



# ELECTRIFYING CALIFORNIA: ECONOMIC POTENTIAL OF GROWING ELECTRIC TRANSPORTATION

COMPANIES, JOBS, GROWTH RATES, AND  
OPPORTUNITIES AS ELECTRIFICATION ACCELERATES

---

Prepared by BW Research Partnership

April 2021

**The Power  
of Now** 



**ADVANCED  
ENERGY  
ECONOMY**

San Francisco | Washington, D.C. | Boston

[aee.net](http://aee.net) | [powersuite.aee.net](http://powersuite.aee.net) | [@aeeenet](https://twitter.com/aeeenet)

# ACKNOWLEDGMENTS

This report was prepared for Advanced Energy Economy by BW Research Partnership. BW Research is a full-service consulting and research firm specializing in workforce and economic development for public entities, including workforce investment boards, economic development agencies, cities, counties, and educational institutions.

BW Research has substantial experience developing customized research projects and a deep understanding of the clean energy sector and its employers, workforce, and supply chain dynamics. BW Research has designed and conducted more than 500 studies for public, private, and not-for-profit organizations globally, and our projects have directly impacted federal, state, and local initiatives. Our research, employer engagement, ideation services, and facilitation have produced tangible results across the world.

## Lead Author

**Philip Jordan, Vice-President | BW Research Partnership**

Philip Jordan is the Vice-President of BW Research Partnership, a global leader in research and evaluation services. Mr. Jordan is a fellow at the Ash Center at Harvard University, where he focuses on globalization and digital transformation and its impact on the future of work. He is on the boards of several nonprofit organizations in the United States and has specific experience internationally, as he is on the faculty of China Programs at the Harvard Kennedy School of Government and is a consultant to the Business Incubator and Accelerator Company (BIAC), a quasi-public innovation entity in Saudi Arabia, to conduct asset mapping and expand opportunities for growth of various supply chains.

Mr. Jordan is co-author of the annual U.S. Energy and Employment Report, the landmark study that quantifies job creation, supply chain growth and development, and transition in the U.S. energy sector (the report was commissioned by the U.S. Department of Energy and is now overseen by the private sector); The Solar Foundation's annual Solar Jobs Census; Energy Efficiency Employment in Canada for Natural Resources Canada; and numerous federal, state, and local studies on innovation, economic growth, and workforce development related to energy.

## About Advanced Energy Economy

Advanced Energy Economy (AEE) is a national association of businesses that are making the energy we use secure, clean, and affordable. AEE is the only industry association in the U.S. that represents the full range of advanced energy technologies and services, both grid-scale and distributed. Advanced energy includes energy efficiency, demand response, energy storage, wind, solar, hydro, nuclear, electric vehicles and more. AEE's mission is to transform public policy to enable rapid growth of advanced energy businesses. Engaged at the federal level and in more than a dozen states around the country, AEE represents more than 100 companies in the \$240 billion U.S. advanced energy industry, which employs 3.2 million U.S. workers. Learn more at [www.aee.net](http://www.aee.net) and follow the latest industry news @AEEnet.

# EXECUTIVE SUMMARY

Advanced Energy Economy engaged BW Research Partnership to examine the economic and job potential for development of the Electric Transportation (ET) industry in California, focusing on opportunities for businesses and workers to benefit from the evolving automotive supply chain as the industry goes electric. Market trends and political tailwinds suggest ET in California is poised to see a tremendous expansion in the coming years. California is already well-positioned for this growth, with well-established design and manufacturing firms operating at the cutting-edge and producing goods that combine sophisticated software and hardware. This report helps illuminate the current state of the ET economy in California, underscoring the current strengths, challenges, and opportunities as the sector continues to grow.

This study begins with an overview of the current ET supply chain, including the current number of jobs and businesses involved in ET, historical growth rates, and projections of near-term growth. The research then discusses “Adjacent Industries and Occupations”, which are firms and workers that are generally not currently involved with ET goods or services but have characteristics similar to those that are. Examining Adjacent Industries is useful for identifying existing companies and workers that could transition from one industry to another with relative ease. This analysis is also useful in highlighting some industries that may benefit from increased demand for their products driven by the rise in ET.

For the purposes of this research, the ET supply chain includes any firm involved in the manufacturing, wholesale distribution, retail sale, installation, research and development, and maintenance of electric vehicles (EVs) and equipment (including automobiles, light and heavy-duty trucks, buses, industrial equipment, agricultural equipment, rail, recreational vehicles, and other ET component parts (including battery, motor controller, electric engine, regenerative braking, and drive system components), and the infrastructure necessary for ET (including charging stations and associated storage and component parts). For companies that are engaged in both ET and non-ET related work, the estimates here are for ET activities only. Also, other zero-emission vehicle (ZEV) platforms, such as hydrogen vehicles, are not part of this study, nor is any direct employment at electric utilities.

BW Research developed a database of 21,000 California businesses potentially involved in the ET supply chain. BW Research then closely examined 4,500 companies within the database to determine if they were involved in ET-related activity. Manufacturing operations were prioritized, as manufacturing is often much more labor-intensive per measure of output, possesses greater overall economic impact than most other sectors, and has the greatest potential to create net new jobs by giving existing manufacturers of inputs and components an opportunity to expand their product lines.



## Key Findings

The key findings and the data presented throughout this report suggest that California is primed to continue leading the country in the design and development of ET goods and services. The continued growth of the ET sector will drive job growth across the state for a variety of workers with a range of educational attainment and skillsets, while also helping the state meet its climate and EV deployment goals.

**With an estimated 3,900 ET-related businesses in 2019, California is the leading state in electric transportation. Moreover, ET jobs can be found across the state.** ET-related jobs are in 55 of the 58 counties across the state. While many of these jobs are concentrated in a few counties, there are high numbers of ET workers around the state, including the Bay Area, Capital Region, and Southern California. Outside these areas, counties with a high concentration of ET workers are San Bernardino, San Joaquin, Riverside, and Yolo counties.

**The ET workforce is projected to see strong growth.** As the central production hub for the most popular electric vehicles (EVs) on the market today, ET employment in California should track closely with increasing EV sales. Currently, there are an estimated 35,000 ET-related workers in California and projected to add another 33,000 jobs by 2024.

**ET activity accounted for \$4.5 billion in Gross State Product (GSP) in 2019.** This is about equivalent to the GSP contributions of industries like General Automotive Repair, Semiconductor Machinery Manufacturing, and Breweries industries in the state.

**There are a range of occupations and skillsets needed for ET work in California.** The design and production of both software and hardware for ET goods means that a wide variety of workers with an array of skills are needed. This means growth in ET jobs presents a range of opportunities for a broad subset of workers.

**California has a robust and growing workforce in Adjacent and Support Industries.** This finding suggests that California already has a substantial talent pool and established talent pipelines in place to educate and train additional workers as the demand for ET goods and services increases. Many of these industries—such as Semiconductor and Related Device Manufacturing and Other Electronic Component Manufacturing—stand to see increases in demand for their products as ET requires these goods in higher volumes than non-electric transportation. A total of 573,000 workers in Adjacent and Support Industries have skills that would allow them and the companies they work for to transition to ET-related work with relatively little training or upskilling required.

**Secondary Adjacent and Support Industries face the challenge of an aging workforce, but there are several training and education programs geared towards ET workforce development.** The workers in these industries are disproportionately older than the general working population in California. This suggests that these industries may face worker shortages as workers begin to reach retirement age, creating new opportunities for younger and underrepresented workers to join a growing industry. Current training and



education programs span the design, development, manufacture, repair, and installation of ET and charging infrastructure. The state would benefit from expanding access to training and education and should focus in on rural and central valley regions.

**Establishing long-term policy and market certainty will help the state retain its leading position in ET jobs and economic benefits.** Codifying robust zero-emission vehicle and infrastructure targets will send strong signals to companies to invest in California. Tracking progress and key workforce trends will help the state to better understand how policies can be adjusted to respond to the rapidly evolving ET industry. Policy development should also be done in way that supports quality jobs for all Californians.

**The Salton Sea presents an opportunity to expand the California ET economy into a new industry.**

Lithium, a metal that is an essential component in most batteries used in ET, can be found in high concentrations in the Salton Sea brine and several ventures are currently experimenting with extraction methods. If lithium extraction proves viable, lithium mining could bring numerous jobs to the region.



# TABLE OF CONTENTS

Acknowledgments ..... i

Executive Summary .....ii

Introduction ..... 1

Electric Transportation and California ..... 3

The California Electric Transportation Workforce ..... 6

Impacts of COVID-19..... 12

Key Trends in California ..... 13

Adjacent Industry Analysis..... 16

    Immediate Adjacent Manufacturing Industries..... 17

    Secondary Adjacent Manufacturing Industries ..... 20

    Support Industries ..... 25

Workforce Demographics ..... 29

Training Inventory..... 35

Conclusion ..... 40

Appendix A: Methodology ..... 41

    Employment and GSP ..... 41

    Data Collection..... 41

Appendix B: ET Training Inventory..... 43

Appendix C: Industry Group Definitions ..... 45

Appendix D: Glossary of Terms..... 48

Appendix E: ET-Employment by Congressional District..... 53

Appendix F: Automotive Manufacturing Training Programs ..... 54





# INTRODUCTION

Advanced Energy Economy commissioned BW Research Partnership to examine the scale of the Electric Transportation (ET) supply chain in California. This examination includes quantifying existing companies and the workforce that support them, as well as a forward-looking section focused on adjacent industries that could benefit from increased ET activity in the state. For the purposes of this study, the ET sector is defined as any firms involved in the manufacturing, wholesale distribution, retail sale, installation, research and development, maintenance and repair of ET vehicles and equipment (including automobiles, light and heavy-duty trucks, buses, industrial equipment, agricultural equipment, rail, recreational vehicles, and other ET), component parts (including battery, motor controller, electric engine, regenerative braking, and drive system components), and the infrastructure necessary for ET (including charging stations and associated storage and their component parts).

To develop the data for this report, BW Research developed a comprehensive database of 21,000 firms potentially involved in ET work. BW Research closely examined nearly 4,500 companies within this dataset, prioritizing manufacturing operations. BW Research confirmed 240 firms with 254 unique locations with current involvement in the ET sector. Based on this sample, BW Research estimates that there are 3,900 businesses involved in some form of ET-related activity across the state.

While the ET sector in California is one of the most developed in the country, the broader industry continues to develop and evolve. The dynamic nature of the ET sector emphasizes the importance of understanding the current scale, workforce, and opportunities for continued growth and development. To capture some of this potential for growth, this report identifies the industries, companies, and workers that could readily transition to and benefit from an expanding ET market. Throughout this report, these areas of opportunity are referred to as “Adjacent” Industries and Occupations. Adjacent Industries provide similar goods or services and have workers who, along with Adjacent Occupations, often have overlapping knowledge, skills, and abilities to those currently involved in ET.<sup>1</sup>

## Sample of ET Companies in California

- ABB
- BYD Corp
- ChargePoint
- Cohu Incorporated
- CoorsTek
- EnelX
- EDF Renewables
- Green Electric Solutions
- Infineon Technologies America Corporation
- Linear Technology
- Orange EV
- Platt Electric Supply
- Rivian Automotive
- Safeway Electric
- Tesla

---

<sup>1</sup> The Adjacent Industries identified in this report currently have little to no involvement in ET activities, but their workers have skill sets that would allow them to move into the ET supply chain with relatively little training and transition with relative ease. Adjacent Occupational analyses focus on the types of workers that are most common within Adjacent Industries.

As the ET sector in California grows, much of this growth is expected to primarily transition, rather than expand, the demand for transportation workers, goods, and services. For example, among service centers, dealerships, and some parts wholesalers and distributors, non-ET employment is expected to transition to ET-related employment rather than generate new and additional roles. However, the opportunity for new jobs and business creation exists among the design and manufacturing of ET products. In California, Automobile Manufacturing, Other Electronic Component Manufacturing, and Semiconductor and Related Device Manufacturing present substantial opportunities to drive creation of new jobs and business. These, and other industries highlighted throughout this report, are poised to grow with ET but are relatively unaffected by declining sales of traditional vehicles, as many of these firms are not involved in traditional transportation. This report emphasizes these Adjacent Manufacturing Industries because they represent the most potential for net job creation in California.

There are three types of Adjacent Industries identified in this report:

**Immediate Adjacent Manufacturing Industries** include companies that are very similar to those identified as ET companies. They are so similar that they share a federal industry classification code (six-digit NAICS). Transition to ET-related work would be most rapid for companies in Immediate Adjacent Manufacturing Industries. Examples of Immediate Adjacent Manufacturing include General Automobile Manufacturing<sup>2</sup>, Motor and Generator Manufacturing, and Other Electronic Component Manufacturing.

**Secondary Adjacent Manufacturing Industries** include companies that are similar to existing ET companies, but less so than Immediate Adjacent Manufacturing Industries. These companies engage in the same general family of activities, but their transition to ET work would take more investment and time than for the Immediate Adjacent Manufacturing Industries. Examples of Secondary Adjacent Manufacturing Industries include Relay and Industrial Control Manufacturing; Semiconductor and Related Device Manufacturing; and Power, Distribution, and Specialty Transformer Manufacturing.

**Support Industries** include companies that are upstream suppliers to companies in Adjacent Industries.<sup>3</sup> These include manufacturers as well as distributors and wholesalers. Growth in the ET market might require changes in operations, but as these firms tend to focus on raw materials and upstream components, those changes are likely to be minimal. These Support Industries are expected to strongly benefit from the growth of the California ET supply chain. Examples include Plate Work Manufacturing, Iron and Steel Mills and Ferroalloy Manufacturing, and Machine Shops.

---

<sup>2</sup> Throughout this report, industries and occupations that are capitalized refer to specific titles in the North American Industry Classification System (NAICS) and Standard Occupational Classification (SOC), respectively. For definitions of these industries and occupations, please see the Glossary in Appendix D.

<sup>3</sup> Support industries do provide some raw materials to existing ET firms, but the small size of the current market has minimal relative impact.





# ELECTRIC TRANSPORTATION AND CALIFORNIA

California is currently a leader in ET and has recently strengthened its lead. In September 2020, Governor Gavin Newsom signed an executive order signaling the state's commitment to achieve 100% light-duty zero-emission vehicle sales by 2035 and a fully zero-emission medium and heavy-duty fleet by 2045.<sup>4</sup> A month later, the California Energy Commission (CEC) released a 2020-2023 Investment Plan for the Clean Transportation Program, which earmarks \$133 million for light-duty EV charging systems and an additional \$130 million primarily for charging systems for medium- and heavy-duty vehicles. These policies will bolster California's leadership role in the EV space. Of the 1.5 million EVs<sup>5</sup> that have been sold nationwide, about 733,600 of those sales have been in California. Consequently, California leads the nation in cumulative EV market share; about 5% of the light-duty vehicles on the road in California are EVs compared to the next-highest states of Washington (2.9%) and Oregon (2.6%) and 1.3% nationally.<sup>6</sup>

Charging infrastructure deployment is similarly progressing in California. The state currently has an estimated 57,000 Level 2 chargers and 4,900 DC fast chargers publicly available, and current funding plans are expected to contribute to the installation of an additional 117,000 Level 2 chargers and 4,300 DC fast chargers by 2025.<sup>7</sup> Alongside charging infrastructure vendors like ChargePoint, Tesla, Powerflex, and Enel X, utilities are joining the effort as key partners. The California Public Utilities Commission has already authorized utilities to invest approximately \$1.5 billion to support California's charging infrastructure needs, including upgrading current distribution systems, and other complementary initiatives. These efforts are complemented by the CEC to reach the state's goal of 250,000 electric vehicle chargers by 2025.<sup>8</sup> In order to achieve the state goals established in Governor Newsom's executive order, the CEC estimates that approximately 1.5 million chargers will be needed to meet charging demand, simultaneously presenting a challenge and significant economic opportunity to rapidly deploy a strategic network of charging infrastructure across the state.<sup>9</sup>

With the current trajectory of state and local policy commitments, California's existing robust ET workforce and strong and growing demand for ET goods primes the ET economy in California for a bright future.

