructure for passenger and medium-and heavy-duty vehicles to utilize. SCE is also offering rebates for purchasing or leasing new or used electric vehicles, funding installation of chargers for transit and school buses, and increasing electrification at the ports, including programs to reach underserved communities and multi-unit dwellings.

Los Angeles Department of Water & Power (LADWP)

Alongside its annual Drive Electric Week, LADWP has introduced the **Charge Up LA!** Program to encourage greater EV use in the region. Among the many resources offered by the program, residents may qualify for residential charging rebates, used EV rebates and commercial charging station rebates.

Los Angeles Metro

The Los Angeles Metro is committed to fulfilling electrification goals, most notably by converting to an all-electric bus fleet by 2030 and by continually expanding the availability of charging stations in park and ride lots. For over 20 years, Metro has teamed up with South Coast Air Quality Management District (SCAQMD), the City of Los Angeles and County of Los Angeles to invest over \$10 million to further R&D for advanced transit vehicles through the Advanced Transit Vehicle Consortium joint venture.



On the Map: A Landscape Analysis of California's Electric Vehicle Industry

Southern California Association of Governors (SCAG) Connect SoCal

SCAG's 2020-2045 Regional Transportation Plan, includes over 4,000 transportation projects to transform the Southern California transportation system. These projects will reduce traffic, improve public health and meet efficiency and environmental goals across Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura counties.

South Coast Air Quality Management District (SCAQMD)

Partnering with LADWP, SCAQMD has developed the SoCalEV program to educate and coordinate with regional stakeholders in preparing for EV through infrastructure projects, streamlining permits and expanding financial incentives. SCAQMD has also initiated programs to expand hydrogen refueling access.

On the Map: Passenger Vehicles

Through its adoption of ZEV and clean energy goals, the state of California has emerged as the nation's trailblazer on setting rigorous environmental goals. In fostering mutually beneficial relationships with regional programs and government actions, automotive companies have made immense contributions to California's climate goals and economy. Several auto manufacturers maintain their headquarters and major operations in California and benefit immensely from the state's vehicle market and resources. In agreement with the California Air Resources Board (CARB), auto manufacturers Ford, Volkswagen, BMW and Honda pledged to take further steps in producing

more fuel efficient fleets.⁷ These four, along with established and up and coming businesses in the auto industry, are stepping up to international climate concerns by designing and manufacturing the next age of zero emission vehicles.

Of the 42 major passenger vehicle company locations in the state, 13 are company headquarters, six are research and development facilities, 19 are design and technical studios and four are manufacturing sites. Of those on the map, Tesla has by far the greatest share of the California EV market, with Tesla vehicles making up 20.3 percent ZEV registrations in California and selling over 365,000 vehicles globally in 2019.⁸ With its design studio located in Los Angeles, Tesla is a large contributor to EV developments in the greater Los Angeles region. Exhibit 2-1 displays the presence of these companies throughout the state.

Incentives

To rapidly expand the market for electric and fuel cell electric vehicles, many incentive programs have emerged to assist potential buyers and manufacturers. A federal tax credit up to \$7,500 is available for new EV buyers for the first 200,000 EVs manufactured per company. The Office of Energy Efficiency and Renewable Energy provides an extensive list of electric vehicles and their associated credits. As discussed in Section 5, state and federal incentives like this should be expanded to further motivate EV manufacturing and sales.

CA EV and EVSE Resources

VELOZ -ELECTRIC FOR ALL:

Veloz is committed to educating and assisting Californians on the EV purchasing process. The organization works to erase the barriers that exist in turning California's passenger vehicles electric.

CARB ZEV REGULATIONS:

CARB has set standards on auto manufacturers, setting a minimum requirement for the number of clean (zero emission) vehicles that must be offered. California is inspiring climate action beyond its borders, as sixteen states have, or are planning on, adapting CARB's regulations as their own. SB 4998 provides for CARB ZEV goals, incentives, policies and programs.

CALSTART CARS INITIATIVE:

CALSTART advocates for greater state and federal EV incentives and develops the clean transportation industry by supporting infrastructure projects and assessing new technologies.

GO-BIZ ZEV MARKET OFFICE

The California Governor's Office of Business and Economic Development (GO-Biz) emphasizes ZEVs as one of its target industries. Through its Market Office, GO-Biz has a team specifically focused on creative opportunities to accelerate the EV cluster's growth.

CALZEV:

Provides education on zero emission transportation and advocated for expanding clean transit to provide all Californians with clean air. Partners with leaders in public health, the environment, scientific organizations and industries.

UTILITY INITIATIVES:

Utility companies throughout California, such as SCE, PG&E and SDG&E offer customers with EVs discounted rates, educational resources and potential rebates and bill credits.

HEADQUARTERS

- Fisker Inc
- Mazda
- Honda
- Seres EV
- Karma Automotive
- Canoo
- Ampere Motor
- Zero Labs
- Independent Electric Vehicles
- Faraday Future
- Lucid Motors
- Tesla

DESIGN & TECH STUDIOS

- Volvo
- Aria Group
- Five Axis
- Ford
- Hyundai
- Tesla
- Kia
- General Motors
- Honda/Acura
- Toyota
- Honda
- BMW
- Designworks
- Volkswagen Group
- Audi
- Icona Design
- Geely
- Toyota
- Mercedes-Benz
- Nissan

MANUFACTURING

- Hino Motors Manufacturing
- TABC Inc.
- Karma

R&D

- Aptiv
- Nissan
- VW Technica Centerl
- Seres EV
- Volkswagen
- Byton

⁷ Eilperin, Juliet and Brady Dennis, "Major automakers strike climate deal with California, rebuffing Trump on proposed mileage freeze." Washington Post. 25 July 2019. <<https://www.washingtonpost.com/climate-environment/2019/07/25/major-automakers-strike-climate-deal-with-california-rebuffing-trump-proposed-mileage-freeze/>>.

⁸ "Tesla Q4 2019 Vehicle Production & Deliveries." Quarterly Investors Report. Tesla. 3 January 2020.

On the Map: A Landscape Analysis of California's Electric Vehicle Industry

As a state, California has several incentives for drivers to make the switch to cleaner vehicles, including special HOV lane exemptions, rebates and financing programs. Additional rebates are available for qualifying Southern California residents and many municipalities are extending benefits to include free parking and FastTrack access. A full list of EV vehicle incentives is provided in the Appendix.

On the Map: Buses, Trucks and Trams

In addition to fostering greater electric vehicle deployment amongst passenger vehicles to drive down pollution and congestion, California is on the path towards electrifying its entire public transit system and incentivizing medium and heavy-duty vehicles to make the electrification transition. CARB announced that the state would reach zero-emission fleets by 2040 and some transit agencies have committed to a totally zero-emission fleet. Foothill Transit plans on converting its fleet to be all-electric by 2030 through a partnership with L.A. County-based electric bus manufacturer Proterra and already leads Southern California with 37 fully electric buses.⁹ The city of Duarte set a leading example for the Southern California region in April of 2019, becoming the first city in the region to convert to an all-electric fleet, a move that is expected to reduce greenhouse gas emissions by 227 tons per year.¹⁰ The Antelope Valley Transit Authority has converted all of its transit buses to battery-electric and will convert all of its commuter routes to battery-electric in 2020. All of the buses were manufactured in LA County by BYD. The AVTA has logged over 2 million miles of zero emission operations. More and more fleets are making the switch and major efforts have been made by the state to electrify fleets, especially in underserved and low-income communities.

Fleet Resources

SCHOOLBUS REPLACEMENT PROGRAM:

The California Energy Commission has established the Schoolbus Replacement Program to secure funds for replacing diesel buses in low income communities with pollution free electric vehicles. The program also establishes training for bus drivers and maintenance technicians.

HYBRID AND ZERO-EMISSION TRUCK AND BUS VOUCHER INCENTIVE PROJECT (HVIP):

Beginning in 2009 and allocating more than \$589 million, CARB's HVIP program supports the adoption of clean trucks and buses in California. More than 50 percent of vehicles purchased through the program are operating in communities disproportionately burdened by harmful air pollutants, implying California's environmental goals are driving much wider environmental progress.

CALSTART - BUS & TRUCK INITIATIVES:

CalStart assists fleets in purchasing the cleanest equipment, validating performance of vehicles and creating partnerships to further development of heavy duty ZEVS. CalStart also develops zero emission and automation-assisted public transit, assists operators in purchasing clean buses, and promotes access to fair funding.

CHARGE AHEAD CALIFORNIA:

An initiative adopted by the state in 2013 and updated every three years, the initiative is creating enhanced fleet modernizations, retiring high polluting vehicles and focusing on improving air quality for low income and disadvantaged areas.

Incentives

To promote greater fleet conversion rates, the California Air and Resources Board (CARB) provides vouchers for trucks and buses making the switch away from fossil fuels. In 2019, more than 100 truck and bus fleet operators requested funding for vehicles produced by more than 20 manufacturers through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP). The state of California also runs The Public Fleet Pilot Project, allocating up to \$7,000 in rebates for ZEVs and PHEV used for public agencies.



BYD Motors

HEADQUARTERS

- Proterra
- US Hybrid
- Trams International
- Adomani
- Stealth EV
- Tesla
- Coach West
- Ebus
- TiG/M
- Zero Truck
- Phoenix Motors
- BYD North America
- Transpower
- Gillig LLC
- Motiv

OTHER BUS, TRUCK AND TRAM COMPANIES

- Volvo
- El Dorado National
- Lion (eSchool Bus)
- CCW: Complete Coach Works
- Aston Bus
- Mercedes-Benz
- Rivian Auto Tech Center
- Green Power Sales (Manufacturing)
- Proterra (Manufacturing)
- Motiv
- CCW: Complete Coach Works
- Rivian Auto (Battery Electric)
- Mitsubishi
- Green Power (Manufacturing)
- New Flyer
- Rivian Auto (Electric Power Conversion)
- Advanced Vehicle Manufacturing

⁹ "We're bringing all-electric double decker buses to the SGV!" 12 July 2018. Foothill Transit. <http://foothilltransit.org/all-electric-double-decker-bus-foothill-transit/>

¹⁰ Scauzillo, Steve. 1 April 2019 "Duarte becomes first city in Southern California with an all-electric bus fleet." San Gabriel Valley Tribune.

On the Map: A Landscape Analysis of California's Electric Vehicle Industry

On the Map: Charging & Alternative Fuels

One of the primary concerns with the push for EVs is ensuring that infrastructure for convenient and reliable charging is addressed. Currently, 6,134 public charging stations with an estimated 22,500 charging ports are already available in the state with a goal of 250,000 chargers by 2025.

Incentives

Across the state, energy providers, local governments and companies have teamed up to incentivize individuals and businesses to increase charging infrastructure. Cities such as Azusa, Pasadena, Burbank, Anaheim and Glendale are leading the Southern California region in offering extra rebates and discounted utility rates for those choosing to install EV chargers.

Hydrogen

Currently, just over 40 hydrogen stations are active in the state, with about 20 more due to open in 2020, these will serve as a vital resource in reaching the state's ZEV goals.¹¹ While still seen as an emerging technology, several companies in the state have taken up the task of harnessing this technology to power vehicles. Southern California based Honda Motor Company and Mazda North American Operations are developing the use of hydrogen technology for powering automobiles. Hydrogen fuel cell technology has been widely praised as an affordable, energy efficient power source, powering vehicles with zero emissions. Currently, over 7,700 FCEVs have been sold and leased in California and 31 fuel cell buses are in operation.¹² As access to hydrogen fueling becomes more accessible, that figure is sure to rise. Included in **Exhibit 2-3** are six hydrogen power companies with headquarters in the state (FirstElement Fuel, Stratos Fuels, Intelligent Energy, Quantum Fuel Systems, H2 Frontiers, and Hyperion Motors, Inc.) and three more with offices and operations located in California. The California Fuel Cell Partnership is a key organization dedicated to expanding the FCEV market and related infrastructure.

EV Charging Resources

DRIVE THE ARC:

Is expanding the inter-city charging network and real-time services. The "Advanced Recharging Corridor" is improving charging infrastructure to help drivers travelling from Monterey to Lake Tahoe.

WEST COAST ELECTRIC HIGHWAY:

Represents 1350 miles of the Interstate 5 stretching through Washington, Oregon and California. The program will provide drivers with a selection of alternative fuels and EV DC fast charging stations every 25 to 50 miles on the I5, Hwy 99 and other roads.

UCLA'S SMART GRID ENERGY RESEARCH CENTER:

UCLA is developing smart charging technology through engagement with utilities, government, tech providers, EV and appliance manufacturers, among others. The Program is developing remote monitoring and control technologies for EVs, through the WinSmartEV Program.

PLUG IN AMERICA:

Is an advocacy group accelerating the implementation of clean and affordable electricity to power plug in vehicles. The program educates the public on EVs and advocates for further initiatives for EV purchasers.

CLEAN TRANSPORTATION PROGRAM - CEC:

Advances the development and use of alternative and renewable fuels through an annual investment fund. The program also expands fuel infrastructure, improve vehicle technologies and establish workforce training programs.

ELECTRIFY AMERICA:

An EV charging company that also educates consumers and builds awareness centered around greater ZEV adoption. Electrify America is investing \$800 million in EV infrastructure in California and \$2 billion nation-wide by 2027 to provide charging infrastructure and energy management.