---

<sup>4</sup> Executive Order N-79-20. <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-text.pdf>

<sup>5</sup> Including Battery-Electric Vehicles (BEVs) and Plug-in-Hybrid Electric Vehicles (PHEVs).

<sup>6</sup> Alliance of Automobile Manufacturers (2019). Advanced Technology Vehicle Sales Dashboard. Data compiled by the Alliance of Automobile Manufacturers using information provided by IHS Markit (2011-0218) and Hedges & Co. (2019). Data last updated 8/20/2019. Data retrieved February 22, 2020 from <https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/>

<sup>7</sup> "2020-2023 Investment Plan Update for the Clean Transportation Program." California Energy Commission. <https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/clean-transportation-program-investment-5>

<sup>8</sup> Ibid.

<sup>9</sup> Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment. <https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127>



# POLICY RECOMMENDATIONS

In order to spur the EV market and support the industry's growing workforce, California has the opportunity to take action now. The state is already a leader in developing and implementing a suite of complementary policies to accelerate the deployment of EVs through incentives, regulations, and other supportive initiatives. It can now build off that leadership with four complementary actions, thereby ensuring that California's economy and workforce continue to benefit from transportation electrification:

- **Establish long-term policy and market certainty:** Fluctuating policies and incentives can introduce business risk that dampens investment in technologies and workforce development needed to support EVs. Clear, durable market signals from the Governor's Office, California Legislature, and state agencies will help ensure California remains a global EV leader as the industry continues to mature. Efforts like Governor Newsom's proposed 2021-2022 State Budget – which includes \$1.5 billion in equitable investment toward zero-emission vehicles and infrastructure over several years – would beget the long-term market certainty needed to fuel California's advanced transportation industry and attract new investment to the state.
- **Continue to create High Road opportunities to grow California's EV workforce:** Developing a skilled workforce should be considered an investment – not a cost.<sup>10</sup> California should continue to explore opportunities to leverage public funding toward EVs and infrastructure in a manner that reasonably supports inclusive, quality jobs for all Californians.
- **Track progress and key workforce trends:** With an industry that is evolving as rapidly as electric transportation, California should take the opportunity to regularly track key opportunities, challenges, and metrics – like the ones captured in this report – associated with growing the EV workforce. Policies that encourage frequent data collection and reporting among the state's energy, transportation, and economic development agencies would give market players a clear view into how the industry is evolving and what trends to anticipate as the EV industry continues to mature.
- **Codify robust zero-emission vehicle and infrastructure targets:** Executive Order N-79-20 sets nation-leading targets to move California toward 100% zero-emission vehicle sales for light-duty vehicles and toward a fully zero-emission medium and heavy-duty vehicle fleet. The CEC's inaugural AB 2127 report also provides a preliminary estimate of the levels of EV charging infrastructure needed to support California's zero-emission vehicle targets. California should seek to codify the zero-emission vehicle goals in Executive Order N-79-20, begin the regulatory processes required to implement these vehicle goals and establish infrastructure targets that align with the CEC's ongoing EV charging infrastructure demand analyses.

---

<sup>10</sup> California Workforce Development Board, *A Jobs and Climate Action Plan for 2030* at ii, available at: <https://laborcenter.berkeley.edu/wp-content/uploads/2020/09/Putting-California-on-the-High-Road.pdf>



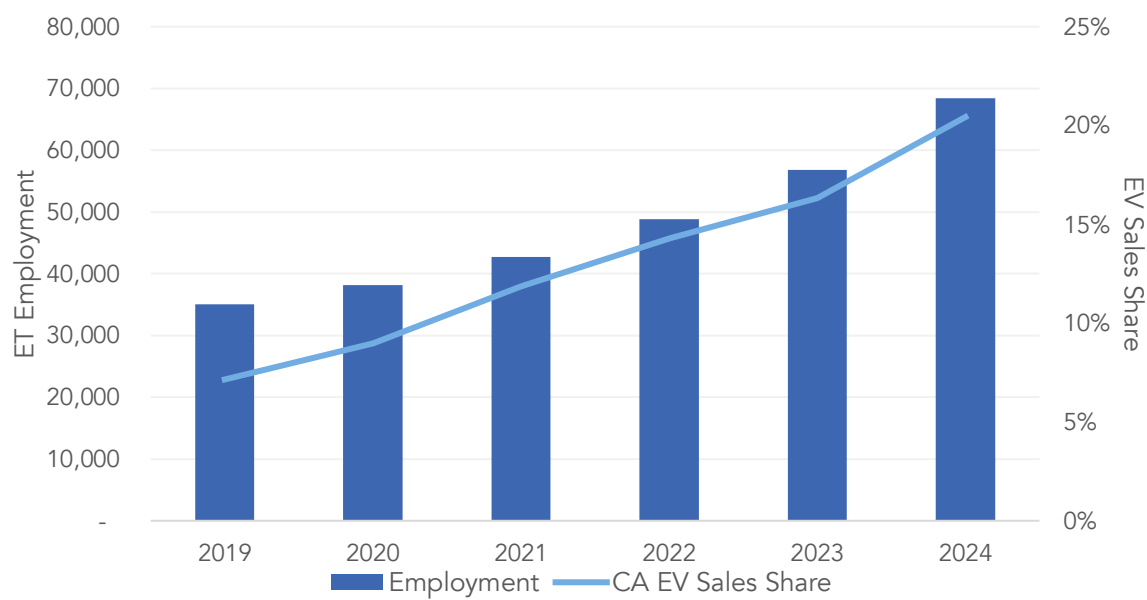
Given the importance of electric transportation to California's economic, climate, and transportation future, the state should move quickly to bolster its EV industry and continue to lead the country's decarbonization efforts. Without concrete action, California risks ceding ground and economic opportunities to other states and countries making significant vehicle, infrastructure, and supply chain investments. Fortunately, California is well-positioned to compete and ensure the benefits of its advanced transportation industries are accessible to workers across the state.



# THE CALIFORNIA ELECTRIC TRANSPORTATION WORKFORCE

California is projected to see ET-related employment grow 79% between 2020 and 2024.<sup>11</sup> ET-related employment in California is estimated to have grown by nearly 7,700 jobs between 2019 and 2021, bolstered by an increase in EV share of annual sales despite the disruptions caused by the COVID-19 pandemic. A continued trend of strong growth in EV sales is projected to support a large expansion of the manufacturing ET workforce in California, bringing the estimated number of ET-related workers in California to about 68,400 by 2024, roughly twice the number of jobs in the Natural Gas Distribution industry (Figure 1).

Figure 1: Projected ET Employment and Share of Electric Vehicles (EVs) Sales<sup>12 13</sup>



ET-related jobs are in 55 of the 58 counties in California. Alameda, Los Angeles, Orange, San Bernardino, and Riverside counties have the greatest number of ET-related workers. The fifty remaining counties with ET-related jobs still account for a substantial portion of the ET-related workforce with nearly 7,600 workers (Figure 2).

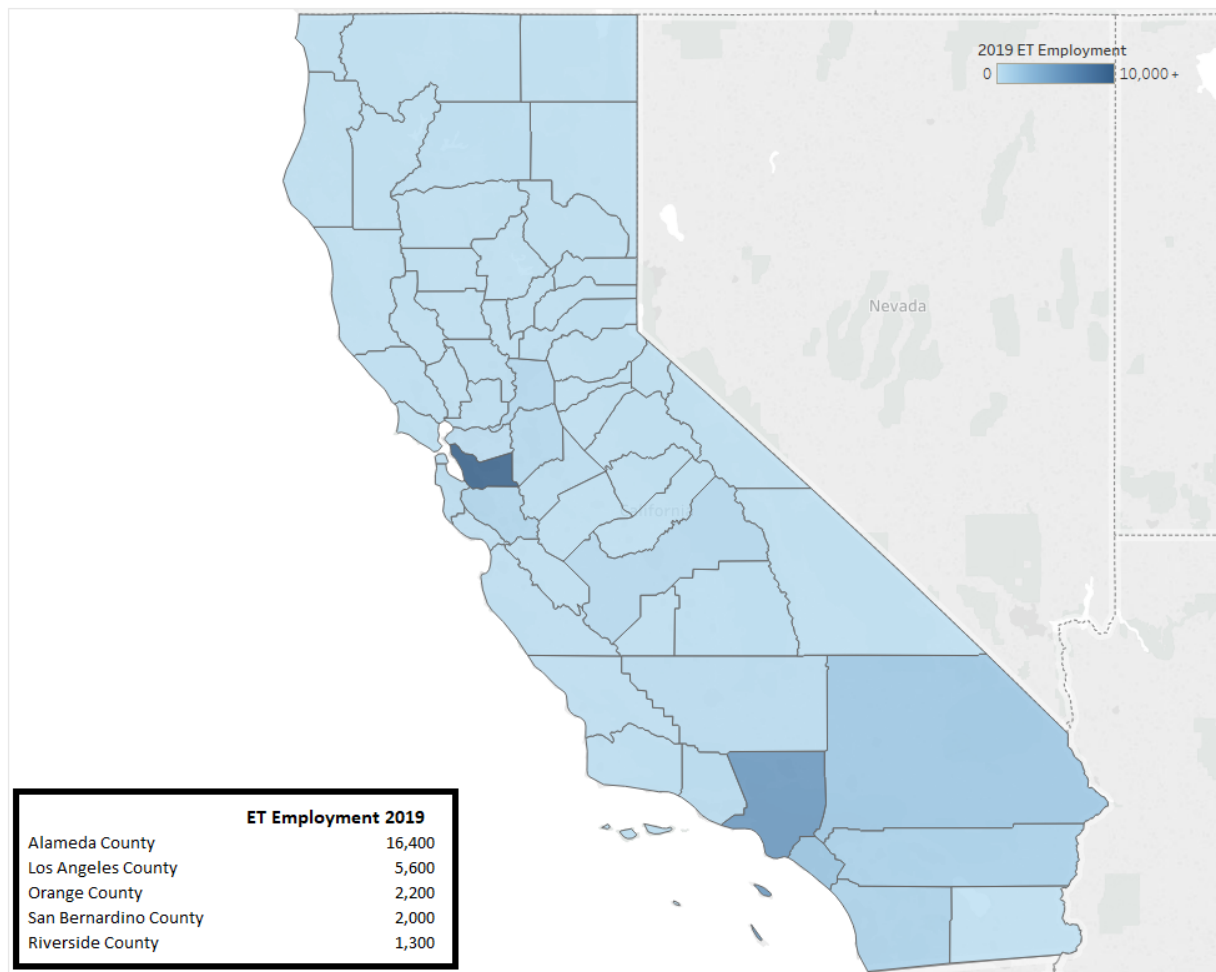
<sup>11</sup> This definition is based on a worker spending any time on electric transportation goods or services.

<sup>12</sup> This definition includes Battery-Electric Vehicles (BEVs) and Plug-in-Hybrid Electric Vehicles (PHEVs).

<sup>13</sup> Project share of EV sales in CA is from EVAdoption. <https://evadoption.com/ev-sales/ev-sales-forecasts/>

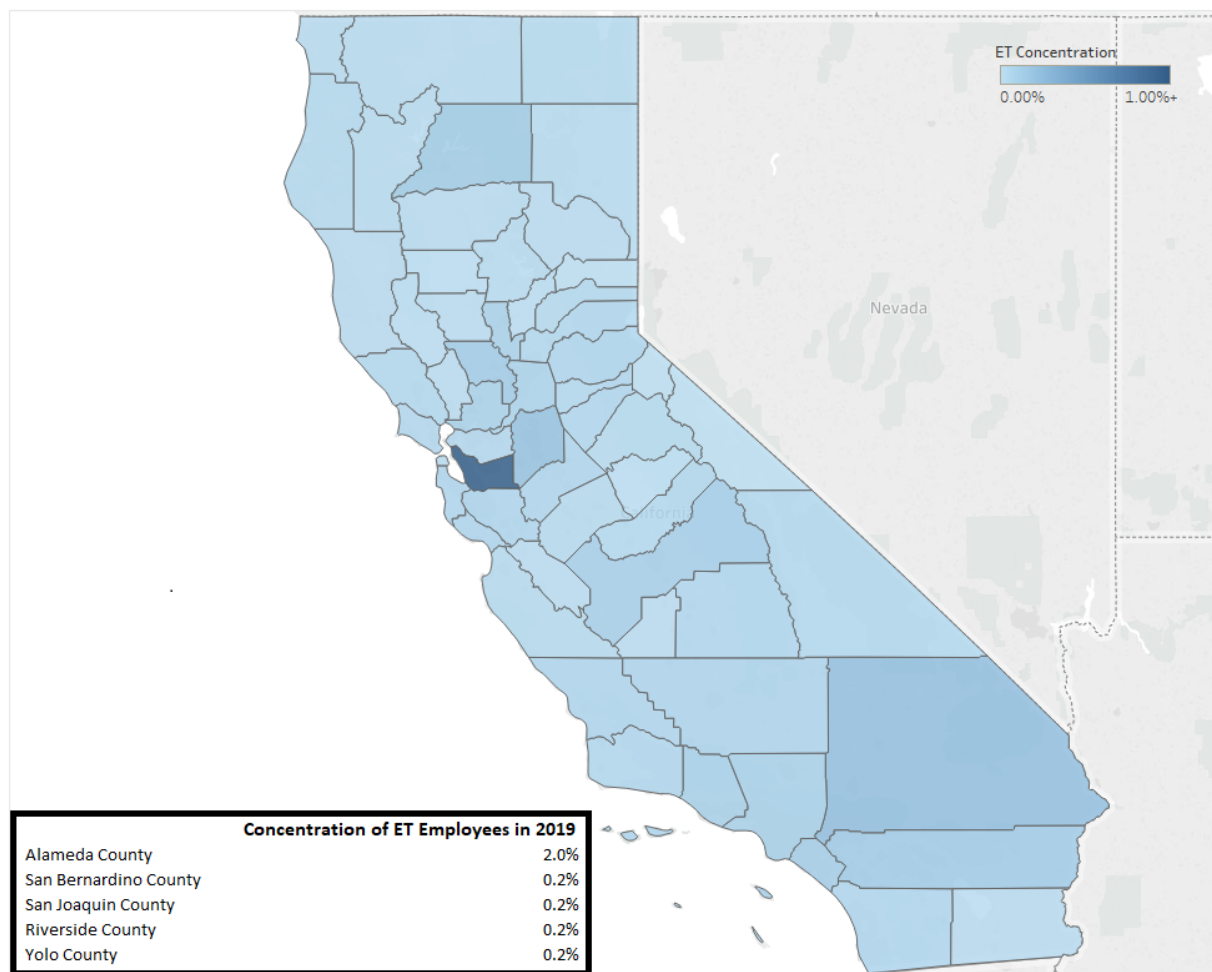


Figure 2: ET-Related Employment, 2019



ET-related jobs account for a significant portion of the workforce in many counties throughout the state. Alameda County has the greatest concentration of ET-related employment, with about 2 out of every 100 jobs in the county involving some ET work. Other counties with a high concentration of ET workers are San Bernardino, San Joaquin, Riverside, and Yolo counties (Figure 3).

Figure 3. Concentration of ET-Related Employment



**ET-related Gross State Product (GSP) in California was estimated to be more than \$4.5 billion in 2019.** This is about equivalent to the GSP contribution of General Automotive Repair firms, Semiconductor Machinery Manufacturing, and Breweries. Motor Vehicle Manufacturing<sup>14</sup> was the greatest contributing factor to ET-related GSP, accounting for more than \$1.77 billion in GSP. Other General Purpose Machinery Manufacturing and Engine, Turbine, and Power Transmission Equipment Manufacturing were also among the largest contributors to ET-related GSP.

<sup>14</sup> This industry includes manufacturing of motor vehicles, automobiles, light truck and utility vehicles, and heavy duty trucks.





**Component and finished goods manufacturing firms are the largest employer of ET-related workers.** These firms account for 56% of all ET-related employment in the state. Wholesale Trade, Distribution, & Transportation accounts for one-fifth (21%) of ET-related employment, or about 7,200 jobs (Table 1).

Table 1: ET-Related Employment by Value Chain

	Employment	Share of Employment
Manufacturing	19,500	56%
Wholesale Trade, Distribution, & Transport	7,200	21%
Repair & Maintenance	4,900	14%
Retail Trade	1,800	5%
Installation	1,100	3%
Professional and Business Services	500	1%

**Key ET occupations have high growth potential.** The eight ET occupations identified in Table 2 account for nearly half (47%) of current ET employment in California. Assemblers and Fabricators account for nearly a third (30%) of current ET employment alone. Nearly all these occupations offer median hourly wages of \$15 an hour or more, and about half offer median wages greater than \$30 per hour (Table 2: Key ET Occupations).



## Company Snapshot

### Enel X

San Mateo County (and others)

Enel X North America designs and engineers its smart charging products in the United States and manufactures them at facilities located in California and in Mexico. All products are designed, engineered, and built with the same commitment to quality. As a subsidiary to the Enel Group, one of the world's largest producers of renewable energy, Enel X is committed to increasing the sustainability of its operations to reach its net-zero carbon goal by 2050.

The Enel X e-Mobility team is primarily located in San Carlos, CA and roles range from product development, engineering, testing and operations in addition to other business functions including sales, marketing and finance. Most of the Enel X e-Mobility customer support team operates out of San Diego, CA primarily working as service representatives.

While a large portion of demand for the Enel X's flagship product, the JuiceBox smart charging station, is in California, the company continues to expand its product portfolio to serve more businesses, fleets and utilities across North America.

Table 2: Key ET Occupations

Key Occupations <sup>15</sup>	2019 ET Jobs	Projected 2024 ET Jobs <sup>16</sup>	Median Hourly Wage
Miscellaneous Assemblers and Fabricators	10,380	19,547	\$15.59
Laborers and Freight, Stock, and Material Movers, Hand	1,475	3,014	\$14.98
Automotive Service Technicians and Mechanics	1,467	2,814	\$22.60
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	970	1,856	\$29.86

<sup>15</sup> Key occupations were identified based on total current employment within ET.

<sup>16</sup> Projected jobs are extrapolated from BLS OES occupational projections through 2024 and ET industry projections developed using data from the 2019 United States Energy and Employment Report, BLS QCEW, and EVAoption.



First-Line Supervisors of Production and Operating Workers	663	1,299	\$30.84
Parts Salespersons	578	1,117	\$16.29
Electricians	466	991	\$31.06
Industrial Engineers	417	855	\$48.52

## Company Snapshot

### EDF Renewables

San Diego County (and others)

EDF Renewables acquired Powerflex in 2019. Powerflex started in 2017, when a group of researchers at CalTech grew frustrated by the lack of available chargers for EV drivers and the exorbitant financial costs of adding multiple additional charging stations to campus. Using existing charging technology at the time, installation of multiple chargers would require upgraded infrastructure that would be cost-prohibitive. To address this challenge, the Powerflex team developed patented technology that allowed multiple EVs to charge simultaneously using existing electrical infrastructure, avoiding expensive infrastructure alterations.

About 40 staff now work on turnkey EV charging solutions, including hardware and software development as well as installation and maintenance. About 20 team members are located in and around Palo Alto, and another 20 are located around EDF Renewables' headquarters in San Diego. While most of the EV charging activity is focused on California, Powerflex has recently expanded some operations along the east coast as nationwide electric transportation continues to grow. The EV charging division currently has multiple new positions open to applicants, a sign of the growth to come.

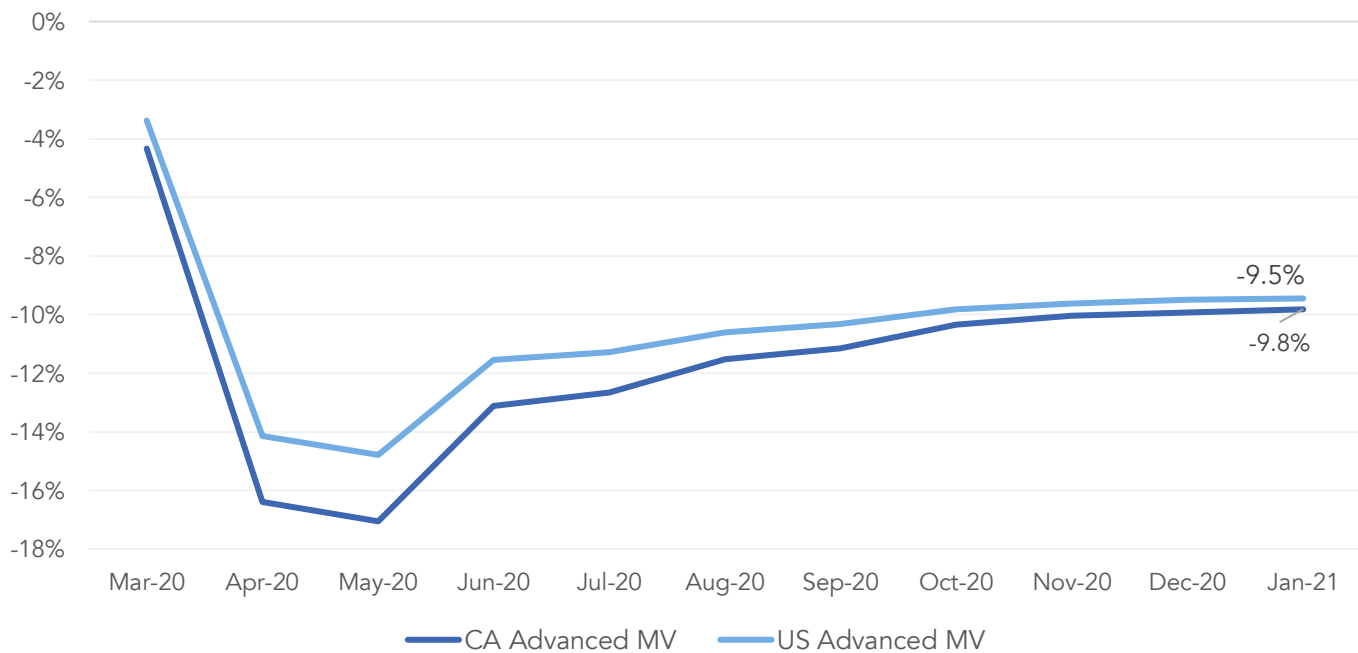
California is the leading state in ET manufacturing, and it is important to note that ET-related growth creates net new jobs in some segments of the economy while minimally impacting others. Among occupations in sales, service, and other downstream jobs, new ET activity is more likely to replace work currently focused on non-ET activities rather than creating new jobs. This results in fewer net new jobs created in downstream roles than in manufacturing. Overall, California's dominance in the design and production of EVs, as well as the design and production of charging infrastructure, make the state and its manufacturing workforce uniquely positioned to benefit from the increased demand for ET.



# IMPACTS OF COVID-19

Advanced Vehicle employment in California declined by nearly 10% between the start of the COVID-19 pandemic and January 2021. Since the early days of the pandemic, BW Research has been tracking the changes in advanced energy employment across the United States.<sup>17</sup> The models developed by BW Research<sup>18</sup> suggest that California employment in advanced vehicles,<sup>19</sup> which includes EVs, declined by nearly 10% (Figure 4). As new COVID-19 cases continue to fall across the state and country, these employment declines can be expected to return to pre-pandemic levels gradually. The Biden administration's recently-announced American Jobs Plan seeks to recover some of these employment losses and foster long-term development in the ET sector; the plan calls for \$174 billion in investment to spur domestic supply chains, retool factories, and promote battery production for EVs.<sup>20</sup>

Figure 4. COVID-19-Related Employment Losses in Advanced Motor Vehicles<sup>21</sup>



<sup>17</sup> [https://www.bwresearch.com/covid/docs/BWResearch\\_CleanEnergyJobsCOVID-19Memo\\_Dec2020.pdf](https://www.bwresearch.com/covid/docs/BWResearch_CleanEnergyJobsCOVID-19Memo_Dec2020.pdf)

<sup>18</sup> [https://www.bwresearch.com/covid/docs/BWResearch\\_CleanEnergyJobsCOVID-19Memo\\_Dec2020.pdf](https://www.bwresearch.com/covid/docs/BWResearch_CleanEnergyJobsCOVID-19Memo_Dec2020.pdf)

<sup>19</sup> This definition includes hybrid electric vehicles, plug-in hybrid vehicles, electric vehicles, natural gas vehicles, hydrogen vehicles, and fuel cell vehicles.

<sup>20</sup> FACT SHEET: The American Jobs Plan. <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/>

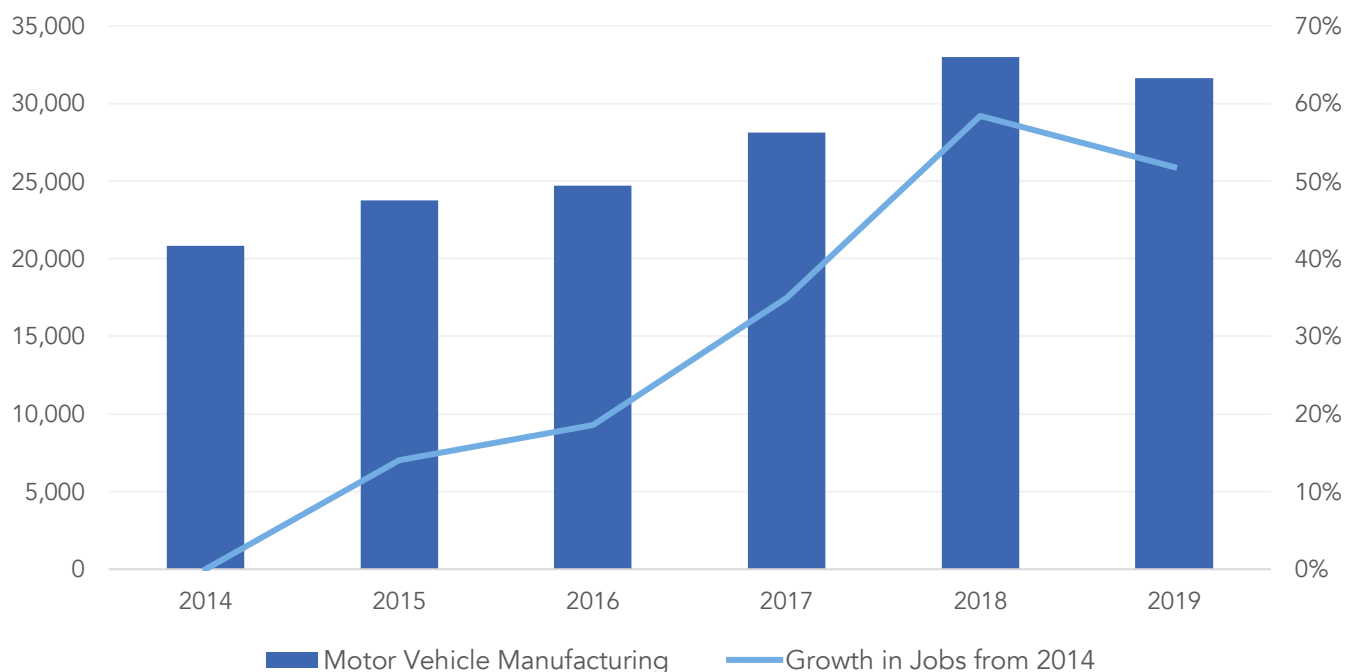
<sup>21</sup> [https://www.bwresearch.com/covid/docs/BWResearch\\_CleanEnergyJobsCOVID-19Memo\\_Dec2020.pdf](https://www.bwresearch.com/covid/docs/BWResearch_CleanEnergyJobsCOVID-19Memo_Dec2020.pdf)



# KEY TRENDS IN CALIFORNIA

EV and Non-EV Motor Vehicle Manufacturing<sup>22</sup> employment in California grew by 52% between 2014 and 2019, representing an additional 10,800 jobs (Figure 5). Tesla's growth in the state helped bolster employment in the more narrowly defined Automobile Manufacturing industry, which accounts for about half (49%) of Motor Vehicle Manufacturing in the state. Other Motor Vehicle Parts Manufacturing and Motor Vehicle Body Manufacturing are other sizable specific industries involved in Motor Vehicle Manufacturing (Figure 6).