- MOEV
- Powerflex Systems
- EVgo
- Tritium
- Volta
- Enevate
- Farasis
- Noodle
- Balqon
- Advance Power Products
- Clean Fuel Connection

HEADQUARTETERS

- Concord Battery
- H2 Frontier
- Recargo/Plug share
- Trojan Battery
- Quantum Fuel Systems
- Freewire Technologies
- Caleb Corporation
- Chargepoint
- Clipperpoint
- Clipper Creek
- EV Safe Charge
- EVconnect
- Stratos Fuels
- FirstElement Fuels
- Greenlots
- Hyperion Motors, Inc.
- Bofuels Energy
- EDF Renewables
- EV Grid
- California Lithium Battery
- Intelligent Energy

OTHER ENERGY RELATED CHARGING & FUELING COMPANIES

- Air Products
- Blink Charging
- NEL Hydrogen
- Smart Charge America
- Iwatani Corporation of America•
- ITM Power



¹¹ Station Map. 2020. California Fuel Cell Partnership. Retrieved from <https://cafcp.org/stationmap>

¹² "FCEV Sales, FCEB, & Hydrogen Station Data". 2020. California Fuel Cell Partnership. Retrieved from https://cafcp.org/by_the_numbers

On the Map: A Landscape Analysis of California's Electric Vehicle Industry

Advancing Charging and Battery Technology

From connecting users to chargers or developing new fuel sources, California is uniquely positioned to benefit from the companies breaking ground in powering transportation.

In the realm of charging, ChargePoint, Inc., operates over 108,500 total charging stations globally and more than 1,900 Express DC (direct current) rapid charging stations through a network of 49,000 charging locations. ChargePoint also provides charging station owners and drivers with mobile application and platform options to interface with partnered charging point operators (CPOs) and electric mobility service providers (eMSPs). ChargePoint's platform also allows charging stations operators to customize and monitor pricing while allowing drivers a tool to find stations, pay for charging services and roam between charging providers.¹³

Among ChargePoint's partners is Greenlots, a member of the Royal Dutch Shell Group. Greenlots specializes in identifying, designing, installing and maintaining of charging infrastructure. Their customers are spread across multiple industries from utilities and government to automakers, retailers and residential property managers who offer EV charging as a benefit. Like ChargePoint, Greenlots also offers drivers a mobile application that functions as both a payment platform for charging services and a location tool to find the closest public charging location.¹⁴

Enevate and Farasis are two companies researching and manufacturing advancements in lithium-ion batteries. To address the concerns of disposing of batteries once they reach the end of their life cycle, the California Environmental Protection Agency (CalEPA) has developed the Lithium-ion Car Battery Recycling Advisory Group in collaboration with the Department of Toxic Substances to advise policymakers on legislation related to secure recycling of batteries.

Emerging Industries

Many related businesses in the EV industry are breaking ground on advancing mobility technologies. From developing artificial intelligence to expanding programming and engineering practices, additional innovators and startups have emerged at exceptional rates as a product of California's thriving EV ecosystem.

EV ridesharing and micro mobility are two of the latest inspirations of the state's lively start up scene. The Los Angeles Department of Transportation (LADOT) is encouraging the growth, partnering with BlueLA to provide memberships for electric car sharing in low income communities. Several companies have followed suit and are on a mission to transform the relationships between Californians and their vehicles while also making strides in improving congestion and pollution in the city. LADOT also partnered with several micro mobility companies to run pilot programs to launch the movement of swapping vehicles for scooters and bikes. LADOT, through the Dockless Mobility Providers program, requires mobility providers to ensure their products are accessible for low-income communities by providing payment plans and non-smartphone payment options. Eleven companies were deemed eligible to participate in the city's program to increase mobility and have since provided over 36,000 scooters and bikes throughout the city.¹⁵

Additional micro mobility providers have emerged throughout the state; a selection of them are listed below:

- Skip
- Bird
- Green Car Commuter
- Spin
- Didi
- Waive
- Lime
- GoCarma
- Envoy

A Global Efforts - International EV Resources

Since the adoption of the state's EV goals, organizations have emerged on all levels, from local campaign movements to international strategic partnerships.

CLEAN CITIES COALITION:

Provides technical assistance, resources and partnerships at the national level to help local coalitions leverage these resources with stakeholders to improve affordable, clean transportation.

C40 ZERO EMISSION VEHICLE NETWORK:

C40, a network of 94 megacities around the world, founded the ZEV Network to help reduce transit emissions. The network accelerates deploying ZEVs through sharing best practices and insights amongst key industry stakeholders. Mayor Eric Garcetti was elected the chair of the C40 Cities Climate Leadership Group in October 2019, signaling L.A.'s commitment to the group.

NEW ENERGY AND INDUSTRIAL TECHNOLOGY (NEDO):

Based in Japan and with offices in Europe, China, the U.S., India, and Thailand, NEDO is one of Japan's largest R&D management organizations. NEDO is focused on addressing environmental issues by enhancing industrial technology through domestic and international projects, such as Drive the ARC.

ZEV INTERNATIONAL ALLIANCE:

Allows members to collaborate with other governments in order to combat climate change, expand the ZEV market and share best practices and data.

THE CLIMATE GROUP:

An international nonprofit working to accelerate climate action by creating events to bring together powerful networks of businesses and governments and further the implementation of sustainable business actions.

BEYOND CARBON - BLOOMBERG PHILANTHROPY:

Assists states and local organizations in passing climate policies and works to expand the climate movement by forging new partnerships at all levels.



¹³ ChargePoint, Inc.

¹⁴ Greenlots.

¹⁵ Los Angeles Department of Transportation, Dockless Mobility Program. <https://ladot.io/programs/dockless/>

On the Map: A Landscape Analysis of California's Electric Vehicle Industry

Company Spotlight: Canoo

Canoo is a Los Angeles based company creating electric vehicles (EV) for subscription only. The company is headquartered in Torrance and was founded in December 2017 by a group of experienced automotive executives and engineers. Today, Canoo has grown to more than 300 team members—covering the entire value chain, bringing together a unique EV with a unique business model for a unique user experience.

Canoo is challenging the traditional way of building, offering and using vehicles based on a threefold approach:

- *A new business model that focuses on reducing production and infrastructure costs to make EV more affordable to customers.*
- *A fresh design capitalizing on the space EVs provide, looking like nothing on the road today and challenging the norms of space and function. The unique design points to the future of cars that are electric and autonomous.*
- *A subscription model that puts an end to ownership, providing a hassle- and commitment-free car experience in modern cities.*

Freeing customers from ownership

Canoo believes that there is a better solution than traditional car ownership. Currently, consumers are forced to go to a dealership and spend time at the DMV (Department of Motor Vehicles) to register their vehicle. Additionally, they must deal with ongoing insurance, maintenance and repairs. And finally, the vehicle's value drops immediately as the owner drives off a dealer's lot.

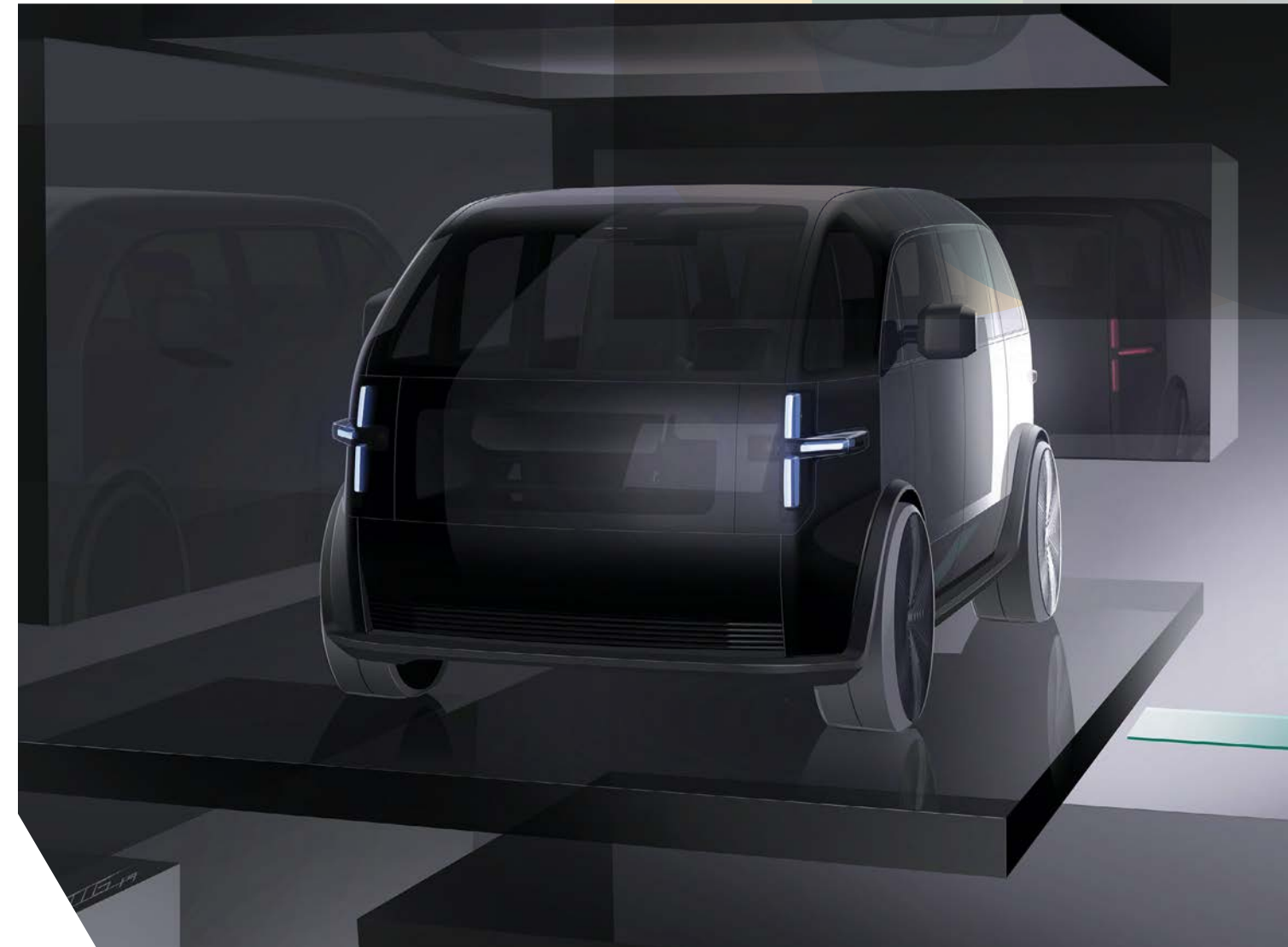
Instead, Canoo plans to free its customers from the burden of ownership by offering a hassle- and commitment-free EV subscription for one monthly price and with no set end date. The subscription may include services such as registration, maintenance, insurance management and charging—all from a single app. Canoo plans to bring the convenience and affordability of the month-to-month subscription model to the car industry, providing consumers with convenience..

Freeing customers from traditional design

There is no need for EVs to look like traditional cars, yet today most still do. Instead, Canoo maximizes EV technology by providing vehicles that have both a very large interior and very small overall footprint, targeted for city use. Canoo offers customers a more spacious and intuitive vehicle.

“We believe that the potential of EV architecture can enable a post-SUV era that addresses the ever-growing desire for space and value,” said Ulrich Kranz, In Charge at Canoo.

“We promised a truly different approach for EVs, and our Canoo proves that we can deliver on that vision. We recently kicked off beta testing, meaning we are on track for our launch date in 2021. We are very proud of the team. In my 30 years' experience, I have never seen so many quality achievements in such a short time.”



On the Map: A Landscape Analysis of California's Electric Vehicle Industry

Company Spotlight: Proterra

Los Angeles County-based Proterra designs and manufactures zero-emission electric transit vehicles and EV technology solutions for heavy-duty applications. Since 2004, Proterra® technology has logged more than 10 million miles on the road with the all-electric Proterra Catalyst® transit buses. According to Proterra, the company has more than 100 customers across 43 U.S. states and Canadian provinces, including transit agencies, airports, universities, national parks, and companies.

Product

The Proterra Catalyst vehicle is purpose-built to be electric and designed to enable energy-dense battery systems to be located safely beneath the floor of the bus and outside the passenger compartment, with the option for additional battery

packs on the roof. This distinct design is said to create a low center of gravity between the two-wheel axles and allows more energy to be stored on board for increased range.

According to Proterra, The Proterra Catalyst vehicle has the longest range of any battery-electric bus in its class; enables up to 25 miles per gallon equivalency (MPGe); and can power an electric bus up a 29-percent grade hill. In 2017, Proterra's 40-foot Catalyst E2 max vehicle broke the world record in test track conditions for the longest distance ever traveled by an electric vehicle on a single charge - 1,101 miles.

Proterra says that its battery systems are designed with safety top of mind. The most energy-dense in the business, by volume and mass, they're made of

tough, ballistic-grade materials that can withstand the challenges of heavy-duty transportation. Proterra battery are built with sensors throughout and active liquid cooling. They also have a built-in proprietary management system that dynamically adjusts the energy reserve to maximize performance and range.

Proterra also offers solutions for public transit agencies to install and manage the charging infrastructure to power their electric fleets. ProterraEnergy™ fleet solutions simplify the transition to an electric fleet with turn-key energy delivery for heavy-duty electric fleets, including design, build, financing, operations, maintenance and optimization of the complete energy ecosystem.

More than any other form of transportation, battery-electric buses are the cornerstone in addressing the future of mobility and sustainability for cities. A switch to zero-emission buses presents a critical opportunity to cut pollution, improve local air quality and reduce oil dependence. The Proterra Catalyst electric bus is 100% electric, with zero tailpipe emissions or pollutants, eliminating about 230,000 pounds of CO2 annually for every diesel vehicle replaced and reducing dependency on fossil fuels.