Figure 5. Motor Vehicle Manufacturing Employment in California<sup>23</sup>

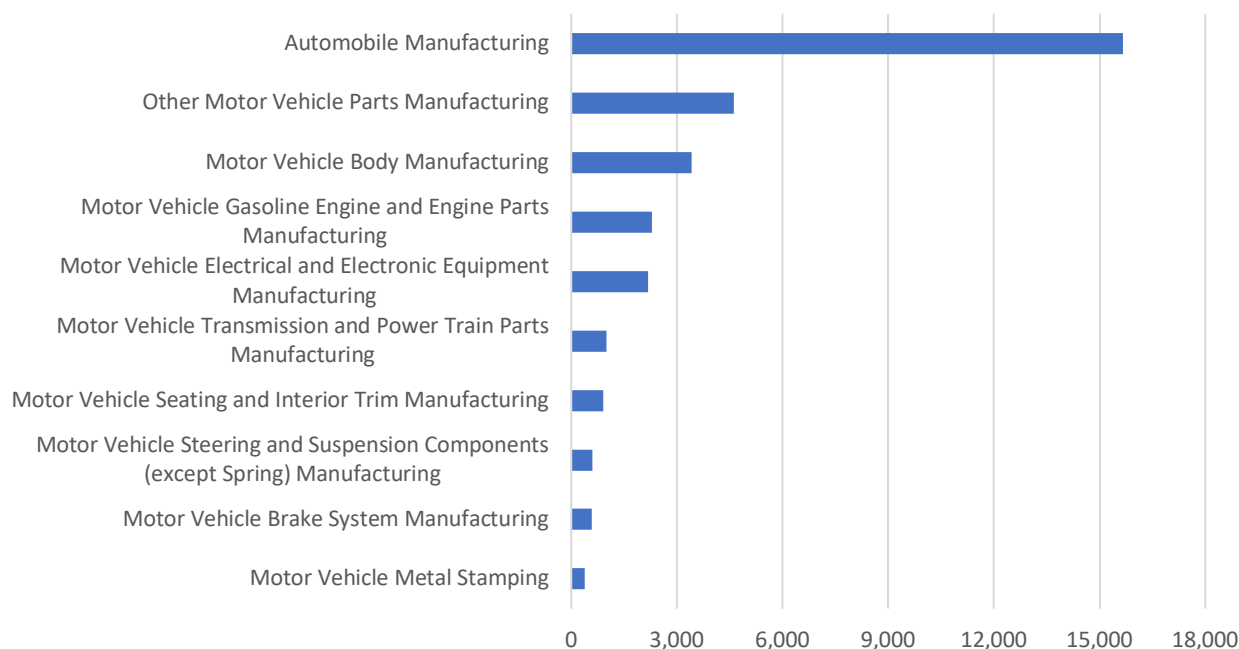


<sup>22</sup> This includes 10 NAICS centered around traditional automobile manufacturing. These NAICS codes are: 336111, 336211, 336310, 336320, 336330, 336340, 336350, 336360, 336370, and 336390.

<sup>23</sup> Ibid.



Figure 6. Motor Vehicle Manufacturing Jobs by Specific Industry, 2019<sup>24</sup>



The market share of Battery-Electric Vehicles (BEVs) and Plug-in-Hybrid Electric Vehicles (PHEVs) in California continues to grow. EVs<sup>25</sup> accounted for more than 2% of all cars on the road in California in 2019, compared to only 0.6% in 2013. In 2019, 145,000 EVs were sold in the state (Figure 7). Despite the slight decline in annual EV sales in 2019 after substantial growth in 2018, the share of EVs on the road continued to grow between 2018 and 2019. Continued growth in market share means that California's automotive fleet continues to electrify every year.

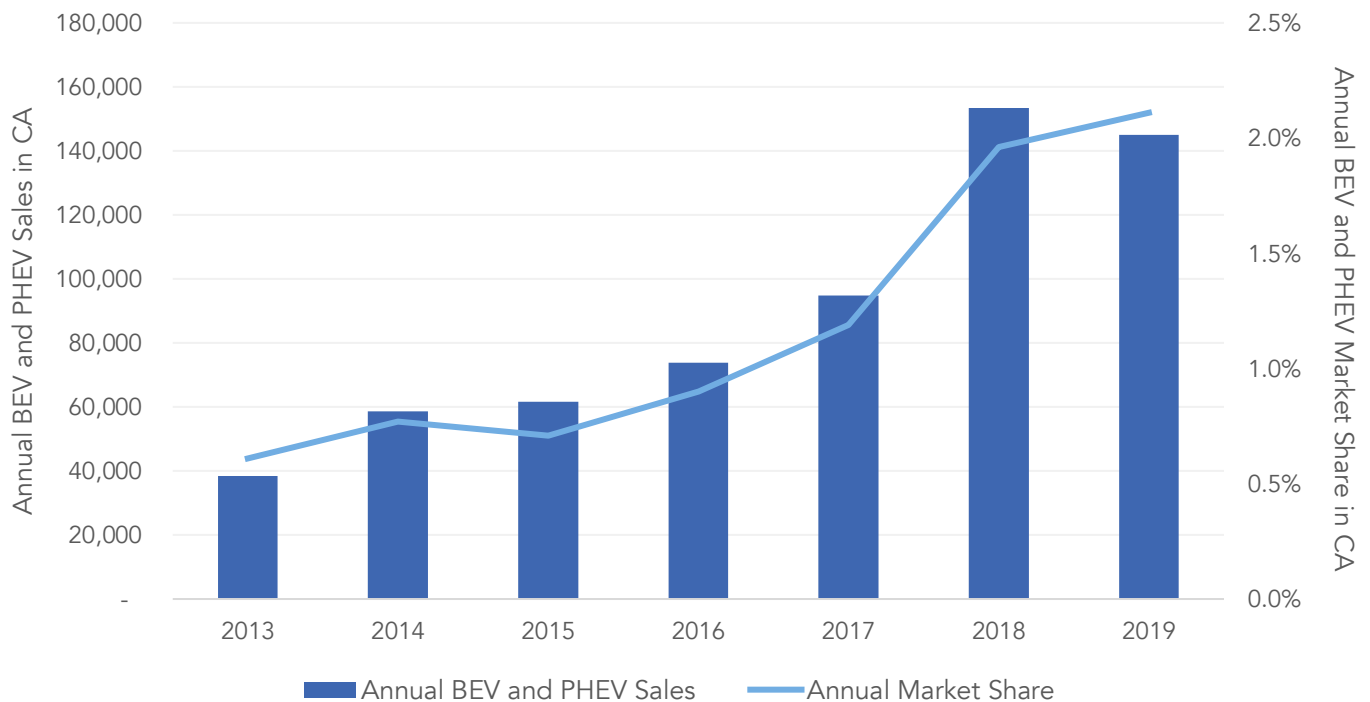
<sup>24</sup> Sub-industry by six-digit NAICS code. Emsi 2020.4

<sup>25</sup> Including Battery-Electric Vehicles (BEVs) and Plug-in-Hybrid Electric Vehicles (PHEVs).





Figure 7. Annual Sales and Annual Market Share of EVs in California<sup>26</sup>



<sup>26</sup> Includes BEV (Battery electric vehicles, which run exclusively on electric fuel) and PHEV (Plug-in hybrid electric vehicles, which run on either or both gasoline and electric fuel). Data from: Alliance of Automobile Manufacturers (2019). Advanced Technology Vehicle Sales Dashboard. Data compiled by the Alliance of Automobile Manufacturers using information provided by HIS Markit (2011-0218) and Hedges & Co. (2019). Data last updated 8/20/2019. Data retrieved February 22, 2020 from <https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/>



# ADJACENT INDUSTRY AND OCCUPATIONAL ANALYSIS

The ET sector spans a wide range of industries in California. To best understand the scope and scale of some of the greatest opportunities in ET as the sector continues to grow, the research team identified Adjacent Industries that have similar workforce competencies, supply chains, and activities to current ET firms. Adjacent Industry and Occupational analyses help identify talent with similar or complementary skillsets that could easily transition to ET work from non-ET industries.

The Adjacent Industries identified in this report currently have little to no involvement in ET activities. Their importance lies in the workers, who have skill sets that would allow them to move into the ET supply chain with relatively little training and transition with relative ease. Identifying these industries and their workers highlights a potential workforce that could easily support and grow with increased ET demand.

Adjacent Industries include three distinct categories: Immediate Adjacent Manufacturing Industries; Secondary Adjacent Manufacturing Industries; and Support Industries. For more information on these industry categories, see Appendix C.

- **Immediate Adjacent Manufacturing Industries.** This category includes the industries that share a federal industry classification code (six-digit NAICS) with ET manufacturing companies. Transition to ET-related work would be most rapid for companies in this category. Examples include Automobile Manufacturing, Motor and Generator Manufacturing, and Other Electronic Component Manufacturing.
- **Secondary Adjacent Manufacturing Industries.** This category includes industries in the same general industry classifications (four-digit NAICS codes) but differs at the more granular level (six-digit NAICS codes). These industries conduct the same family of activities as ET manufacturing firms, but their transition to ET work would take more investment and time than Immediate Adjacent Manufacturing Industries. Examples include: Semiconductor and Related Device Manufacturing, Other Aircraft Parts and Auxiliary Equipment Manufacturing, and Guided Missile and Space Vehicle Manufacturing.
- **Support Industries.** This category includes industries that are upstream of Immediate Adjacent Manufacturing Industries. They are typically industries that involve raw materials extraction and manufacturing. Growth in the ET market might require changes in operations, but since these companies tend to focus on raw materials and upstream components, those changes are likely to be minimal. Examples include: Plate Work Manufacturing, Iron and Steel Mills and Ferroalloy Manufacturing, and Bolt and Machine Shops.

An Adjacent Occupational analysis is somewhat different from an Adjacent Industry analysis in that the occupational analysis is conducted through a workforce lens. Adjacent Occupational analyses highlights types of workers that are most common among Adjacent Industries and examines their frequency throughout the



entire statewide economy. Such an analysis identifies occupations with similar knowledge, skills, abilities, tasks, and other work activities, regardless of the industry in which the workers are currently in. The result is a list of occupations that share enough similarities such that the required workforce or on-the-job training to transition to an ET job would be minimal. Ultimately, an Adjacent Occupational analysis provides an occupation-oriented perspective of the potential talent pool for ET work.

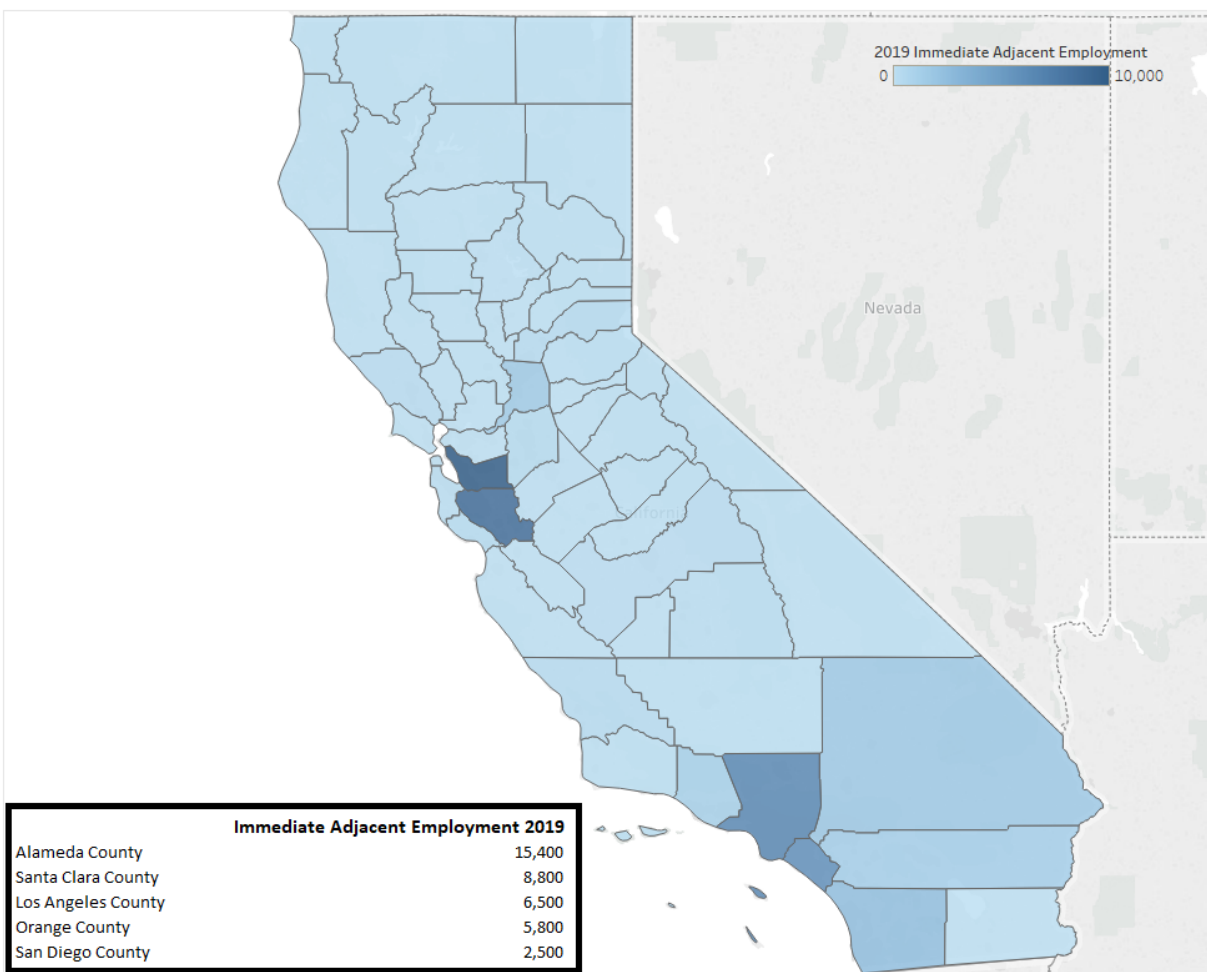
## **Immediate Adjacent Manufacturing Industries**

### **Industry Analysis**

California has about 48,700 workers who are employed in Immediate Adjacent Manufacturing Industries (IAMIs). Alameda County alone has 15,400 workers, while Santa Clara and Los Angeles Counties have 8,800 and 6,500 IAMIs workers, respectively. San Bernardino and Riverside Counties also each have more than 1,400 IAMIs employees (Figure 8).

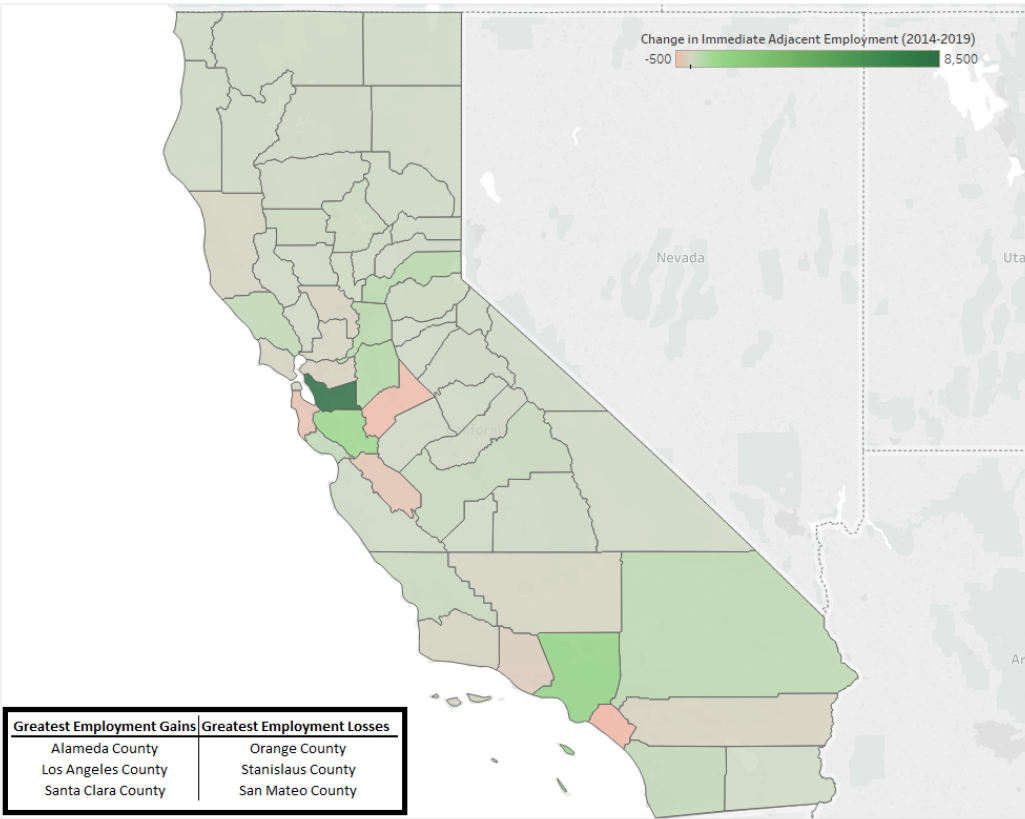


Figure 8: Immediate Adjacent Manufacturing Industry Employment, 2019



Alameda County's number of workers in IAMI more than doubled between 2014 and 2019, adding 8,500 jobs. Orange and Stanislaus Counties lost about 500 workers each in IAMI during this time. Overall, the state added a total of 10,400 IAMI jobs during this five-year period (Figure 9). Increased ET activity in the state could serve as a potential lifeline for these workers, as they could transition to ET-related work with relatively little training or upskilling.