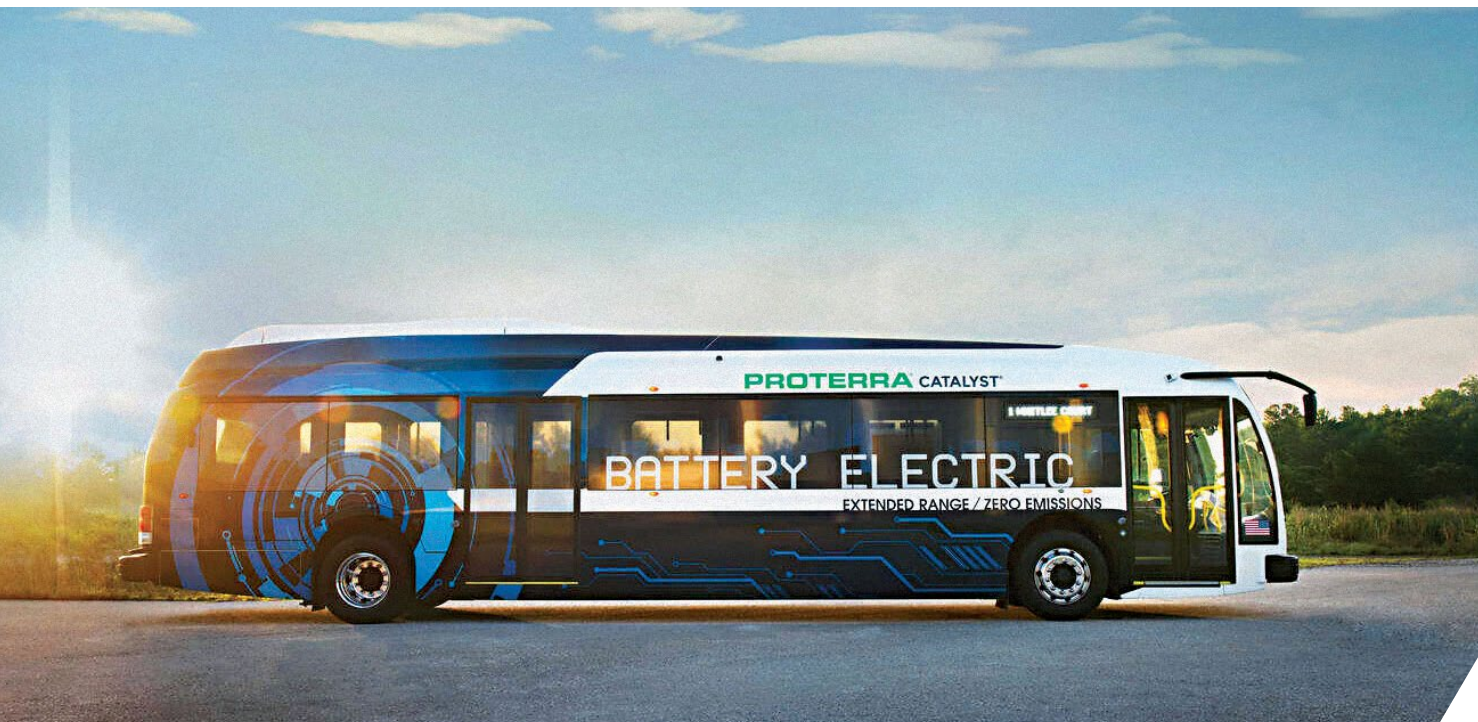
Impact in California

Proterra has two facilities in the state of California. Proterra's headquarters and battery manufacturing facility is in Silicon Valley, and its West Coast bus manufacturing facility is located in City of Industry in Los Angeles County. The City of Industry facility employs more than 125 people in various functions such as engineering, customer service, supply chain and production.

Proterra recently announced that it has partnered with the United Steelworkers to provide union representation for hourly production employees at its City of Industry facility. Further, Proterra signed the Los Angeles County Fair Chance Pledge to signify the ongoing commitment to incorporate Fair Chance

hiring practices into Proterra's recruitment process and promote the full participation of justice-involved individuals in California's economy.

Proterra was recently selected by the California Department of General Services as a vendor to supply Proterra battery-electric buses and Proterra charging systems for the California statewide contract. Transit agencies and other institutions can purchase Proterra battery-electric buses and Proterra charging systems through the state's pre-established contract, which helps streamline local transit agencies' access to the vendor and vehicle that best meet their specific transit system needs.



3. EV DEPLOYMENT IN SOUTHERN CALIFORNIA

“Southern California leads the state in EV consumption...”



3. EV Deployment in Southern California

Sales, manufacturing and design of electric vehicles are largely taking place in the five-county Southern California region. Total light-duty EV sales in CA were 655,000 between 2011 and September 2019, with roughly 45 percent (295,000 vehicles) sold in the five-county Southern California region alone.¹⁶ Helping the industry thrive in the region is its large concentration of EV companies as well as government resources and incentive programs. Southern California leads the state in EV consumption and in addition to its significant share of the sales market, Southern Californians have accounted for a dominant share of California’s Clean Vehicle Rebate Project (CVRP), which is administered by CARB’s Center for Sustainable Energy. Southern California represents 46 percent of CVRP shares, while the Bay Area (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties) account for 35.4 percent (**Exhibit 3-1**).

Of the Southern California region, Los Angeles County is the dominant contributor to electric vehicle consumption, accounting for over half of all rebates (**Exhibit 3-2**). In the County of Los Angeles, five percent of all new vehicle registrations were electric, or plug in hybrid electric in 2018.

Attempting to stake out national and global leadership on climate, the City of Los Angeles has committed to a Green New Deal of its own. This suite of climate goals include pillars such as having 25 percent ZEV cars on the road by 2025 and installing 28,000 electric vehicle chargers by 2028.¹⁷ As seen in **Exhibit 3-3**, these goals are more ambitious than current trends. In a business as usual scenario, ZEV adoption may only reach 10 percent by 2025. Nevertheless, these goals are achievable if businesses, policy workers, climate activists and many more stakeholders work together and create realistic road maps to transform the region’s transportation.

¹⁶ Auto Alliance; California New Car Dealers Association.

¹⁷ “L.A.’s Green New Deal.” 2019. City of Los Angeles. <https://plan.lamayor.org/sites/default/files/pLAN_2019_final.pdf>.

Exhibit 3-1: Share of EV & PHEV Rebates in CA 2010-2019

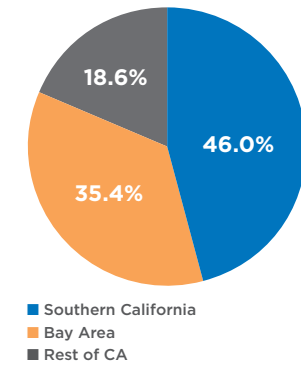


Exhibit 3-2: Share of EV & PHEV Rebates in Southern California 2010-2019

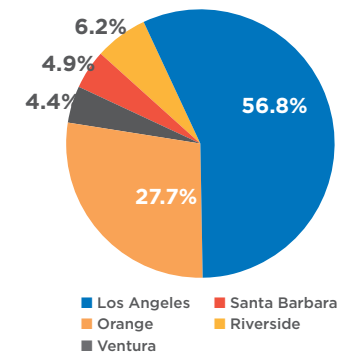
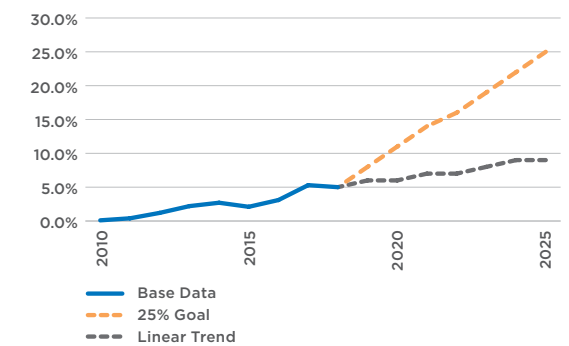


Exhibit 3-3: Linear Estimate vs. Vehicles needed on the road by 2025 in Los Angeles County



EV Deployment in Southern California

Our County: Los Angeles Countywide Sustainability Plan

In 2019, the County of Los Angeles approved a twelve goal sustainability plan focused not only on climate goals but community livability, resiliency and green economic growth. Goal 7 of this plan aims at a fossil fuel-free Los Angeles County, which the County hopes to achieve by adding 60,000 new public EV charging stations to serve the increased share (30 percent) of new private light-duty vehicles predicted by the County to be ZEVs by 2025.. By 2035, the County's targets include 70,000 additional public EV charging stations to service the 80 percent of new private light vehicles predicted to be ZEVs. By 2045, the County is aiming for 100 percent of all new private light vehicles to be ZEVs. The County's baseline for these targets is 1,013 public EV charging stations as of 2018 and almost 42,000 registered EVs in the County as of 2017.

In its own operations, the County plans on 5,000 EV charging stations at its facilities by 2025, and 15,000 stations by 2035. The County aims for its own light duty vehicles to be 100 percent ZEVs by 2025, 100 percent of its medium duty vehicles to be ZEVs by 2035 and 100 percent of its fleet to be ZEVs by 2045.¹⁸

L.A.'s Green New Deal

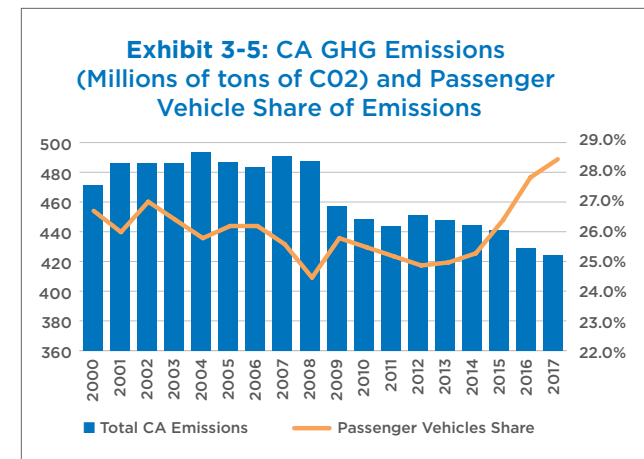
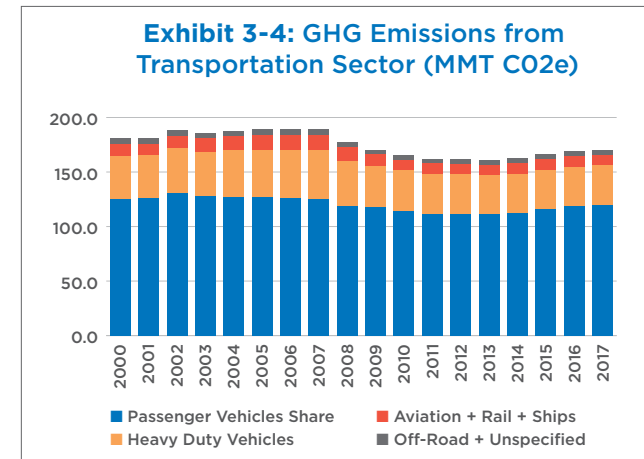
Building on his first Sustainability City Plan in 2015, City of LA Mayor Eric Garcetti launched in 2019 an expanded version of the plan under the heading of LA's Green New Deal. The plan is intended to be a pathway by which the City can achieve the aims of the Paris Agreement and guide the City to cut 30 percent more in GHG emissions than the 2015 plan. The Green New Deal reports that 21 percent of LA's greenhouse gas emissions come from transportation sources. In order to address this source of GHG emissions specifically and to accomplish its climate

goals broadly, the City has included a component of its Green New Deal exclusively devoted to ZEVs. Currently, the City is aiming for 25 percent of all LA vehicles to be ZEVs by 2025; 80 percent by 2035; and 100 percent by 2050. Moreover, the City has committed to electrifying 100 percent of LA Metro and LA Department of Transportation buses by 2030. Finally, the City has committed to reducing port-related GHG emissions by 80 percent by 2050. To pursue these goals, the City aims to distribute 1,000 EV rebates, 11,5000 Level 2 EV charger rebates and 75 DC fast charger rebates by 2021. The City also plans to install 10,000 publicly available chargers by 2022 and 28,000 by 2028. Longer term, the City plans for 100 percent electrification of paratransit shuttles by 2026 and 100 percent zero emissions on-road drayage trucks by 2035.¹⁹

Emissions, Public Health & The Future of California's Energy

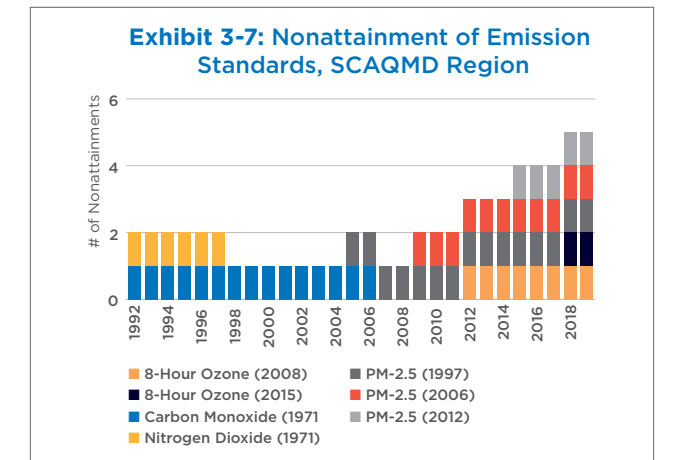
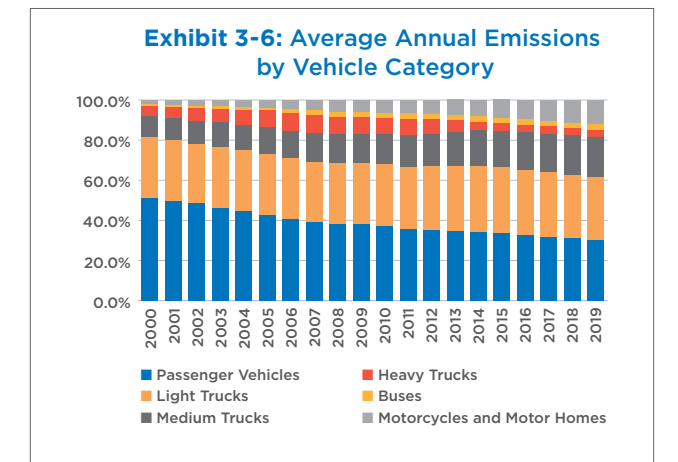
Emissions & Public Health

Overall, California has made significant progress in its greenhouse gas emissions, decreasing emissions by 12.7 percent from 2003 to 2017. Exhibit 3-5 shows the decline in total state emissions since 2000. However, the share of carbon emissions produced by passenger vehicles has increased in recent years despite an expanding EV market. On average, passenger vehicles have accounted for just over a quarter of all greenhouse gas emissions in the state since 2000. Emissions from heavy duty vehicles has remained consistently around or slightly above 8 percent over the same period. As such, increasing the volume of ZEVs, light, medium and heavy duty, is a key strategy for state and local policymakers in reducing vehicle emissions.