Figure 9: Change in Immediate Adjacent Manufacturing Industry Employment, 2014-2019



### Occupation Analysis

There are one million jobs across the ten-most common Immediate Adjacent occupations across all industries in California. These occupations also cover a broad range of skill and education requirements, ranging from technical-skill heavy fabricator and machining roles to jobs that require advanced education, like Industrial and Electronics Engineers. Six out of ten of these occupations offer median annual earnings of \$60,000 per year or more (Table 3).

Table 3. Key Immediate Adjacent Manufacturing Occupations

Key Occupations	2014 Jobs	2019 Jobs	Projected 2024 Jobs <sup>27</sup>	Typical Entry-Level Education	Median Annual Earnings <sup>28</sup>
-----------------	-----------	-----------	-----------------------------------	-------------------------------	--------------------------------------

<sup>27</sup> These projections are from EMSI 2020.4 and based on occupation-specific growth across the state. They are not based on ET growth estimates.

<sup>28</sup> Earnings include wages as well as benefits, such as healthcare or dental insurance.



Laborers and Freight, Stock, and Material Movers, Hand	296,957	397,130	420,522	No formal educational credential	\$31,158
Software Developers and Software Quality Assurance Analysts and Testers	195,786	253,701	288,762	Bachelor's degree	\$130,437
Miscellaneous Assemblers and Fabricators	111,406	110,723	106,442	High school diploma or equivalent	\$32,427
Inspectors, Testers, Sorters, Samplers, and Weighers	52,142	59,356	55,199	High school diploma or equivalent	\$40,851
First-Line Supervisors of Production and Operating Workers	53,844	49,925	50,578	High school diploma or equivalent	\$64,147
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	37,376	42,309	41,786	High school diploma or equivalent	\$36,816
Machinists	36,315	36,389	37,080	High school diploma or equivalent	\$45,469
Electronics Engineers, Except Computer	29,872	27,585	27,274	Bachelor's degree	\$125,715
Industrial Engineers	23,823	27,147	28,708	Bachelor's degree	\$100,922
Electrical and Electronic Engineering Technologists and Technicians	23,784	23,919	23,845	Associate's degree	\$67,912

## Secondary Adjacent Manufacturing Industries

### Industry Analysis

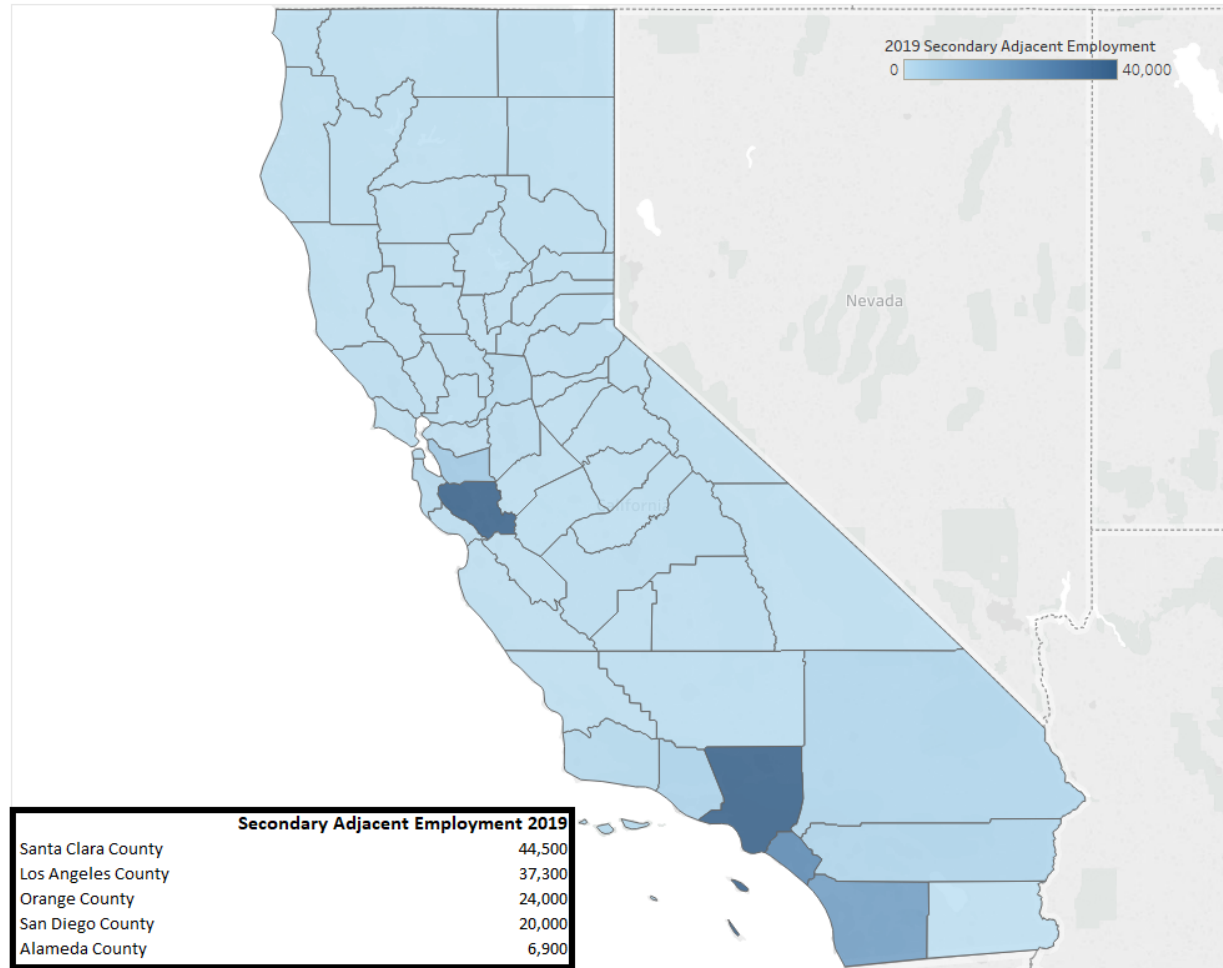
California was home to 161,000 jobs in Secondary Adjacent Manufacturing Industries (SAMI) in 2019. About 85% of these jobs can be found in five counties: Santa Clara County (44,500 jobs), Los Angeles County





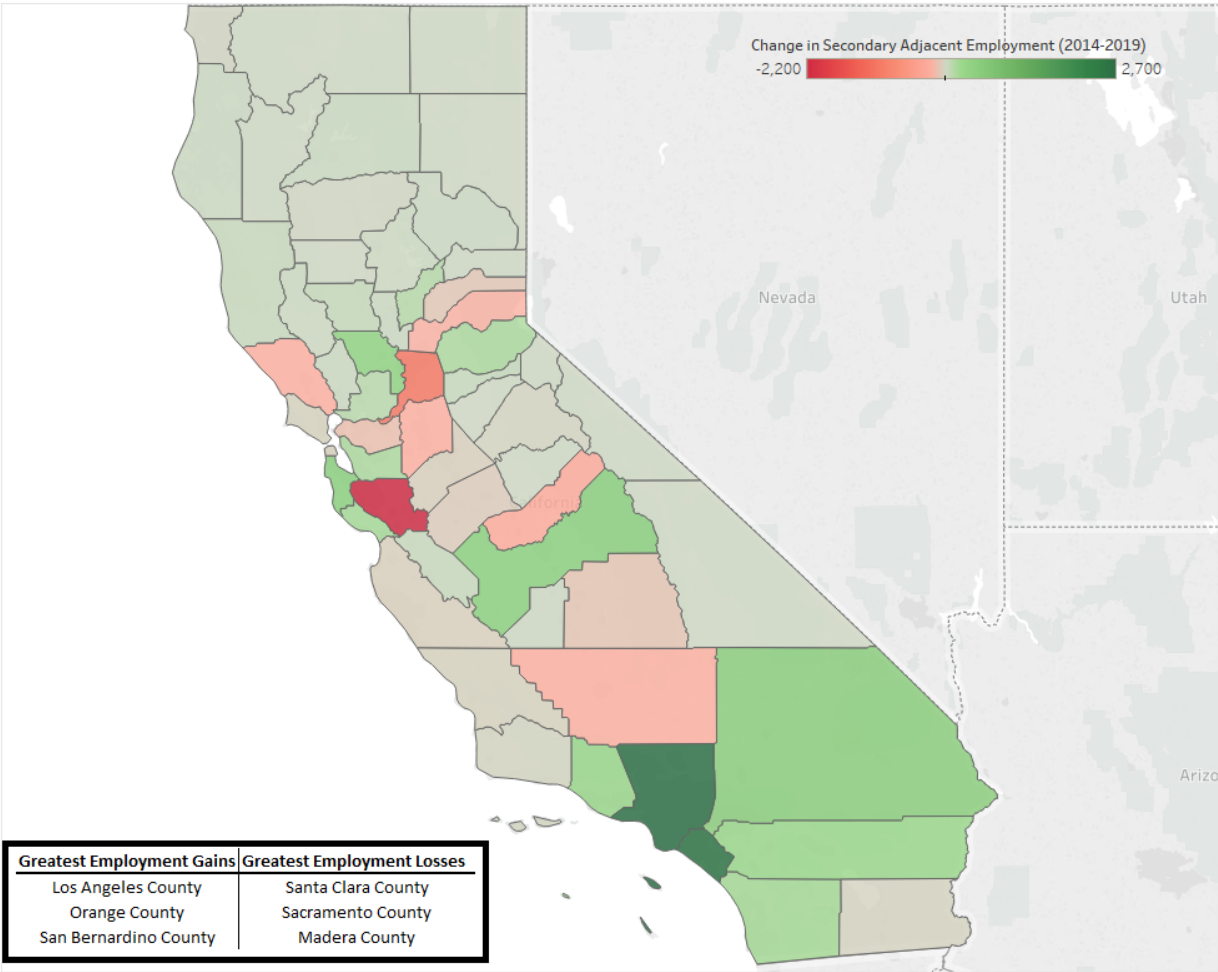
(40,100), Orange County (26,600), San Diego County (20,200) and Alameda County (7,000). Fourteen other counties around the state have 500 or more SAMI jobs (Figure 10).

Figure 10: Secondary Adjacent Manufacturing Industry Employment, 2019



California has added only 3,500 SAMI jobs between 2014 and 2019, representing a 2% increase over five years. Several counties saw substantial declines in SAMI employment; Santa Clara County lost 2,200 SAMI jobs, and Sacramento County saw 1,000 SAMI jobs disappear. In fact, 21 out of 58 counties across the state lost SAMI jobs during this 5-year timeframe (Figure 11). Additional ET activity throughout the state could help some of these displaced workers, as SAMI workers could likely transition to ET-related work with moderate amounts of training or upskilling.

Figure 11: Change in Secondary Adjacent Manufacturing Industry Employment, 2014-2019



## Occupational Analysis

The ten-most common Secondary Adjacent Occupations account for more than 620,000 jobs across all industries in the state, meaning there is already a substantial workforce with skills that could easily transition into ET-related work. There is notable overlap between Key Immediate and Secondary Adjacent Occupations, largely because both Adjacent Industries conduct similar types of work, such as manufacturing and assembling, that require similar types of workers. These similarities reflect the importance and pervasiveness of these occupations within these industries.

The Key Secondary Adjacent occupations can be found throughout the California economy. These occupations also cover a range of typical education requirements, ranging from a high school diploma or equivalent to a Bachelor's degree. The nearly quarter-of-a-million software developers in the state are also notable. As electric transportation and supporting technologies become more advanced, the role of software developers will likely increase.

Table 4: Key Secondary Adjacent Occupations

Key Occupations	2014 Jobs	2019 Jobs	Projected 2024 Jobs <sup>29</sup>	Typical Entry-Level Education	Median Annual Earnings <sup>30</sup>
Software Developers and Software Quality Assurance Analysts and Testers	195,786	253,701	288,762	Bachelor's degree	\$130,437
Miscellaneous Assemblers and Fabricators	111,406	110,723	106,442	High school diploma or equivalent	\$32,427
Inspectors, Testers, Sorters, Samplers, and Weighers	52,142	59,356	55,199	High school diploma or equivalent	\$40,851
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	37,376	42,309	41,786	High school diploma or equivalent	\$36,816
Machinists	36,315	36,389	37,080	High school diploma or equivalent	\$45,469
Architectural and Engineering Managers	30,872	34,603	35,309	Bachelor's degree	\$169,125

<sup>29</sup> These projections are from EMSI 2020.4 and based on occupation-specific growth across the state. They are not based on ET growth estimates.

<sup>30</sup> Earnings include wages as well as benefits, such as healthcare or dental insurance.



Electronics Engineers, Except Computer	29,872	27,585	27,274	Bachelor's degree	\$125,715
Industrial Engineers	23,823	27,147	28,708	Bachelor's degree	\$100,922
Electrical and Electronic Engineering Technologists and Technicians	23,784	23,919	23,845	Associate's degree	\$67,912
Semiconductor Processing Technicians	4,359	5,176	4,795	High school diploma or equivalent	\$36,982

## Company Snapshot

### Greenlots

Los Angeles County (and others)

Greenlots, a member of the Shell Group, offers EV charging solutions to fleet operators, utilities, cities and governments, retailers and automakers. Greenlots' industry-leading software and services allow network operators to efficiently deploy, manage, and leverage EV charging infrastructure at scale. The company's smart charging solutions helps customers manage dynamic electric vehicle charging loads and respond to local and system conditions. Greenlots' headquarters and innovation lab are based in Los Angeles; the company has nearly 100 employees across California.