Considering other organic emissions (including carbon monoxide, nitrogen oxides, sulfur oxides and particulate), light passenger vehicles have made significant gains since 2000. Indeed, passenger vehicles only contributed 30 percent of total organic emissions in 2019, compared to 51 percent in 2000. Meanwhile, light truck emissions have remained stable in terms of their contribution to total vehicle emissions at over 30 percent, while medium trucks have increased their contribution from 10 percent in 2000 to just under 20 percent in 2019.

South Coast regional emissions could also be greatly diminished through wider adoption of EVs of all sizes. The South Coast Air Quality Management District (SCAQMD) 2016 Air Quality Management Plan admits that, despite substantive progress since the early 1990s, the region still fails to meet many federal emissions standards on ozone and particulate matter.²⁰ Exhibit 3-4 demonstrates that the emissions standards for which the region was noncompliant rose from 2009 until 2019. Indeed, the region was noncompliant for two ozone and three particulate matter National Ambient Air Quality Standards (NAAQS).



¹⁸ OurCounty Los Angeles Countywide Sustainability Plan. <https://ourcounty/la.lacounty.gov/>

¹⁹ LA's Green New Deal: Sustainable City Plan, 2019. <https://plan.lamayor.org/background>

²⁰ Final 2016 Air Quality Management Plan. March 2017. South Coast Air Quality Management District. Pp. 1.9-10.

EV Deployment in Southern California

As shown in **Exhibit 3-8**, the source of these emissions is overwhelmingly linked to the transportation industry, which accounted for 40 percent of GHG emissions in 2017. While these levels are significant when compared to the aspirations for California's transportation emissions, there is enormous potential for these rates to further decrease. Passenger vehicles account for 70 percent of all transportation emissions, while heavy duty vehicles such as trucks and freight emit 21 percent (**Exhibit 3-9**).



As discussed in this report, the immense adoption of electric vehicles in the state, coupled with supportive new policy measures and innovative regional projects are likely to vastly reduce the level of emissions produced compared to past years. The progress made thus far, and commitment seen by regional stakeholders, are causes for optimism on the path to zero emissions.

Exhibit 3-8: GHG Emissions by Source, 2017

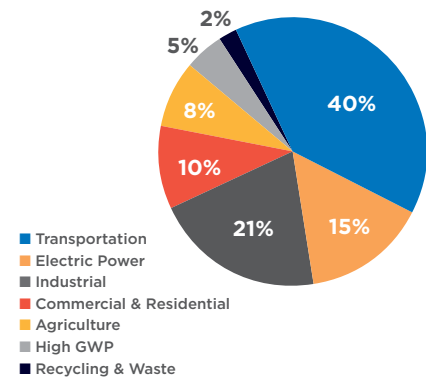
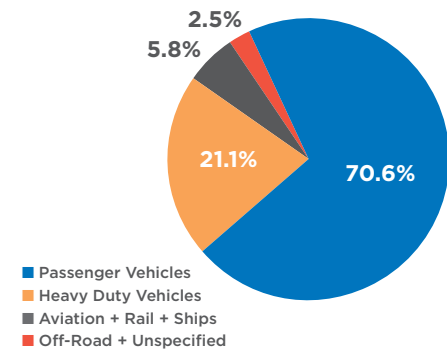


Exhibit 3-9: Share of Emissions by Transportation Sector, 2017



Public Health

Among the many benefits of expanding the availability of electric and fuel cell electric vehicles are the improvements linked to public health by reducing emissions. Indeed, the Los Angeles-Long Beach MSA was ranked the most ozone-polluted area in the U.S. in 2019 and the fifth most for year-round particle pollution.²¹ Los Angeles County has the highest concentrations of smog causing pollutants in the state, causing Angelinos to be exposed to 60 percent higher levels of vehicle pollution than the rest of Californians.

The ozone, particulate matter, and other smog-forming emissions from vehicles greatly impact air quality in the region. Increased exposure to these pollutants can lead to shortness of breath, damaged airways, increased lung diseases such as asthma and bronchitis and other health concerns. The exposure can be especially damaging to children, as their lungs have not fully developed. Low income households are also deemed to be particularly at risk, as those with the lowest income are 25 percent more likely to be exposed to particulate matter greater than 2.5 micrometers in diameter (PM 2.5) than the state's most affluent households.

According to the Union of Concerned Scientists, "research estimates that PM2.5 from on-road transportation leads to approximately 3,100 premature deaths per year in California due to cardiovascular disease, heart attacks, and other illnesses." In 2018, the Environmental Protection Agency (EPA) estimated that death rates linked to pollution have an annual cost of \$29 billion.²²

Energy

Attempts to increase battery life for EVs are ongoing; however, the current warranted lifespan of most EV batteries is eight years or 100,000 miles.²³ Batteries contain toxic materials and must be recycled with care to avoid contaminating soils and water sources. Several manufacturers are developing recycling processes to reuse up to 100 percent of battery materials. Others are choosing to repurpose batteries, with projects such as powering streetlights or elevators. Additionally, the source of electricity used in manufacturing and operating EVs is of relevance in addressing emissions issues. Given current data, one study has estimated that for California to rely one hundred percent on electric vehicles, electricity consumption would increase by 55 percent.²⁴ The same study found that to meet capacity, California would be faced with opening new power plants or buying additional electricity from other states. However, if daytime charging is prioritized to take advantage of excess solar energy (the duck curve), time of day planning will reduce the need to build more utility plants, which will be discussed further in policy recommendations.

²¹ State of the Air 2019. American Lung Association.

²² Union of Concerned Scientists, *Inequitable Exposure to Air Pollution from Vehicles in California*. February 2019.

²³ "Electric Vehicle Batteries: Materials, Cost, Lifespan." Union of Concerned Scientists. 9 March 2018.

²⁴ Davidson, Todd, Dave Tuttle, Joshua D. Rhodes and Kazunori Nagasawi, *Is America's Power Grid Ready for Electric Cars?* City Lab. December 7, 2019.

4. REGIONAL WORKFORCE ANALYSIS

“EV ecosystem will involve a multiplicity of goods and services production...”

4. Regional Workforce Analysis

Though subject to intense industry, policy and academic interest, the electric vehicle industrial ecosystem has no set definition or codification. Most industry and labor-related research depends on the North American Industrial Classification System (NAICS) codes and Standard Occupation Codes (SOC). To that end, the LAEDC endeavored to create a working definition to define the ecosystem and assess its employment footprint in the state of California and the Southern California region.

Using a sampling of the companies presented in Section 2, these companies were queried on the company database by Dun and Bradstreet to identify relevant six-digit NAICS codes. Using this sampling methodology, the LAEDC identified 17 NAICS subsectors of which the electric vehicle ecosystem is estimated to be composed. These subsectors are given in **Exhibit 4-1**.

This definition takes into consideration that the EV ecosystem will involve a multiplicity of goods and services production, as the automotive industry in general does. This includes but is not limited to energy creation and delivery for these vehicles; the manufacturing of charging equipment; battery fabrication; vehicle manufacturing; vehicle and parts retail; transportation of the vehicles and parts; transportation fleets and services using electric vehicles; vehicle-related software development; insurance and financial instruments related to vehicle ownership; management and support activities for vehicle manufacturing and sale companies; vocational training and rehabilitation to work with electric vehicles; and personal repair services for vehicle owners. Therefore, this ecosystem framework

considers the entire pipeline of electric vehicle manufacturing, sale, ownership and maintenance, including the associated infrastructure required for widespread adoption and use comparable to internal combustion vehicles.

Exhibit 4-1: Electric Vehicle Industry Ecosystem Definition

NAICS Industry

221	Utilities
238	Specialty Trade Contractors
335	Electrical Equipment, Appliance and Component

Manufacturing

336	Transportation Equipment Manufacturing
423	Merchant Wholesalers, Durable Goods
441	Motor Vehicle and Parts Dealers
485	Transit and Ground Passenger Transportation
511	Software Publishers
523	Securities, Commodities Contracts and Other Financial Investments
524	Insurance Carriers and Related Activities
541	Professional, Scientific and Technical Services
551	Management of Companies and Enterprises
561	Administrative and Support Services
611	Educational Services (Vocational Training)
624	Vocational Rehabilitation
811	Repair and Maintenance
999	Unclassified

Source: Dun & Bradstreet, BLS; Definition by LAEDC

Regional Workforce Analysis

In order to determine the proportion of these industries that directly relate to electric vehicles, LAEDC drew upon a body of research initially conducted by the U.S. Bureau of Labor Statistics through the Green Goods and Services (GGS) survey²⁵, to provide an initial baseline for determining the proportion of jobs related to green activities, of which electric vehicles are a major component²⁶. Though the GGS was discontinued, the BLS still provided a matrix of industries at the 6-digit NAICS level initially targeted for the survey and its two years of employment data (2010 and 2011), were used to project the green jobs estimates at the state and regional level through 2018. These green jobs estimates, combined with the constructed definition of the EV ecosystem, enabled the LAEDC to produce electric vehicle jobs estimates for the state of California and Southern California region. These estimates were produced from both the industrial and occupational perspective. Additionally, the LAEDC produced forecasts at the Southern California regional level for electric vehicle job growth out to 2023.

Exhibit 4-2: EV Ecosystem by Industry, 2018

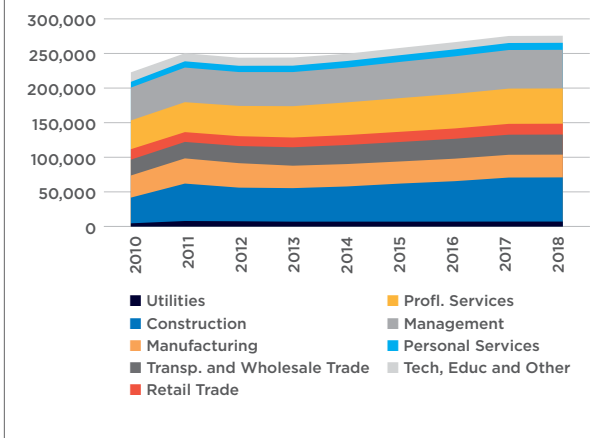
	SoCal	CA
Utilities	3,000	7,100
Construction	28,000	63,800
Manufacturing	16,100	32,900
Transp. and Wholesale Trade	12,500	29,000
Retail Trade	3,400	15,700

Exhibit 4-3: State of EV Employment in CA

	EV Ecosystem	Total
Total Jobs	275,600	17,355,900
Average Wage	\$91,300	\$68,500
% Total Job Share	1.6%	100%
% Annual Growth, 2010-2018	2.8%	1.9%
<i>Source: BLS QCEW; Estimates by LAEDC</i>		
Prof. Svcs.	19,200	51,000
Management	26,300	55,800
Personal Services	4,700	10,100
Tech, Educ and Other	5,900	10,200
Total	119,200	275,600

Estimates by LAEDC

Exhibit 4-4: California EV Ecosystem Employment, 2010-2018



In 2018, the EV ecosystem and its constituent industries employed roughly 275,600 Californians, making up 1.6 percent of California's total employment but having grown an average of 2.8 percent per year since 2010, outpacing the 1.9 percent average annual growth rate of the state's total employment over the same period. Additionally, EV jobs are estimated to pay, on average, substantially more than the average job in California. Indeed, in 2018 the average EV job paid \$91,300 annually, or 33 percent more than the average job in California (\$68,500 annually). The largest constituent industries of the EV ecosystem are construction (23.2 percent), management (20.2 percent), professional services (18.5 percent) and manufacturing (11.9 percent).

In the five counties of Southern California, the pattern is largely the same. In 2018, the Southern California regional EV ecosystem employed 119,200 workers, accounting for 1.5 percent of total regional employment. However, these jobs grew an average of 2.9 percent per year, on average, between 2010 and 2018 whereas the overall job growth was only 1.7 percent per year over the same period. Finally, Southern California EV jobs paid 47 percent more than the regional average with an annual wage of \$80,900. The largest constituent industries are construction (23.5 percent), management (22.1 percent), professional services (16.1 percent) and manufacturing (13.5 percent). Though still a nascent part of the state and region's overall employment, growth and wage patterns portend that the EV ecosystem represents a family of industries that could serve as a powerful economic stimulant going forward.

Exhibit 4-5: Southern California EV Ecosystem Employment, 2010-2018

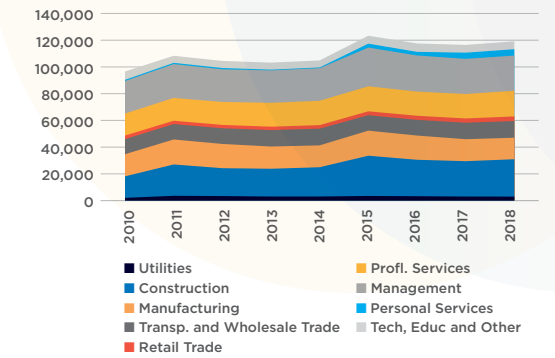
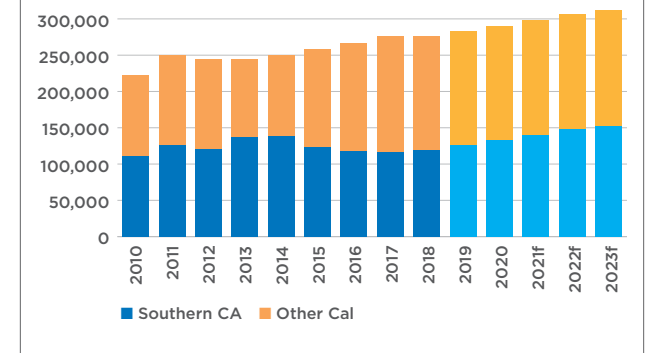


Exhibit 4-6: State of EV Employment in Southern CA

	EV Ecosystem	Total
Total Jobs	119,200	7,889,900
Average Wage	\$80,900	\$54,900
% Total Job Share	1.5%	100%
% Annual Growth, 2010-2018	2.9%	1.7%

Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-7: California EV Cluster Employment Forecast



²⁵ "Measuring Green Jobs." Bureau of Labor Statistics, U.S. Department of Commerce. <https://www.bls.gov/green/home.htm>

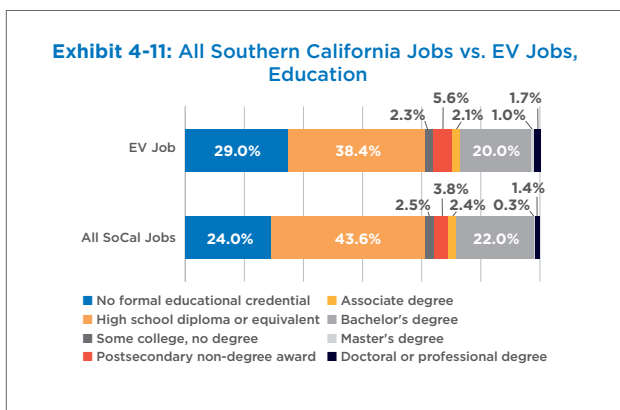
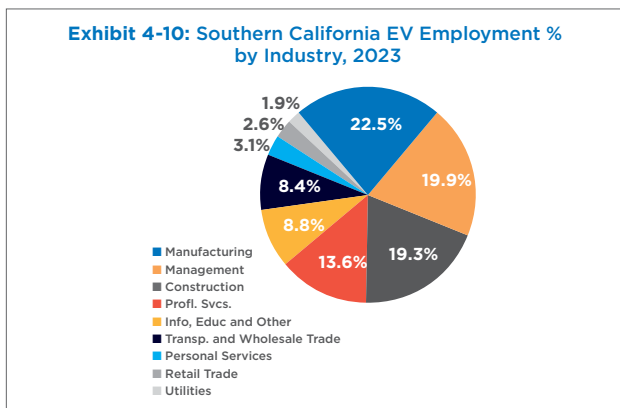
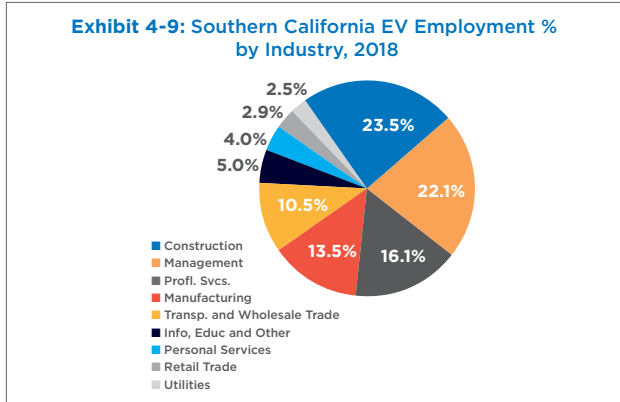
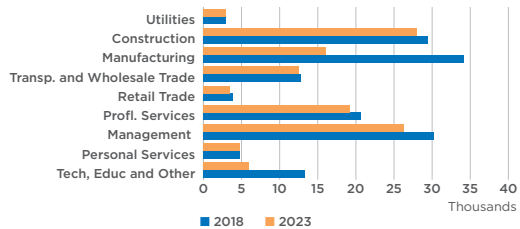
²⁶ A call to legislate new state and federal data tools concerning green jobs, including EV-related jobs, is included in Section 5.

Regional Workforce Analysis

A fast-growing subset of the economy through the last decade, it is forecasted that the EV ecosystem will continue to grow robustly over the next five years. The LAEDC estimates that electric vehicle-related jobs will grow by 27.8 percent between 2018 and 2023 to a total of 152,200. For the state as whole, EV-related employment is projected to reach 312,000 jobs. The largest regional gains are expected to be in manufacturing, with growth of 112.5 percent, and the category composed of data and technology, education and unclassified employment with 125.8 percent growth.

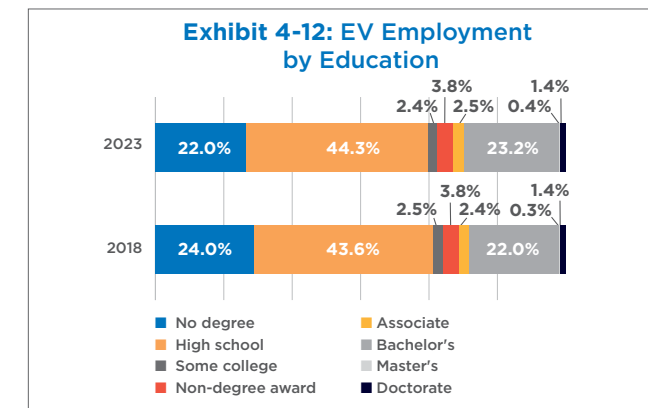
By 2023, EV-related manufacturing is expected to constitute 5.9 percent of total EV employment compared to 2.9 percent in 2018. Overall, however, the largest industries are predicted to remain the drivers of EV-related employment with utilities, construction, manufacturing and management collectively composing 32.8 percent of the ecosystem's employment (compared to 30.3 percent in 2018).

Exhibit 4-8: Southern California EV Ecosystem Employment by Industry, 2018-2023 Forecast



As will be considered in Section 5, the success of the Southern California electric vehicle ecosystem will rely on capitalizing on competitive advantages, not just in Southern California's current economy and workforce, but also its future workforce and economy. As can be seen in Exhibit 4-8, electric vehicle-related employment requires a slightly higher entry-level education threshold than Southern Californian employment overall. Indeed, EV-related jobs are more likely to require a formal credential and are 5.2 percent more likely to require at least a high school diploma or equivalent, and 2 percent more likely to require a bachelor's degree. That said, there are marginally fewer workers in the EV ecosystem with postgraduate degrees, but this could change as the ecosystem develops and battery-, vehicle- and consumer-related research increase in the region. Moreover, master-planning for infrastructure, especially regarding vehicle charging, will likely require additional experts with advanced degrees in urban planning and urban economics.

As demonstrated in Exhibit 4-10, the trend in the ecosystem is toward greater education for entry-level employment. Between 2018 and 2023, EV-related work requiring at least a high school diploma is estimated to grow by 0.7 percent and requiring at least a bachelor's degree by 1.2 percent. By comparison, entry-level roles in the ecosystem needing no credential whatsoever are forecasted to diminish by 2 percent over the same period.



In considering how EV jobs have changed and are predicted to change as the ecosystem continues to grow, the types of occupations must also be considered. Many occupations transcend industries, meaning a worker in a particular occupation can work in various industries as defined by NAICS codes. LAEDC's occupational employment estimates and forecasts are given specifically for those employed in constituent industries of the electric vehicle ecosystem. Moreover, occupations are defined by the minimum entry-level education required for that particular occupation.

The occupational employment estimates in Exhibits 4-12 and 4-13 are presented as targets based on several criteria. In both tables, occupations were selected by being 25 percent or more above the annual living wage for Los Angeles County, which was \$29,864 in 2018. Moreover, these occupations had to be competitive as measured by location quotients (LQs), which proxy for regional comparative advantage by measuring how concentrated an occupational role or industry are in the region vis-à-vis the nation. Finally, the targeted occupations could not be in the following occupational groups: art, design, entertainment, sports and media occupations; healthcare practioners and technical occupations; healthcare support occupations; personal care and service occupations; food preparation and serving related occupations; sales and related occupations; and management occupations. These occupational categories were exempted as either not being specific enough to electric vehicles or, like management occupations, were not entry level.

Regional Workforce Analysis

For **Exhibit 4-13**, occupations were selected on the basis of having the highest 2018 employment after being subjected to the aforementioned criteria.

Exhibit 4-13: Top EV Occupations by 2018 employment, LAEDC Forecast 2018-2023

SOC	Occ Title	EV 2018	EV 2023	Occ Wage	LQ	Education
23-2011	Paralegals and Legal Assistants	511	549	\$55,590	1.22	Associate degree
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	262	312	\$60,690	1.2	Postsecondary non-degree award
17-3011	Architectural and Civil Drafters	262	282	\$63,580	1.22	Associate degree
17-3023	Electrical and Electronics Engineering Technicians	234	366	\$63,860	1.06	Associate degree
15-1134	Web Developers	145	183	\$78,200	1.32	Associate degree
17-3022	Civil Engineering Technicians	85	90	\$71,860	1.06	Associate degree
23-2099	Legal Support Workers, All Other	70	75	\$51,480	1.32	Associate degree
19-4091	Environmental Science and Protection Technicians, Including Health	53	58	\$60,930	1.1	Associate degree
17-3025	Environmental Engineering Technicians	51	58	\$53,840	1.48	Associate degree
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	40	82	\$64,360	1.14	Postsecondary non-degree award
13-2011	Accountants and Auditors	1,569	1,923	\$84,650	1.15	Bachelor's degree
13-1199	Business Operations Specialists, All Other	1,530	1,922	\$80,250	1.47	Bachelor's degree
13-1111	Management Analysts	911	1,070	\$98,160	1.04	Bachelor's degree
13-1161	Market Research Analysts and Marketing Specialists	871	1,145	\$71,460	1.34	Bachelor's degree
17-2051	Civil Engineers	681	724	\$108,340	1.12	Bachelor's degree
15-1133	Software Developers, Systems Software	643	995	\$125,770	1.36	Bachelor's degree
15-1199	Computer Occupations, All Other	629	749	\$86,950	1.32	Bachelor's degree
17-2071	Electrical Engineers	400	574	\$112,630	1.05	Bachelor's degree
27-1024	Graphic Designers	335	461	\$58,920	1.46	Bachelor's degree
13-1081	Logisticians	296	423	\$83,980	1.11	Bachelor's degree

For **Exhibit 4-14**, occupations were targeted for having the most openings between 2018 and 2023. Taken together, both exhibits present a concrete image of the types of roles current EV ecosystem workers inhabit and those they will likely inhabit five years hence.

Exhibit 4-14: Top EV Occupations by 2018 employment, LAEDC Forecast 2018-2023

SOC	Occ Title	EV 2018	EV 2023	Occ Wage	LQ	Education
17-3023	Electrical and Electronics Engineering Technicians	234	366	\$63,860	1.06	Associate degree
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	262	312	\$60,690	1.2	Postsecondary non-degree award
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	40	82	\$64,360	1.14	Postsecondary non-degree award
23-2011	Paralegals and Legal Assistants	511	549	\$55,590	1.22	Associate degree
15-1134	Web Developers	145	183	\$78,200	1.32	Associate degree
51-5111	Prepress Technicians and Workers	38	65	\$42,060	1.25	Postsecondary non-degree award
17-3024	Electro-Mechanical Technicians	39	63	\$61,750	1.73	Associate degree
17-3011	Architectural and Civil Drafters	262	282	\$63,580	1.22	Associate degree
17-3019	Drafters, All Other	24	41	\$54,300	1.1	Associate degree
17-3025	Environmental Engineering Technicians	51	58	\$53,840	1.48	Associate degree
13-1199	Business Operations Specialists, All Other	1,530	1,922	\$80,250	1.47	Bachelor's degree
13-2011	Accountants and Auditors	1,569	1,923	\$84,650	1.15	Bachelor's degree
15-1133	Software Developers, Systems Software	643	995	\$125,770	1.36	Bachelor's degree
13-1161	Market Research Analysts and Marketing Specialists	871	1,145	\$71,460	1.34	Bachelor's degree
17-2072	Electronics Engineers, Except Computer	285	485	\$124,380	1.57	Bachelor's degree
17-2071	Electrical Engineers	400	574	\$112,630	1.05	Bachelor's degree
13-1111	Management Analysts	911	1,070	\$98,160	1.04	Bachelor's degree
13-1081	Logisticians	296	423	\$83,980	1.11	Bachelor's degree
27-1024	Graphic Designers	335	461	\$58,920	1.46	Bachelor's degree
15-1199	Computer Occupations, All Other	629	749	\$86,950	1.32	Bachelor's degree

Development and displacement: reflecting on the decline of internal combustion engines (ICE) – related employment

As is the case with any technological innovation, new forms of employment often reflect rising demand in one area while demand falls in another. In the case of electric and zero emissions vehicles, this diminished demand will likely occur in gasoline sales, ICE-related manufacturing and traditional automotive mechanical work.