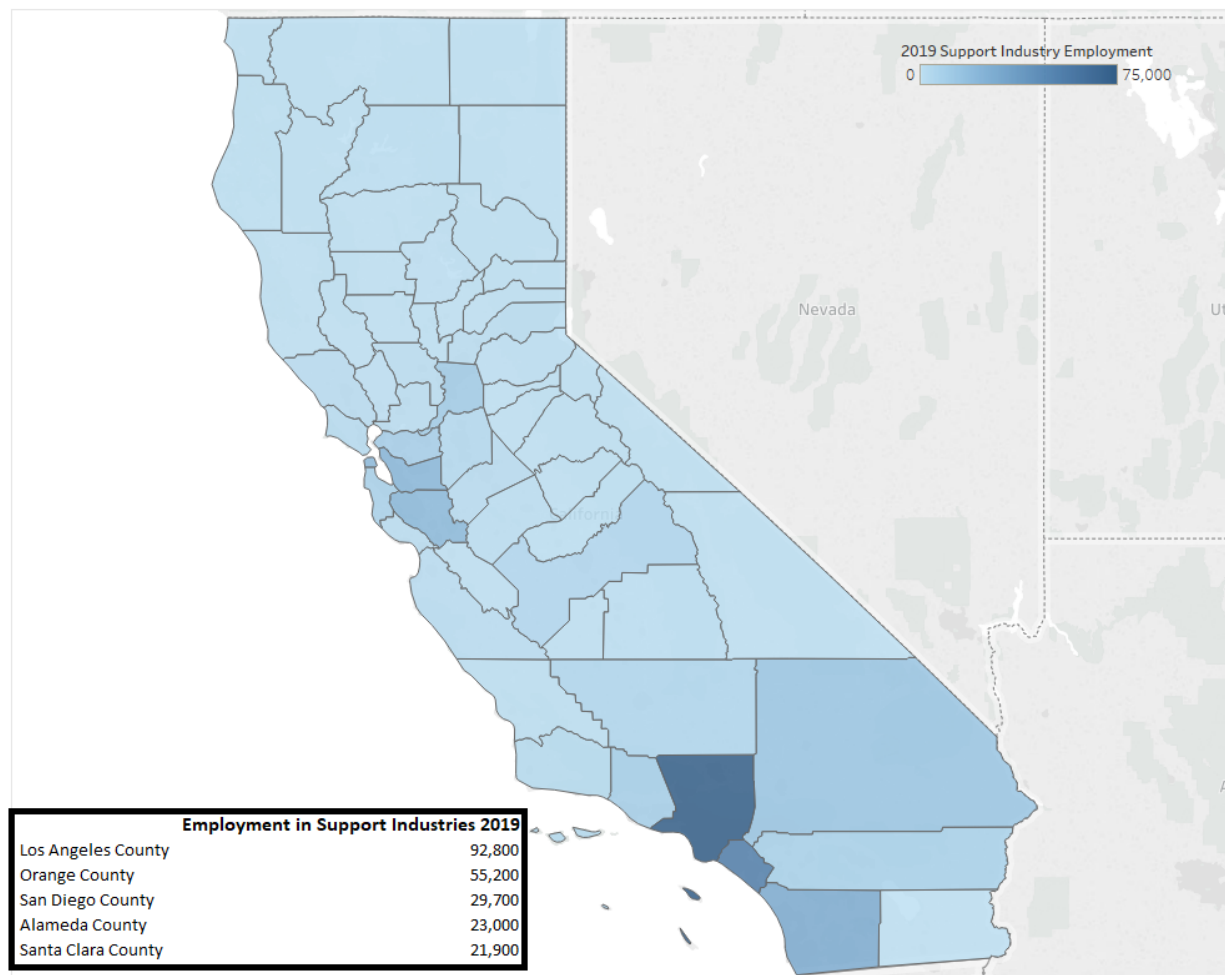


## Support Industries

### Industry Analysis

The Support Industries (SI) employ **363,700 workers across California**. Los Angeles County has nearly twice as many SI jobs as any other county in the state, with 92,800 people working in these industries. Other counties in southern California, including Orange, San Diego, and San Bernardino counties, have large numbers of SI workers as well (Figure 14).

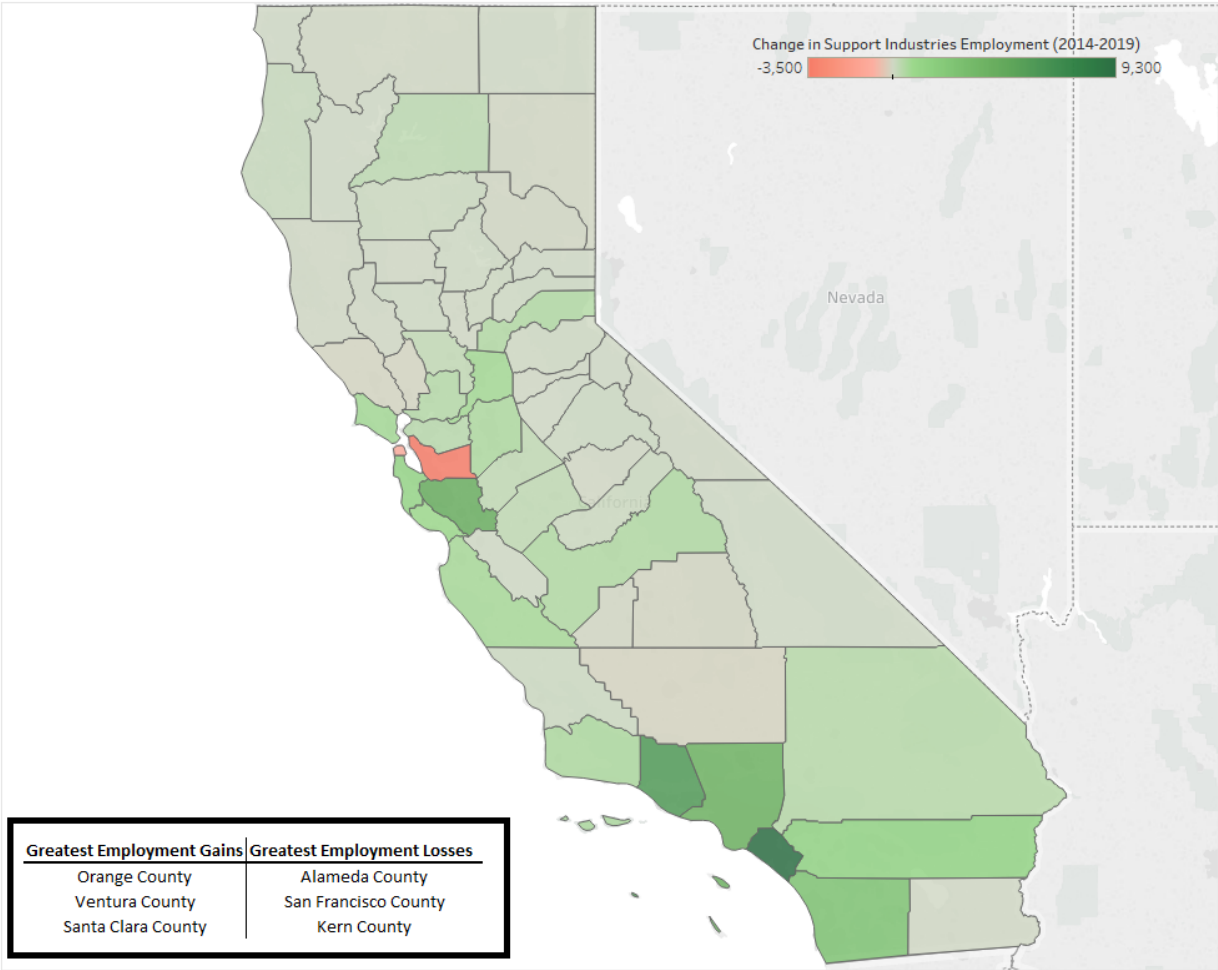
Figure 12. Support Industry Employment, 2019



California jobs in Support Industries grew by 10% between 2014 and 2019, adding 34,300 jobs. Most of these job increases were Southern and Central Coast counties (Figure 13).



Figure 13: Change in Support Industries Employment, 2014-2019





## Occupational Analysis

The ten-most common occupations found within Support Industries account for nearly 2 million jobs across the state. These occupations span a range of skill sets and educational requirements, including administrative roles such as General Office Clerks and Bookkeeping, Accounting, and Auditing Clerks, as well as managerial roles like General and Operations Managers and Project Management Specialists. All ten occupations offer Median Annual Earnings that exceed the individual median income (\$31,960)<sup>31</sup> in California (Table 5). This suggests that growth in Support Industries driven by ET activity could increase demand for a wide range of occupations across the state.

Table 5: Key Support Industry Occupations

Key Occupation	2014 Jobs	2019 Jobs	Projected 2024 Jobs <sup>32</sup>	Typical Entry-Level Education	Median Annual Earnings <sup>33</sup>
Office Clerks, General	361,437	376,960	382,551	High school diploma or equivalent	\$37,274
General and Operations Managers	258,275	266,051	282,029	Bachelor's degree	\$113,256
Software Developers and Software Quality Assurance Analysts and Testers	195,786	253,701	288,762	Bachelor's degree	\$130,437
Project Management Specialists and Business Operations Specialists, All Other	144,010	213,976	224,220	Bachelor's degree	\$75,795
Customer Service Representatives	201,450	213,810	220,884	High school diploma or equivalent	\$38,938
Bookkeeping, Accounting, and Auditing Clerks	196,190	192,388	192,623	Some college, no degree	\$47,195

<sup>31</sup> U.S. Census Bureau.

<sup>32</sup> These projections are from EMSI 2020.4 and based on occupation-specific growth across the state. They are not based on ET growth estimates.

<sup>33</sup> Earnings include wages as well as benefits, such as healthcare or dental insurance.



Accountants and Auditors	150,540	154,820	163,147	Bachelor's degree	\$75,878
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	148,352	150,686	149,486	High school diploma or equivalent	\$62,109
Financial Managers	74,798	94,766	102,985	Bachelor's degree	\$139,651
Machinists	36,315	36,389	37,080	High school diploma or equivalent	\$45,469



## Company Snapshot

### EVgo

Los Angeles County (and others)

Founded in 2010 and headquartered in Los Angeles, EVgo is the nation's largest public fast charging network for electric vehicles (EVs), and the first to be powered by 100% renewable electricity. With more than 800 fast charging locations in more than 67 metropolitan areas across 34 states, EVgo owns and operates the greatest number of public fast charging locations in the U.S. and serves more than 220,000 active customers. In California, EVgo has more than 300 fast charging locations across the state, and 83% of Californians currently live within 10 miles of an EVgo charger. The EVgo team currently includes approximately 100 employees in California and primarily operate out of the Los Angeles headquarters, with a strong presence in the Bay Area as well.

For both its public charging network and fleet charging solutions, EVgo employees serve across a range of functions, all dedicated to the acceleration of transportation electrification with best in class technology and reliability. Those functions include, but are not limited to, site acquisition, engineering and design, business development, construction management, field operations, and customer service. In addition to their employees, EVgo also hires a large network of contractors around the state to install and maintain their charging network, which boasts a 98% uptime.

EVgo is a first mover and first learner in transportation electrification and has long been a partner of first choice for other leaders like General Motors, Nissan, BMW, Lyft, Uber and others. The company continues to grow and expand, announcing a commitment to add thousands of additional chargers to the EVgo public network over the next few years and ramping up fleet electrification efforts for delivery and logistics partners.

## WORKFORCE DEMOGRAPHICS

Tracking the demographics of workers is one important way to ensure that the significant economic benefits from the growth of the ET sector are accessible and distributed equitably. While Black or African-American



worker representation is generally in line with statewide workforce averages, that representation is far below the U.S. automotive manufacturing industry, which has historically employed a high rate of Black or African-American workers. In 2020, 18.2% of U.S. automotive manufacturing workers were Black or African American, a rate 50% greater than the share of working age Black or African Americans.<sup>34 35</sup> Lessons learned from the traditional automobile sector, such as expanding outreach, awareness, and education and training opportunities to underrepresented communities, can ensure that meaningful career opportunities are accessible to all.

Accessibility is something the Governor’s Office of Business and Economic Development (GO-Biz) is seeking to address; the Labor and Workforce Development Agency and Office of Planning and Research are working with a group of state agencies to design a Just Transition Roadmap. This roadmap will provide an economy-wide strategy to ensure that all Californians benefit from the transition to carbon neutrality, including communities and workers most impacted by climate change and the realignment of fossil fuel industries. GO-Biz will leverage this Just Transition Roadmap while developing and implementing the state’s ZEV strategy to ensure California is prepared to meet the needs of the ZEV market.

The workers in Adjacent and Support industries are similar in their demographics to the overall California workforce with three notable exceptions: Asian-Americans are generally over-represented in the industries and Hispanic or Latino workers and women are underrepresented (See Figure 16).

## **Immediate Adjacent Industry Workforce Demographics**

**The Immediate Adjacent workforce has a relatively high proportion of workers that are Asian, while women are underrepresented relative to the overall workforce** (Figure 14). The IAMI workforce is also relatively concentrated among workers between the ages of 25 and 54, with a relatively lower share of younger (24 and younger) and older (55 and older) workers (Figure 15).

---

<sup>35</sup> 2020 Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity. Labor Force Statistics from the Current Population Survey. U.S. Bureau of Labor Statistics.



Figure 14. Immediate Adjacent Workforce Demographics

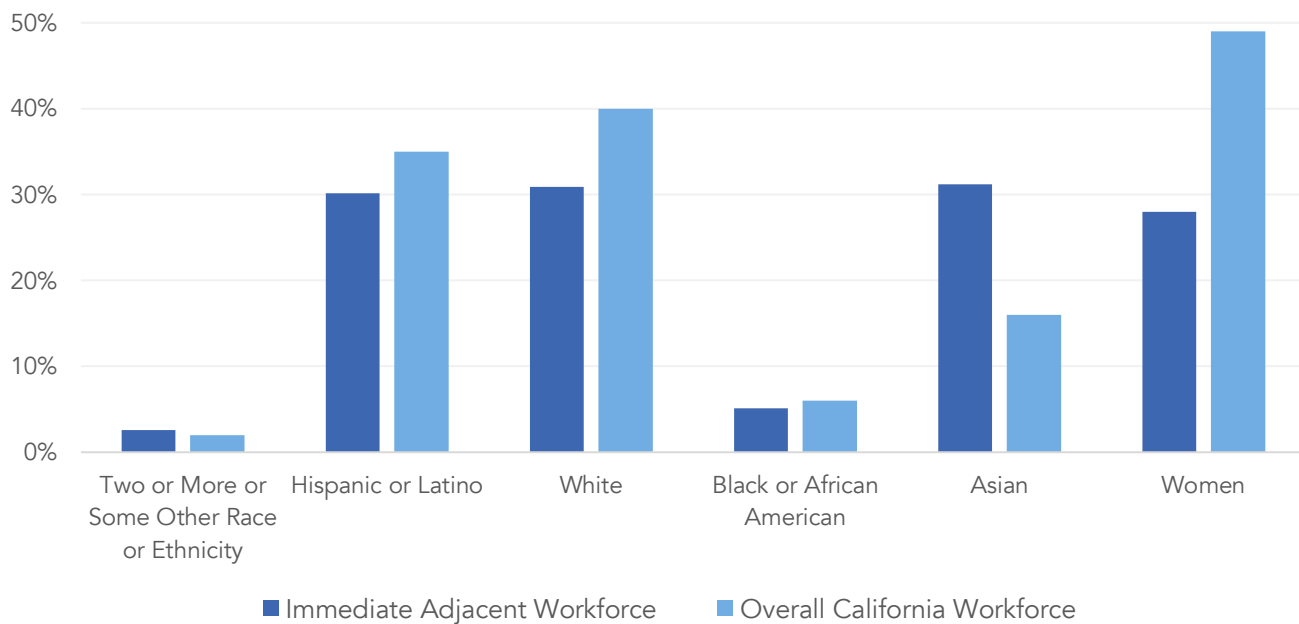
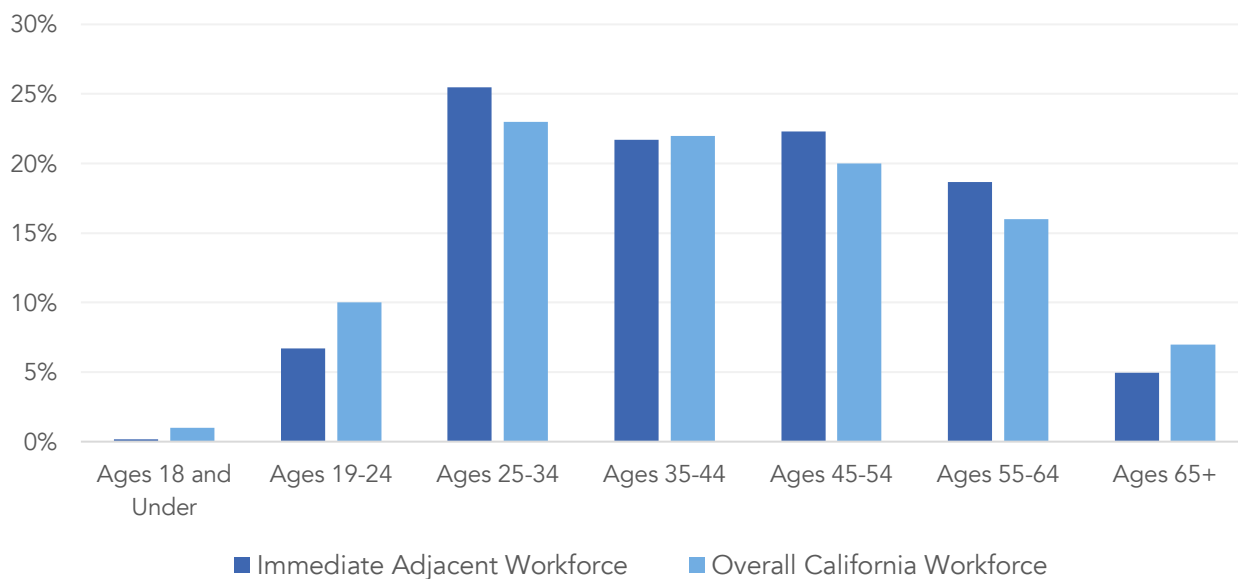


Figure 15. Age Distribution of Immediate Adjacent Workforce



## Secondary Adjacent Workforce Demographics



The racial, ethnic, and gender composition of the Secondary Adjacent Industry workforce is similar to the demographics of the Immediate Adjacent workforce. The Secondary Adjacent workforce has a relatively high proportion of Asian workers, and women are represented at nearly half the rate (28%) as they are in the overall workforce (49%) (Figure 16). The SAMI workforce is also relatively older; about half (51%) are between the ages of 45 and 64 (Figure 17). This suggests that employers may struggle to find a qualified workforce in five to ten years as these workers retire.

Figure 16. Secondary Adjacent Workforce Demographics

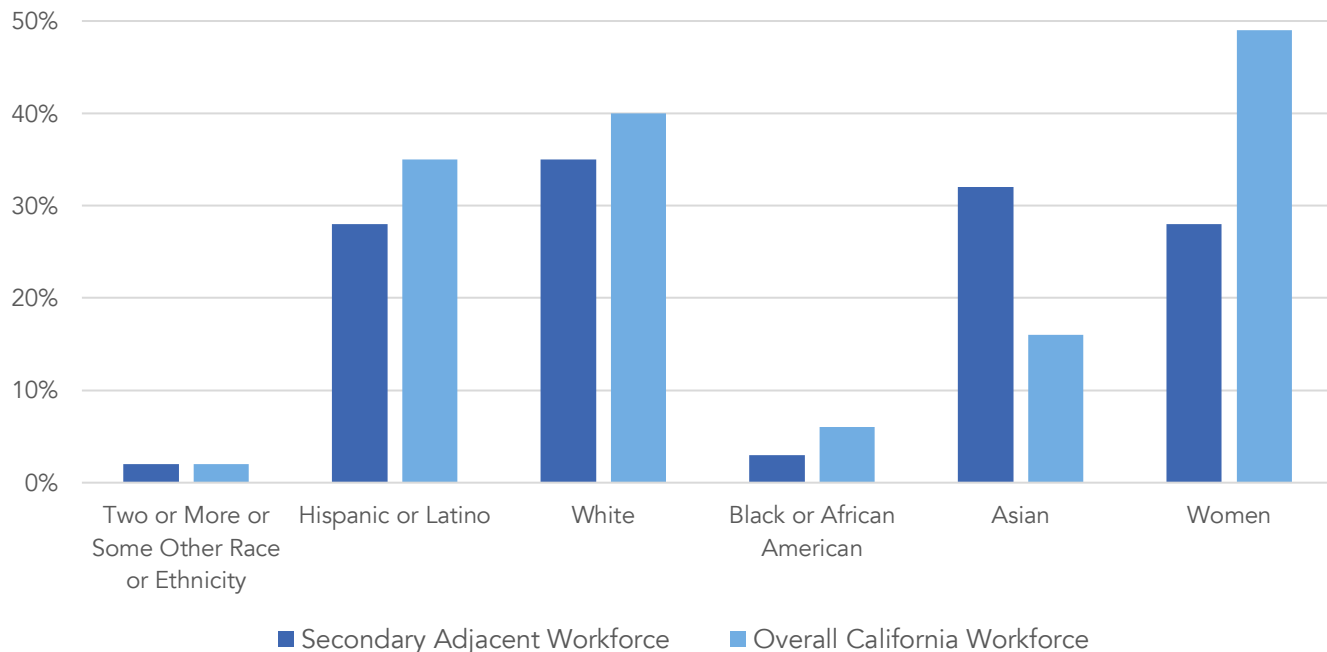
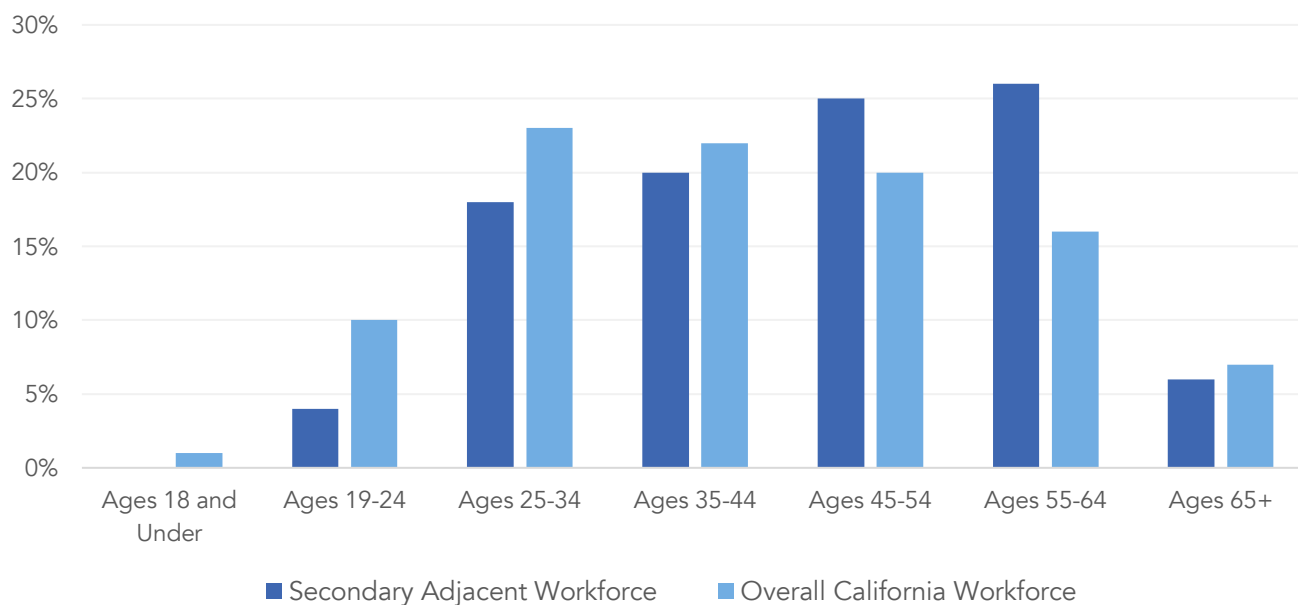


Figure 17. Age Distribution of Secondary Adjacent Workforce



### Support Industry Workforce Demographics

The Support Industry workforce's demographic makeup is fairly similar to the broader statewide workforce, though women are slightly underrepresented (Figure 18). The Support Industry workforce does skew slightly older than the overall workforce; 46% of Support Industry workers are 45 years of age or older (Figure 19). This could result in considerably greater hiring challenges in the longer-term future as these workers retire.



Figure 18. Support Industry Workforce Demographics

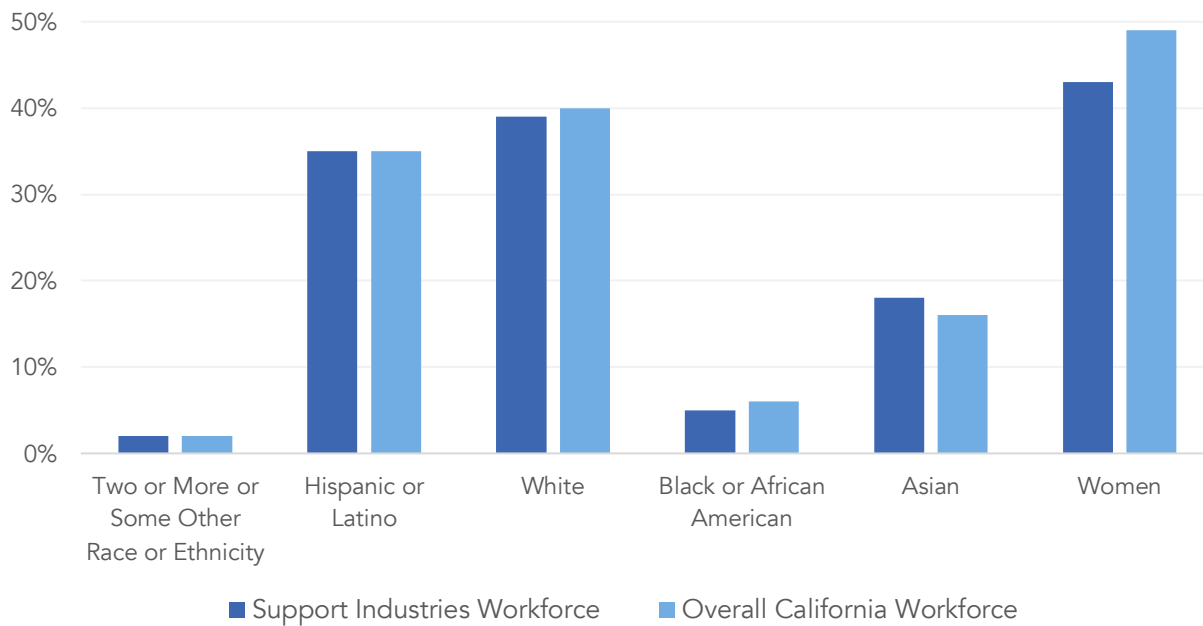
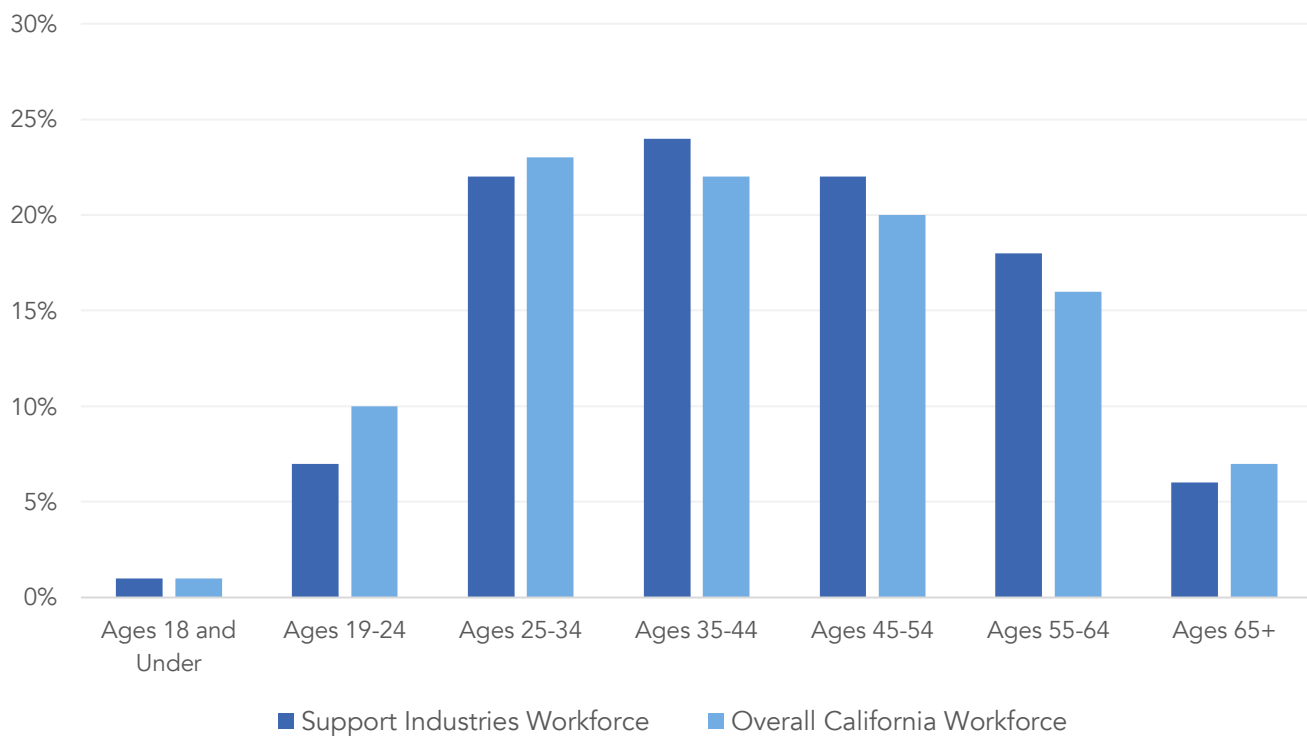


Figure 19. Age Distribution of Support Industry Workforce





## Company Snapshot

### Tesla

#### Alameda County (and others)

Tesla is integral to California's ET economy. More than 20,000 Tesla employees across the state work in some capacity on electric vehicles. This sizable workforce generated more than \$2 billion in Gross State Product in 2017. As of Spring 2021, Tesla's factory in Fremont employs more than 20,000 people alone. The 5.3 million square foot plant has sections dedicated to body, assembly, stamping, plastics, and paint, as well as office space. Workers at the factory produce components for and assemble Model S, Model X, Model Y, and Model 3 vehicles. Tesla has a separate manufacturing facility in Fremont for vehicle seats.