Part of this displacement arises from the mechanical nature of electric vehicles themselves. Indeed, conventional automobile powertrains have over 2,000 individual parts, whereas those in electric vehicles may have as few as 20. This shift, not only in technology but also in the labor required, has not gone unnoticed by auto manufacturer and auto labor interests. In a 2019 white paper about electric vehicles, especially battery-powered vehicles, the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America (UAW) stated, “EV powertrains are simpler and require less labor than ICE powertrains, which could have a negative impact on auto employment

levels, while new technologies could shift the auto value chain to companies outside traditional manufacturing.” UAW specifically identified two industries, motor vehicle gasoline engine manufacturing (NAICS 33631) and motor vehicle powertrain components manufacturing (NAICS 33635), as specifically vulnerable.

In the state of California, these two industries accounted for 0.02 percent of total employment, or roughly 3,300 jobs. Over the period from 2010 to 2018, this subset of the state’s employment only grew 1.0 percent. In Southern California, these two industries amount to 0.03 percent of total regional employment with roughly 2,700 jobs. Over the 2010 to 2018-time horizon, these jobs grew an average of 2.1 percent annually. Despite some growth over the last decade, powertrain and ICE manufacturing account for almost negligible proportions of state and regional employment. Given the scope of projected job growth in the next five years for electric vehicles, this working population could easily be targeted for reabsorption into the economy through rehiring and reeducation initiatives.

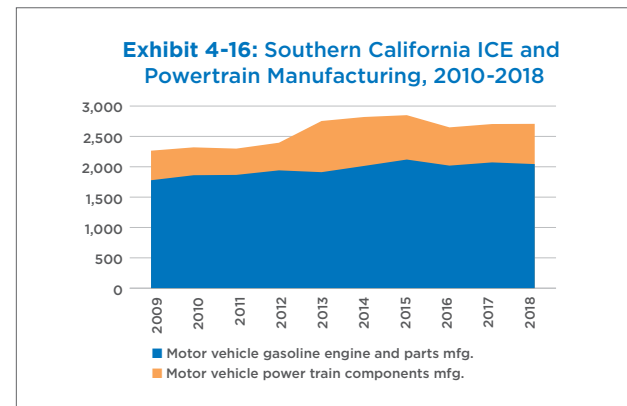
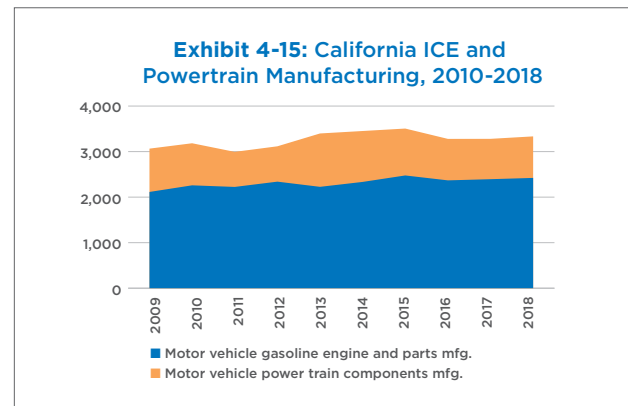
The transition to an entirely electric vehicle infrastructure also portends the diminution of oil and gas as engine combustibles. Concurrent goals for renewable energy sources also signal the decline of natural gas used for electricity generation. Taking both these trends into account, it is worth considering how the transition of California’s light, medium and heavy-duty vehicles to entirely electric will impact the state’s oil and gas industry, historically a significant wealth generator for the Golden State.

In 2018, gasoline station employment reached 62,220 in California. As EV’s increase their share of both new vehicles and the state’s total stock of vehicles, many gasoline stations may convert to electric charging stations. Provided with the proper incentives by state and local authorities, gas stations might be part of the transition from combustible engines to electric ones as fuel pumps become electric chargers.

Regulation and increased efficiencies in oil and gas extraction have contributed to employment losses in the industry over the last several years. However, since crude oil and natural gas are global commodities, Californian producers still have ample markets even if the widespread adoption of EVs limits demand for petroleum-based fuels. Refiners may feel the effects of reduced demand stemming from a transition from ICE to EV’s in the short-term, but heavy industries that include petrochemicals, aviation, manufacturing and heavy transportation also rely on refined petroleum products and may,

to a degree, insulate the industry from employment loss related to the transition. Additionally, if feasible, they may have the ability to reconfigure to export products to markets outside of California. While the phasing out of natural gas in electricity generation is imminent, the largest expenditures on natural gas in California are made by the residential sector for household uses.

Looking ahead, the electric vehicle cluster in California and Southern California will be a critical job and wage creator, employing thousands of state residents across various industries from utilities and manufacturing to customer services and maintenance. As with all ascendant technologies, electric vehicles will be the source of change in some industries, including but not limited to industries as varied as the manufacturing of automotive engines to gas stations. In many regards, the growth of EV cluster jobs will provide new opportunities for those currently employed in industries on the decline. In other cases, existing industries will adapt to accommodate Californian’s demand for vehicles that run on electricity rather than on combustible fuels. In the case of employment loss, state and local policymakers should enact programs that provide pipelines from eclipsed industries into comparable positions in the EV workforce. Overall, the short- and long-term growth of EV-related employment will benefit all Californians as it puts the state on the global forefront of a cluster driving the world to a cleaner transportation future.



5. EMPLOYMENT TRANSFORMATION & POLICY PROPOSALS

“Electric vehicles and their growing workforce are becoming a core tenant to the California economy.”



5. Employment Transformation & Policy Proposals

The electrification of vehicles, while slow moving, is gaining momentum in California. As described in prior modules, electric vehicles and their growing workforce are becoming a core part of the California economy. In order to further develop and bolster electric transport, policy action should be taken at the local, state and federal levels to incentivize the production and utilization of green transportation.

Effective policies such as incentives, rebates and various savings plans are available at all levels of government to encourage the purchasing and charging of electric vehicles. Further policy recommendations include mitigating barriers associated with limited infrastructure and high production costs. Both consumers and manufacturers must continue to be incentivized to purchase and produce electric vehicles over traditional fossil fuel ones.

Expansion of Policy Programs

Despite tremendous growth in the electric vehicle field in recent years, EVs still only make up 1.4 percent of vehicles on Californian roads. High demand for California's rebate programs has caused some policies to shift the focus of their subsidies away from high income consumers. For example, CARB's rebates were eliminated in December 2019 for vehicles over \$60,000 and reduced for other EVs and PHEVs. However, rebates are not being lowered for low-income buyers, signaling CARB's continued effort to support EV²⁷ affordability.

If electric vehicles are more costly than traditional fuel vehicles, the rate of adopting green technologies will remain low, especially for

moderate and low-income households. Increasing resources for initiatives such as CARB's rebate program and CRVP will assist households in effectively addressing the issue of upfront cost barriers associated with electric vehicles. These incentives could be expanded to exempt low-income families from paying registration fees, in order to drive further adoption for those who need assistance the most. Potential room for effective policies also includes replacing rebates with a state income tax credit or deduction and expanding the state's cash for clunkers to provide extra funding for individuals trading in their used, gasoline-powered vehicles for EVs.

Other programs, such as EV access to HOV and fast track lanes will continue encouraging greater adoption. Policymakers may also debate the benefit of having an additional HOV lane, exclusively for EV vehicles, if congestion is becoming an issue for normal carpool drivers. A list of electric vehicle incentives is included in the appendix. The expansion of these programs would greatly aid the electric vehicle adoption in the areas affected.

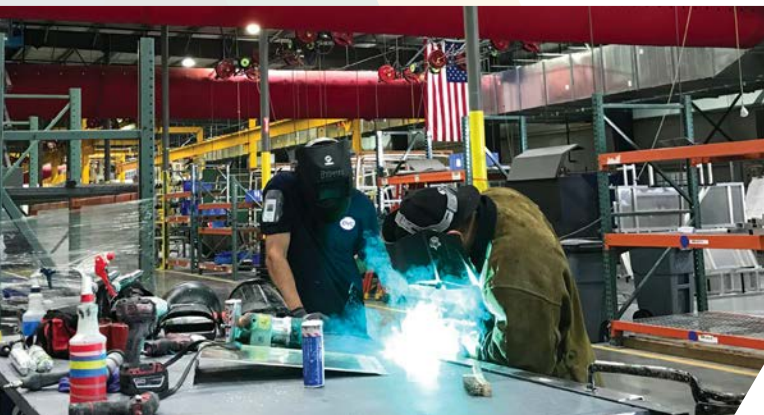
AB 383 suggested legislation would establish the California Green Mobility Commission, consisting of 17 members, as specified, to: brand, promote and market California's fast-growing "green mobility" industries, such as zero emission vehicles; to serve as a central point of contact for businesses engaged in mobility industries; to attract out-of-state and international green mobility businesses; and to support the health and competitiveness of these green mobility industries in California.

27 Berman, Bradley. November 12, 2019. "California drops EV rebates for cars over \$60k, plug-ins below 35 miles of EV range". Electrek. <https://electrek.co/2019/11/12/california-drops-ev-rebates-for-cars-over-60k-plug-ins-below-35-miles-of-ev-range/>

Eradicating Barriers to Manufacturing & Electrification

There are currently 126 different electric vehicle models sold in the United States. While this number has increased rapidly in the past five years, electric vehicles only represent 5 percent of the 2,410 vehicles models sold in the United States.²⁸ Increasing the number of electric cars and models produced though policy would be easiest achieved by further subsidizing research and development as well as the manufacturing of electric vehicles.

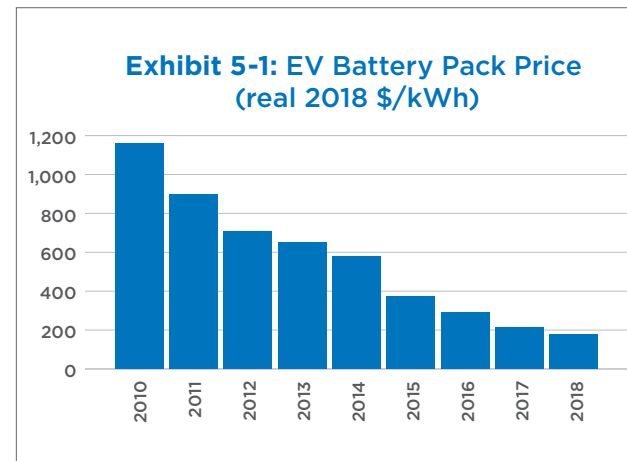
The up-front price disparity between electric and conventional vehicles is a significant barrier to consumer adoption rates. One of the costliest barriers of EV manufacturing driving this price discrepancy is battery production. Currently, batteries cost anywhere from \$150-\$200 per kilowatt hour on average. **Exhibit 5-1** demonstrates the cost of battery pack production for electric cars, as projected by different studies and industry leaders. As battery pack costs are anticipated to fall over the next ten years, the International Council on Clean Transportation forecasts that the initial purchasing price between conventional vehicles and battery



BYD Motors

electric vehicles will reach an equilibrium by 2024 to 2028, depending on vehicle range.²⁹

To continue, if not accelerate, these trends in battery production, policies can be put in place to encourage greater EV manufacturing across the U.S. For example, the American Recovery and Reinvestment Act of 2009 set aside \$2.4 billion in funding for advanced battery and electric drive projects.³⁰ However, many incentive programs remain centered around consumer needs and much more can be done to assist manufacturers. For example, New Mexico has a tax credit program up to five percent for manufacturers of advanced technology and alternative fuel products, while Georgia offers a tax credit for up to five years for alternative fuel and advanced vehicle manufacturers, based on the number of full-time job opportunities created.³¹ California could also create a similar tax incentive program by creating a state-wide tax-credit or by lowering the tax rate for electric car production. As the nation's largest economy, the Golden State could incentivize a significant amount of production with a similar tax-credit.



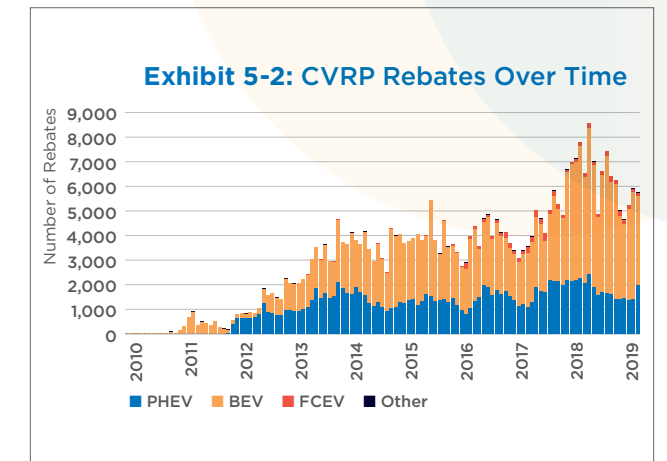
Beyond a tax incentive, more can be done to emphasize the importance of manufacturers in the state. Efforts like the USA Electrify Forward Act could be implemented on a state level to generate a greater manufacturing presence. The Electrify Forward Act focuses on updating residential and commercial building codes for EV installations, accelerating domestic manufacturing of batteries and updating the department of energy's grant and loan program for advanced technology vehicle manufacturing. With tech centers and EV headquarters constituting such a large share of the EV cluster in California, extending incentives to manufacturers can further strengthen the industry by ensuring resources are accessible along all parts of production.

Changing Consumer Preferences through Incentivization

California historically has been on the forefront of incentivizing electric vehicles, typically by creating incentives and rebates for vehicle demand. These subsidies occur at both the local and state levels. Statewide, programs such as the Clean Vehicle Rebate Project (CVRP) provide assistance to EV purchasers. The CVRP program has issued over 350,000 rebates over the life of the program totaling to \$809 million in funding supplied.³² 61 percent of rebates were for BEVs while 36 percent were for PHEVs. As demonstrated in **Exhibit 5-2** below, the CVRP program has grown substantially over time and has become a huge success. The number of rebates has grown in recent years, indicating an increase in consumer demand. Eligibility requirements, such as income caps and registration qualifications, are common for these programs and should be carefully reviewed by buyers.

In addition to the CRVP, local cities have taken the initiative to incentivize electric vehicle adoption. Los Angeles Department of Water and Power implemented the "Charge Up LA!" program, offering rebates of up to \$4000 for 240-volt (level 2) chargers.³³ In a similar vein, the San Joaquin Valley Air Pollution Control District manages the "Charge Up!" program.³⁴ Sonoma supplies consumers with electric vehicle charging equipment when they purchase an electric vehicle.

To achieve the state's goals of reducing the carbon intensity of transportation fuels, the Low Carbon Fuel Standard program provides credits to EV customers through the Electrical Distribution Utilities. This program also provides funding for SCE's Clean Fuel Reward Program, which provides customers with a new or leased EV a rebate of up to \$1,000. All these incentives help explain why California leads the nation in electric vehicle adoption and has nearly 50 percent of the nation's electric vehicles and should be the foundation for even more robust incentive regimes to achieve state EV goals.



28 U.S. Environmental Protection Agency. Retrieved from <https://www.fueleconomy.gov/feg/findacar.shtml> (2020)

29 Lutsey, N. and Nicholas, M. 2019. "Update on electric vehicle costs in the United States through 2030". The International Council on Clean Transportation. https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

30 "President Obama Announces \$2.4 Billion in Grants to Accelerate the Manufacturing and Deployment of the Next Generation of U.S. Batteries and Electric Vehicles". 2009. U.S. Department of Energy <https://www.energy.gov/articles/president-obama-announces-24-billion-grants-accelerate-manufacturing-and-deployment-next>

31 U.S. Department of Energy, Alternative Fuels Data Center. (2020). State Laws and Incentives. Retrieved from <https://afdc.energy.gov/laws/state>

32 "CVRP Rebate Statistics". 2020. California Air Resources Board. <https://cleanvehiclerebate.org/eng/rebate-statistics>

33 "Charge Up LA!" Los Angeles Department of Water & Power <https://www.ladwp.com/ladwp/faces/ladwp/residential/r-gogreen/r-gg-driveelectric>

34 "Grants and Incentives". 2019. San Joaquin Valley Air Pollution Control District. <http://valleyair.org/grants/>

Reduce the Rate of Climate Change: A more sustainable future for coming generations

Another major step forward in reducing GHG's will be further aligning EV charging with the time of day that solar energy is in peak production, that is, when excess solar is being curtailed or dumped. Many utilities already offer time of day pricing and incentives, but a real emphasis could be placed on encouraging additional workplace charging. Installation and use of chargers at workplaces allow EVs to be charged during peak solar hours, rather than the 4 to 9 P.M. period, when fossil fuels are more likely to be used.

To encourage greater manufacturing goals, Congress should amend the federal income tax credit that phases out the credit amount (\$7,500) after a manufacture reaches 200,000 in vehicle sales in the four quarters that follow when manufacturer reaches this threshold. For Tesla, this credit was eliminated by the end of 2019, and General Motors will lose this credit by the second quarter of 2020.³⁵ Both state and federal governments need to boost sales at all levels so that manufacturers feel empowered to reach state deployment goals. Capping rewards based on number of sales disincentivizes manufacturers, especially makers of both EVs and combustion engine vehicles, from prioritizing EVs over fossil fuel vehicles.

In order to improve research, the U.S. Department of Labor, particularly the Bureau of Labor Statistics, should reinstitute survey tools that help estimate the prevalence of green jobs, including but not limited to those involved in the EV cluster. At present, researchers are limited to deploying their own survey tools using their own definitions, which can and do vary, to examine the firms and employment of the EV cluster in their own geographies. Federal research tools which include state and local data should be reimplemented to help promote the growth and health of this cluster. California could take the lead by implementing its own data tools concerning the EV cluster.

4 Simple Steps to Supporting EVs

- 1 - Get Involved!** Engage with the regions' robust resources for the ZEV industry including the LAEDC's e4 Mobility Alliance Council. E4 Council topics focus around business of future and workforce of the future convening start-ups, cutting-edge companies, academia, VCs, and professional service firms. Additionally, e4 Council convenes policy and tech-to-market workshops and roundtables. You won't want to miss this opportunity to work with the e4 community to grow the ZEV cluster. Don't forget to participate with the other great ZEV-focused programs mentioned in this report.
- 2 - Use Resources!** Contact the LAEDC's Business Assistance team who can provide site selection, incentives, and expansion/location resources to ZEV companies. In that past several years, the Business Assistance team, working with local economic development and state agencies such as Go-Biz, have assisted numerous ZEV companies from buses, trucks, and vehicles to invest locally, grow business, and build the talent pipeline in the County of Los Angeles. Contact them here: <https://laedc.org/wtc/chooselacounty/business-incentives/>
- 3 - Support Policy!** Numerous agencies including the LAEDC are pushing good policies that will greatly impact the future of ZEVs and ZEV infrastructure. Keep updated with the LAEDC e4 Policy Working Groups. Attend and provide support at California Air Resources Board meetings, especially programs under SB 498 and SB 1017 which are set to accelerate incentives, policy and programs for the ZEV goals and business in California.
- 4 - Drive ZEVs!** Be a part of the "Made in California ZEVs" campaign that will be a win for the environment, a win for good-paying California jobs, and a win for ZEV business in California.

Funding Considerations

Long term funding plans assist manufacturers, consumers and dealers in making investment decisions and unlock private capital. CARB has supported the need to create three-year spending goals, while annually updating the CVRP forecast. In order to signal to sellers that EV funding will be sustainable and that the market will ultimately remain profitable, long term goals, such as the state's 2045 deployment goal, rather than short term successes need to be the primary focus for

incentive programs. California and its municipalities should be wary of status-quo funding goals that pose the risk of year to year fluctuations. CARB's analysis of funding needed to reach 5 million vehicles on the road suggests that an additional \$5.6 billion will be needed in rebate funding.³⁶

In order for the City of Los Angeles to meet its goal of having 25 percent ZEVs on the road by 2025 or for California to make it to 5 million by 2030, enhancing adoption programs is a major component of reaching these objectives.

Additional Resources:

The LAEDC's **California SmartMatch** program offers B2B matchmaking services that identifies OEM supply chain need and matches the need with diversified small and medium size companies. The program assists electric vehicle companies in finding women, minority, disadvantaged, veteran owned and HUB zoned suppliers. The program has already assisted in over 200 matching opportunities for OEMs in finding low-cost, just-in-time, local businesses to assist in increased production demands and mitigation from increased tariff costs. Find out more and register for the program here: <https://laedc.org/2018/06/11/california-smartmatch/>

The LAEDC's **Center for Competitive Workforce** is a collaboration between the LAEDC and the 19 community colleges in the LA Basin and funded through California's Strong Workforce Program. CCW convenes business leaders and faculty to strengthen relationships and communication, identify trends in skills and competencies, and builds efficient talent development programs. The program develops work-based learning opportunities (e.g. internship and apprenticeship) by directly engaging employers, colleges and the entire talent development ecosystem in the region. More information can be found here: <https://competitiveworkforce.la>

The LAEDC's **e4 Mobility Council** meets quarterly and brings together business leaders, including the electric vehicle OEMs, suppliers, EV charging companies, and software companies to foster promotion of the advanced transportation/mobility cluster in California. Council agendas include industry market trends, strategies for growing business, best practices, policy initiatives, and focused ecosystem growth. Find out more here: <https://laedc.org/our-services/initiatives/e4-mobility-alliance/>

The State of California's Governor's Office of Business and Economic Development (**GO-Biz**) has a dedicated ZEV Marketing Office working to accelerate the deployment of zero emission vehicles and infrastructure in pursuit of California's goal of 5 million ZEVs on the road in California by 2030. This target is focused on meeting California's climate, air quality, and clean energy goals. Find out more on the State of California's website <https://www.business.ca.gov/Programs/Zero-Emission-Vehicles-ZEV>.

Additionally, the LAEDC's **World Trade Center** Los Angeles, combines public and private resources to help L.A. businesses expand into international markets and promotes L.A. County as a destination for foreign investment, to attract capital and development projects to the region-enhancing the region's economy, employment, and business opportunities for local firms. Find them here: <https://www.wtcla.org>

³⁵ Kane, Mark. 21 February 2019. "U.S. Federal EV Tax Credit Update For January 2019". InsideEvs <https://insideevs.com/news/342948/us-federal-ev-tax-credit-update-for-january-2019/>

³⁶ "Proposed Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives". 20 September 2019. California Air Resources Board. <https://ww3.arb.ca.gov/msprog/raqip/fundplan/fy1920fundingplan-appc-rev.pdf>

6. FINAL THOUGHTS

“The Golden State can steer global aspirations for cleaner transportation.”

6. Final Thoughts

While the title of the nation’s auto capital may be up for debate, there’s no denying California’s status as the nation’s hub for electrification. From trams to scooters, the Golden State is quickly steering away from fossil-fuel powered vehicles. However, the state and many of its localities have set for themselves objectives beyond the current rate of adoption to aggressively address climate change. In electrifying the state’s largest source of GHG emissions, Californians may soon reap the rewards of a cleaner, quieter, more affordable transportation system. Electric vehicles not only can transform California’s streets, highways and cities in terms of air quality and reduced noise pollution; the electric vehicle cluster also has the capacity to be major engines of job creation and prosperity. Additionally, improvements in grid integration and partnerships between the state and utility providers will allow California to reduce overall emissions and reach its goal of 100 percent clean electric energy by 2045.

The role of public policy and the California’s legislative willingness to adopt incentives and regulations will continue to deliver value by increasing EV adoption. Although forecasts highlight the huge jumps that must be made between current trends and goals for 2030 and beyond, California’s businesses and drivers have the capacity to combine their resources and energies to create policies and strategies to meet these aims. Moreover, further alignment between business, education and policy in the realm of this forward-thinking cluster could transform California into the anchor of the global electric vehicle cluster as the world’s nexus of EV design, development, manufacturing and sale. In the same way California drove the world’s dreams of the automobile, the Golden State can steer global aspirations for cleaner transportation.



Appendix: Summary of EV Incentives

Area	Vehicles	Level	Federal Tax Credit
State of California	Fueling & Charging Equipment	State	CA Residential Charging Station Financing Program
	Fueling & Charging Equipment	State	California Clean Vehicle Rebate Project (CVRP)
	Fueling & Charging Equipment	State	California Electric Vehicle Infrastructure Project (CALeVIP)
	Insurance	State	Farmers Insurance
	Vehicles	State	ZEV and Near-ZEV Weight Exemption
	Vehicles	State	Carl Moyer Memorial Air Quality Standards Attainment Program (Emission Reduction Grants)
	Fueling & Charging Equipment	State	Financing Program - Residential EV Charging
	Manufacturers	State	California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) tax exclusion
	Insurance	State	Travelers Insurance
	Parking	State	CA EV Charging Station Financing Program
	Special Decals & Permitting	State	HOV lane exemption (DMV)
	Special Decals & Permitting	State	Free parking & charging at participating hotels
	Vehicles	State	Rebate - ZEVs in public fleets
	Vehicles	State	Clean Cars 4 All
	Vehicles	State	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
Vehicles	State	Grant & Financing - Clean Vehicle Assistance Program	
Vehicles	State	Cash for Clunkers	
Southern California - All Counties	Other	SoCal	Free EV charging at LAX
	Parking	SoCal	Free metered parking in Hermosa Beach
	Parking	SoCal	Free on-street metered parking in Santa Monica
	Utility Rate Discounts	SoCal	Southern California Edison rate discounts
	Vehicles	SoCal	Rebate - SCE Clean Fuel Reward Program
	Fueling & Charging Equipment	SoCal (not SD or Ventura)	South Coast Air Quality Management District Charging Incentive
	Vehicles	SoCal (not SD or Ventura)	Rebate - Replace Your Ride

Appendix: Summary of EV Incentives

Area	Vehicles	Level	Federal Tax Credit
SoCal & SD Counties	Fueling & Charging Equipment	LA County	Rebate - Charging Infrastructure Rebate
	Fueling & Charging Equipment	LA County	LA Department of Water and Power utility discount rate
	Fueling & Charging Equipment	LA County+	LA Department of Water and Power charging infrastructure rebate (Charge up LA! Program)
	Vehicles	Orange County/SD	Rebate -annual credit on SDG&E bill (SDG&E)
	Utility Rate Discounts	Riverside County	Riverside Public Utilities
	Fueling & Charging Equipment	San Diego	Power Your Drive - SDG&E
	Fueling & Charging Equipment	SD County	Nissan LEAF "No Charge to Change" Program (partnership with Evgo)
	Utility Rate Discounts	SD County	SD Gas and Electric
	City Programs	Fueling & Charging Equipment	City of Riverside
Fueling & Charging Equipment		City of Santa Monica	EV Charging Station Rebate Program
Vehicles		LA County - Antelope Valley	Alternative Fuel Vehicles Rebate (new vehicles only)
Fueling & Charging Equipment		LA County - Azusa	Azusa Light & Water Charging Infrastructure Rebate
Utility Rate Discounts		LA County - Azusa	Azusa Light & Water Utility Rates
Utility Rate Discounts		LA County - Burbank	Burbank Water & Power TOU rates
Fueling & Charging Equipment		LA County - Pasadena	EV Charging Infrastructure Rebate
Fueling & Charging Equipment		LA County - Burbank	Burbank Water & Power Charging Infrastructure Rebate
Fueling & Charging Equipment		Orange County - City of Anaheim	Rebate - Personal EV charging infrastructure (City of Anaheim PUD)
Vehicles		LA County - Pasadena	Rebate - EV purchase
Vehicles		Orange County - City of Anaheim	Rebate - Public Access EV charging infrastructure
Fueling & Charging Equipment		LA County - Glendale	Glendale Water and Power charging rebate
Bay Area		Fueling & Charging	Bay Area
	Vehicles	Bay Area	Bay Area EV Discount Program
	Special permit/decal	Bay Area	Bay Area FastTrak Discount
	Fueling & Charging	Bay Area	PG&E electric vehicle rate plans
	Fueling & Charging	Bay Area - City of Berkeley	Berkeley Residential Curbside Electric Vehicle Charging Pilot
	Fueling & Charging	Bay Area	The EV Charge Network Program - PG&E
	Vehicles	Bay Area - San Mateo County	San Mateo County - Affordable Used Electric Cars
	Vehicles	Bay Area	Community Housing Development Corporation Transportation Assistance

Appendix: Summary of Additional EV Support Programs

Organization	Description
Los Angeles Cleantech Incubator	Through the Transportation Electrification Partnership & the Zero Emissions 2028 Roadmap, LACI calls for accelerating EV infrastructure in time for the 2028 Olympics and Paralympic Games
Sustain SoCal	Provides cleantech related conferences, workshops and other events for all regional stakeholders
The Governor's Office of Business and Economic Development (GO-Biz)	Works to accelerate deployment of ZEV infrastructure and has developed plans to meet the state's 2030 goals.
Sustainable Communities and Climate Protection Act (SB 375)	Under this Act, CARB sets GHG emission standards and each region must prepare a corresponding Sustainable Communities Strategy (SCS) as a component of its transportation plan
Clean Miles Standard and Incentive Program (SB 1014)	CARB and CPUC will create new emissions standards for the transportation industry to reduce GHG emissions

Appendix: Data Tables

Exhibit A-2: EV Employment by Industry, California

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Utilities	4,528	7,899	7,516	6,948	7,003	6,970	7,022	7,091	7,095
Construction	37,180	54,070	48,593	48,438	50,810	55,054	58,425	63,587	63,818
Manufacturing	31,957	36,417	35,354	32,409	32,382	31,963	32,530	32,912	32,921
Transp. and Wholesale Trade	22,915	23,789	24,799	26,672	27,539	28,184	28,714	29,017	29,007
Retail Trade	15,076	14,151	14,228	14,057	14,360	14,696	14,968	15,675	15,674
Prof. Svcs.	41,596	43,279	43,713	45,295	47,255	48,700	49,964	50,958	50,964
Management	47,464	50,022	48,938	49,289	50,211	52,349	54,237	55,759	55,804
Personal Services	8,250	9,069	9,045	9,231	9,517	9,694	10,056	10,121	10,123
Tech, Educ and Other	13,757	11,608	11,712	11,826	10,509	10,491	10,434	10,169	10,230
Total	222,723	250,304	243,899	244,164	249,586	258,099	266,350	275,290	275,637

Appendix: Data Tables

Exhibit A-1: EV Employment by Industry, Southern California

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Utilities	2,036	3,576	3,374	3,045	3,062	3,462	3,262	3,024	2,981
Construction	16,107	23,466	20,863	20,777	21,898	30,115	27,278	26,457	27,958
Manufacturing	16,557	18,671	18,143	16,623	16,364	18,763	18,118	16,451	16,101
Transp. and Wholesale Trade	11,277	11,523	11,731	12,319	12,494	11,523	11,731	12,319	12,494
Retail Trade	2,674	2,506	2,505	2,523	2,644	2,934	3,077	3,198	3,443
Prof. Svcs.	16,456	17,070	17,169	17,861	18,217	18,728	18,086	18,301	19,209
Management	24,364	25,316	24,419	24,287	24,375	28,977	27,029	26,307	26,319
Personal Services	872	940	997	550	565	2,913	2,696	4,612	4,743
Tech, Educ and Other	6,229	5,269	5,296	5,245	5,242	5,925	6,295	5,813	5,909
Total	96,572	108,338	104,497	103,230	104,860	123,339	117,571	116,481	119,157



BYD Motors

Appendix: Data Tables

Exhibit A-3: Southern California EV Employment by Occupational Group, 2018-2023

SOC	Occupational Group	2018	2023	Openings	EV Wage	All Industry Wage
11-0000	Management Occupations	7,988	10,768	2,181	\$121,827.67	\$174,452.85
13-0000	Business and Financial Operations Occupations	8,274	10,404	2,338	\$81,866.67	\$75,817.09
15-0000	Computer and Mathematical Occupations	4,591	6,077	1,388	\$96,988.13	\$91,119.93
17-0000	Architecture and Engineering Occupations	4,297	6,116	1,343	\$90,053.23	\$86,509.90
19-0000	Life, Physical, and Social Science Occupations	1,269	1,648	397	\$80,561.00	\$77,623.27
21-0000	Community and Social Service Occupations	413	686	130	\$59,285.63	\$58,897.82
23-0000	Legal Occupations	1,626	1,757	471	\$90,438.33	\$99,878.32
25-0000	Education, Training, and Library Occupations	672	1,162	200	\$89,930.00	\$68,679.32
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1,667	2,219	517	\$72,825.48	\$65,757.37
29-0000	Healthcare Practitioners and Technical Occupations	2,070	3,435	620	\$103,832.65	\$88,774.98
31-0000	Healthcare Support Occupations	1,032	1,665	316	\$40,201.18	\$40,401.46
33-0000	Protective Service Occupations	3,315	3,979	679	\$74,665.00	\$51,088.29
35-0000	Food Preparation and Serving Related Occupations	1,034	1,417	323	\$30,176.11	\$30,085.80
37-0000	Building and Grounds Cleaning and Maintenance Occupations	5,689	6,718	1,448	\$45,840.00	\$40,682.81
39-0000	Personal Care and Service Occupations	2,211	3,601	656	\$36,209.13	\$33,352.72
41-0000	Sales and Related Occupations	9,652	11,172	2,561	\$57,821.50	\$60,726.50
43-0000	Office and Administrative Support Occupations	19,752	24,172	5,120	\$44,158.00	\$42,251.58
45-0000	Farming, Fishing, and Forestry Occupations	58	87	13	\$40,597.14	\$38,394.74
47-0000	Construction and Extraction Occupations	19,030	20,495	5,232	\$53,726.10	\$57,222.06
49-0000	Installation, Maintenance, and Repair Occupations	5,345	6,329	1,643	\$54,237.91	\$53,493.86
51-0000	Production Occupations	8,921	15,699	2,720	\$41,159.09	\$41,472.76
53-0000	Transportation and Material Moving Occupations	10,248	12,630	2,788	\$50,694.62	\$40,308.04
	Total	119,157	152,238	33,081		

Glossary

Plug in hybrid electric vehicle (PHEV): typically use batteries to power an electric motor and use another fuel, such as gasoline, to power an internal combustion engine.

Battery electric vehicle (BEV): vehicles with rechargeable batteries and no gasoline engine. Battery electric vehicles store electricity onboard with high-capacity battery packs.³⁷

Fuel cell electric vehicle (FCEV): vehicles powered by hydrogen. FCEVs drive using electricity created on-board from hydrogen and oxygen. Hydrogen is stored in the vehicle as a compressed gas. When running low, a driver fills the tank at a hydrogen fueling station. FCEVs take 5 to 7 minutes to fill and have a range similar to gasoline vehicles (250-400 miles).³⁸

Greenhouse Gas Emissions (GHG): gases including Carbon Dioxide, Methane, Nitrous Oxide, and Fluorinated gases that trap heat in the atmosphere.³⁹



³⁷ "Types of Electric Vehicles: BEV, PHEV AND HEV". 2020. EVgo. Retrieved at <https://www.evgo.com/why-evs/types-of-electric-vehicles/>

³⁸ California Fuel Cell Partnership, Air Climate Energy Water Security. <https://cafcp.org/sites/default/files/W2W-2016.pdf>

³⁹ "Overview of Greenhouse Gases." April 2019. United States Environmental Protection Agency.

Approach and Methodology

Every reasonable effort has been made to ensure that the data contained herein reflect the most accurate and timely information possible and they are believed to be reliable.

The report is provided solely for informational purposes and is not to be construed as providing advice, recommendations, endorsements, representations or warranties of any kind whatsoever.

In order to estimate and forecast employment and wages for what this report has termed the electric vehicle ecosystem, the LAEDC had to draw upon its existing employment forecasting models while relying existing labor force research pertaining to green jobs to create a model for estimating electric-vehicle related employment.

In 2010 and again in 2011, the Bureau of Labor Statistics (BLS) produced a Green Goods and Services (GGS) survey aimed at determining the number of firms and employees at the national and state levels that participated in environmentally beneficial business activities. The BLS defined green jobs as either:

- 1 Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources; or
- 2 Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources.

It was assumed that electric vehicle production and sale, and the production, sale, installation and maintenance of electric vehicle-supporting infrastructure, would fall under the first of the above criteria.

Due to U.S. federal budget sequestration in 2013, the Obama Administration discontinued the GGS, leaving only two years of data regarding green jobs and establishments. However, the BLS had produced an industry matrix at the 6-digit NAICS level that identified the industries the BLS targeted for survey. Therefore, the BLS had left behind a framework for determining potentially green employment. Using the two years of green jobs data and given the growth rate of potentially green, the LAEDC modeled the growth of green jobs between 2010 and 2018.

To estimate the number of green jobs that pertain to electric vehicles, the NAICS codes pertaining to the companies presented in Section 2 were ascertained using Dun & Bradstreet. A NAICS definition for the electric vehicle ecosystem was thereby developed. Using data from the Quarterly Census of Employment Wages (QCEW), employment for this array of industries in which electric vehicle-related employment is hypothesized to exist was determined for 2010 to 2018. To proceed from the green jobs estimates and historical data of EV-identified industries, the relationship between both these data and overall employment, as given by the QCEW, was modeled. This allowed the creation of a conversion matrix to proceed from the NAICS definition to employment estimates from 2010 to 2018.

Forecasts for the electric vehicle ecosystem, both industrial and occupational, were produced using the LAEDC's regional forecast matrix in conjunction with historical trends for the electric vehicle ecosystem to produce estimates for the growth of the ecosystem between 2018 and 2023.

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Chart Data Sources

Exhibit ES-2 Source: CA DMV, U.S. Dept. of Energy; Estimates by LAEDC

Exhibit ES-3 Source: Estimates by LAEDC

Exhibit 6-1 Source: National Renewable Energy Laboratory, IHS Markit

Exhibit 1-2 Source: Source: DMV Registration Data; Estimates by LAEDC.

Exhibit 1-3 Source: Source: CA DMV, EVAdoption.com; Estimates by LAEDC

Exhibit 3-1 Source: Source: California Air and Resources Board, Clean Vehicle Rebate Project

Exhibit 3-2 Source: Source: California Air and Resources Board, Clean Vehicle Rebate Project

Exhibit 3-3 Source: Source: DMV Registration data; Estimates by the LAEDC

Exhibit 3-4 Source: California Air and Resources Board

Exhibit 3-5 Source: California Air and Resources Board

Exhibit 3-6 Source: California Air Resources Board

Exhibit 3-7 Source: EPA

Exhibit 3-8 Source: California Air and Resources Board

Exhibit 3-9 Source: California Air and Resources Board

Exhibit 4-1 Source: Source: Dun & Bradstreet, BLS; Definition by LAEDC

Exhibit 4-2 Source: Estimates by LAEDC

Exhibit 4-3 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-4 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-5 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-6 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-9 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-10 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-11 Source: ACS; Estimates by LAEDC

Exhibit 4-12 Source: ACS; Estimates by LAEDC

Exhibit 4-13 Source: BLS OES; Estimates by LAEDC

Exhibit 4-14 Source: BLS OES; Estimates by LAEDC

Exhibit 4-15 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-16 Source: BLS QCEW; Estimates by LAEDC

Exhibit 4-17 Source: BLS QCEW

Exhibit 5-1 (Cost) Source: The International Council on Clean Transportation, 2019

Exhibit 5-1 (Price) Source: The International Council on Clean Transportation, 2019

Exhibit 5-2 Source: California Clean Vehicle Rebate Project, 2019

Exhibit 6-2 Source: California Clean Vehicle Rebate Project, 2019



FOR MORE INFORMATION

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