Across the Bay from the Fremont Factory, in Palo Alto, is Tesla Headquarters. Tesla's Lathrop factory produces vehicle parts via castings operations. The greatest number of Tesla employees outside of Alameda County can be found in Santa Clara, Los Angeles, San Mateo, and Sacramento Counties. These roles range from production associates to service technicians to process engineers and sales advisors. This workforce around the state will continue to grow as demand continues to rise for EVs and their infrastructure. In fact, Tesla recently expanded its Fremont footprint with a pilot battery cell manufacturing facility, indicating Tesla and California's ET economy will continue to grow together.



# TRAINING INVENTORY

The research team examined the training and education opportunities available to California residents interested in joining the ET workforce. The ET jobs in California are diverse and accessible to a wide range of workers with varying skillsets, spanning Software Developers, Machinists, and Sales Representatives. This diverse array of jobs has an even more diverse range of training and education requirements. Because there are so many potential training opportunities that can lead to ET careers, only programs that are specifically geared towards ET activity are included in this inventory, while programs that include some ET-related curricula, but are not wholly ET-focused, were left out. For example, seventy-eight community colleges across California currently offer automotive technician and maintenance programs. While these programs increasingly contain modules on hybrid and electric vehicles, this material often makes up a small portion of the overall curriculum. For this reason, automotive technician and maintenance programs are not included in this inventory. To see a complete list of the trainings identified, please see Appendix B.

Manufacturing roles, such as Machinists and Assemblers, are a crucial component of the ET economy in California. Trainings for these roles are rarely ET-specific, and workers are typically developed through the California Community College system or union-related work experience. Twenty-nine community colleges and other education and training providers offer Machine Tool Technology/ Machinist programs that graduated a total of 900 students in 2019.<sup>36</sup> Unions also play a key role in developing these types of manufacturing workers. The Advanced Manufacturing & Transportation Apprenticeships of California and the California Tooling and Machining Apprenticeship Association, often in partnership with community colleges, help job seekers gain experience and qualifications as CNC Machinists, Technicians, Tool & Die Makers, Mold Makers, and other Machinist roles. While these programs are not included in this training inventory due to their lack of distinct ET-related programming, they are vital to training the ET workforce in California.

Sixteen training programs geared specifically towards ET-related activities were found across the state. The research team also identified several publicly-available informal informational videos and webinars. Most (10 out of 16) training programs identified were specific courses and specializations within Bachelor's and Master's Mechanical and Electrical Engineering programs. There are also several training opportunities provided by private companies or trade associations that allowed graduates to receive a certificate in charging station installation.

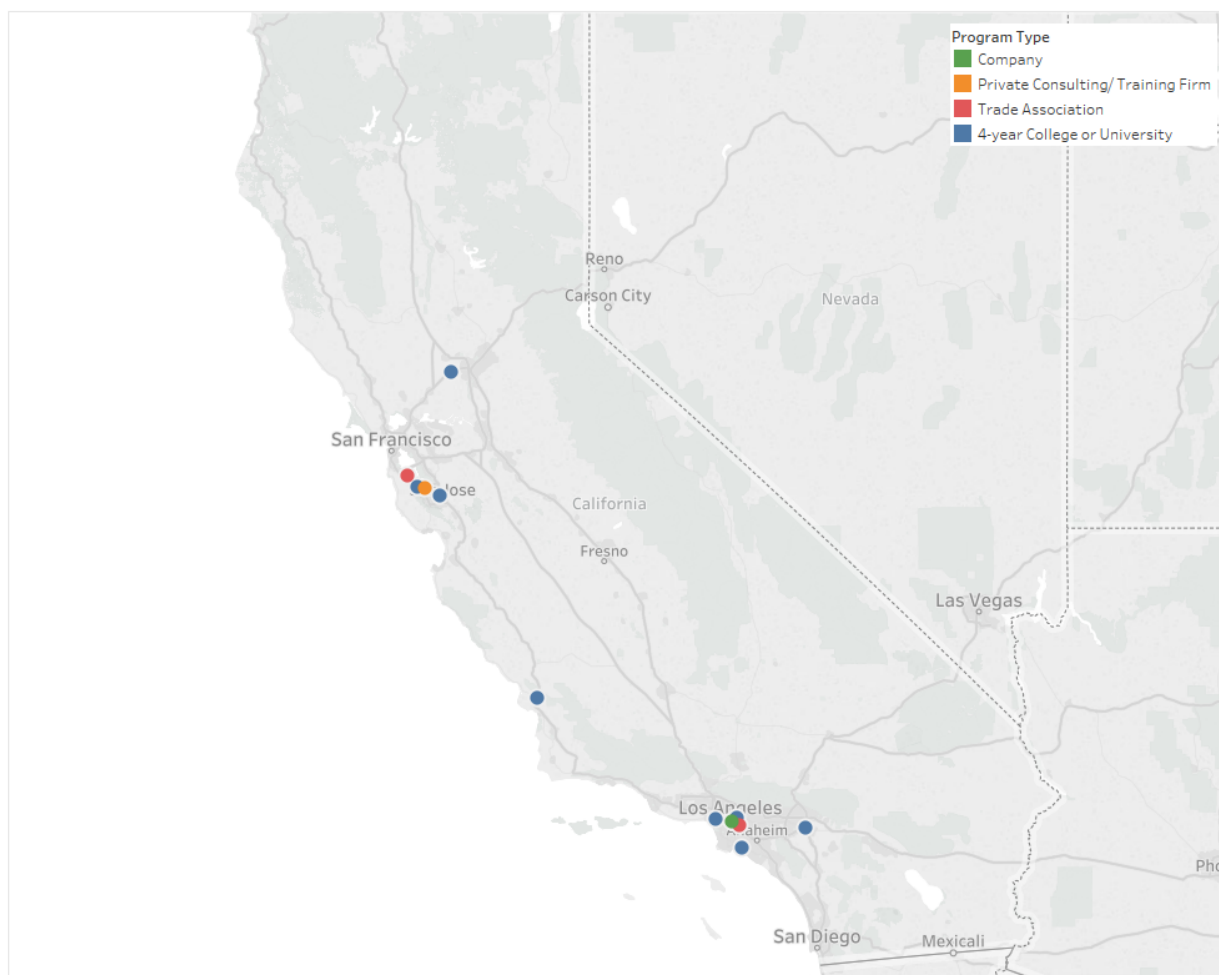
---

<sup>36</sup> For more information on these training programs and where they are accessible, please see Appendix F: Automotive Manufacturing Training Programs



Most ET-related training programs are found around the Bay Area (Figure 21) and South-Central (Figure 22) California, among the largest population centers. These regions also tend to have the greatest number of EVs and EV chargers.<sup>37</sup> Many programs are also available online; the research team identified at least seven programs that were available online. As ET adoption continues to grow in California, it will be important that training programs are accessible to students across the state, and not just among some of the larger population areas.

Figure 20. ET Training Programs in California

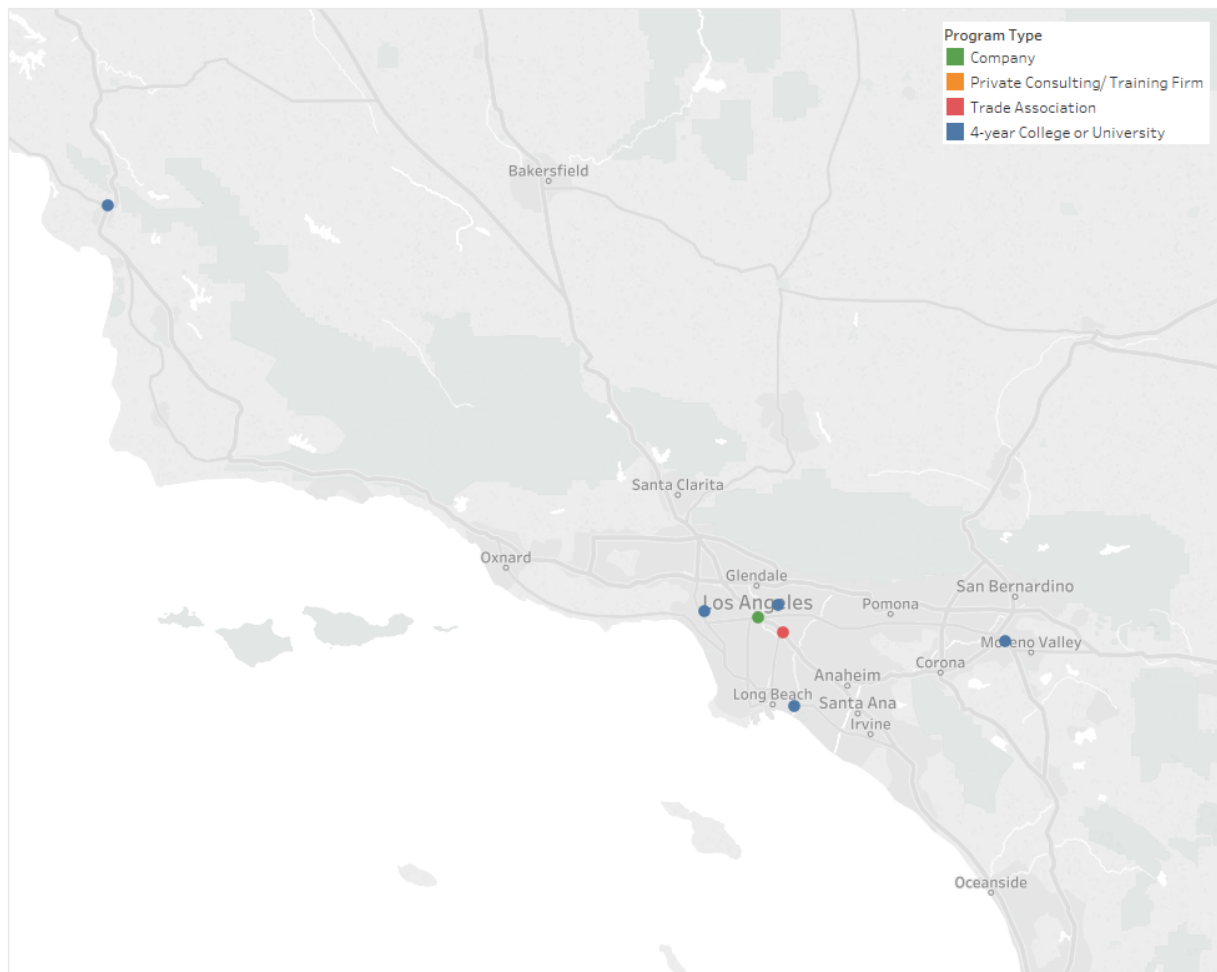


<sup>37</sup> <https://maps.nrel.gov/cec/?aL=0&bL=cdark&cE=0&IR=0&mC=36.0624217151089%2C-119.15771484375&zL=7>





Figure 22. ET Training Programs in Central and Southern California



# CONCLUSION

The Electric Transportation (ET) sector in California accounted for 35,000 jobs across 3,900 businesses in 55 counties across the state in 2019. ET-related jobs in the state are projected to increase 94% between 2019 and 2024, largely driven by increasing demand for electric vehicles. While this represents a substantial increase in ET workers, this research suggests the current workforce and training pipelines are prepared to meet the growing demand.

A wide range of ET jobs can be found across the state. While a majority (56%) of ET jobs are involved in manufacturing, there is an array of jobs available within manufacturing, ranging from Assemblers and Fabricators to First-Line Supervisors and Industrial Engineers. The increased need for both hardware and software within ET products means that Software Developers work on products alongside Fabricators. These dynamics mean that ET jobs in California are available for a wide variety of workers with a broad range of skills and education.

The growth of ET in the state also presents a substantial opportunity for Adjacent and Support Industries. Growing ET activity results in increased demand for inputs and support services. Furthermore, as ET expands, workers in Adjacent Industries facing downturns could relatively easily retool and transition their skillsets to join the growing ET workforce.

The current size and projected growth of Electric Transportation in California suggest that ET will play an increasingly prominent role in the state and its economy. Supporting the ET sector will help ensure that a wide range of well-paying jobs are available to a broad workforce with an array of skills. California demonstrates that there is an ET job for virtually any skillset or background.



# APPENDIX A: METHODOLOGY

## Employment and GSP

Employment and GSP extrapolations were performed using data collected for this report, as well as data from the 2019 United States Energy Employment Report (USEER) and EMSI. The methodology used for the 2019 USEER meets the highest statistical and methodological standards and has been reviewed by the Bureau of Labor Statistics (BLS) and the Department of Energy (DOE). More details about the methodology can be found here: [usenergyjobs.org](https://www.usenergyjobs.org).

## Data Collection

The research team utilized desktop research, phone calls, email, and other forms of outreach to generate a database of companies known to be active in ET. Firms from the potential database (this database was comprised of companies from industries which were believed to be involved in ET) were first examined through desktop research to determine if they were related to ET activity. Any firms that were confirmed or identified as potentially involved in ET were called via telephone up to two times. Once phone contact was established, BW staff would confirm involvement in ET, and ask supplementary questions confirming employment counts and asking about in-state suppliers and customers. If phone contact could not be established, voicemails were left and, when possible, emails sent.

BW Research employed a number of strategies to maximize the data collection effort given the considerable size of the potential database. These approaches are outlined below:

- Prioritization of manufacturing NAICS codes. Manufacturing roles present the greatest opportunity for job creation, as manufacturing is generally more labor intensive and has substantial downstream supply chains and workforces that support them.
- “Snowball” methodology. Once a firm confirmed that they were involved in ET in some capacity, researchers followed up by asking about any relevant in-state suppliers and customers. This allowed the research team to develop a more complete picture of the supply chain.
- Among industries which the research team did not exhaust via phone interviews, staff conducted desktop research to identify relevant firms that advertised ET-related products or services.

Of the 21,049 firms in the assembled potential database, 4,460 firms were examined closely by the research team. Of these, 1,167 were contacted via telephone at least once. Of the 16,589 firms that remain unexamined, 92% fall under five industry codes: 28% percent are electrical contracting firms, 22% are other



electronic parts and equipment merchant wholesalers, 19% are urban transit systems, 17% are industrial machinery and equipment wholesalers, and 6% are miscellaneous rental and leasing facilities.

Some of the industry definitions of electric transportation used in this report are not included and reported in the USEER motor vehicles section. These industries include:

- Automobile Retail (NAICS 4411)
- Rail Transportation (NAICS 4281)
- Farm and Garden Machinery and Equipment Merchant Wholesalers (NAICS 42382)
- Agricultural Implement Manufacturing (NAICS 33311)
- Railroad Rolling Stock Manufacturing (NAICS 33651)
- Industrial Machinery and Equipment Merchant Wholesalers (NAICS 42383)
- Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers (NAICS 42361)
- Engineering Services (NAICS 54133)
- Electrical Contractors and Other Wireless Installation Contractors (NAICS 23821)
- Power and Communication Line and Related Structures (NAICS 33451)
- Navigational, Measuring, Electromedical, and Control Instruments Manufacturing (NAICS 33451)
- Electrical Equipment Manufacturing (NAICS 33531)
- Plate Work and Fabricated Structural Product Manufacturing (NAICS 33231)

Having confidently determined the involvement of 5,615 firms out of the BLS estimated 65,676 firms in industries that were identified as potentially involved in ET, the margin of error is among these industries is approximately 1.41% for incidence.





## APPENDIX B: ET TRAINING INVENTORY

Provider	Program	Program Type	Occupational Focus	City	Zip Code	Duration
<b>Pacific Gas and Electric Company (PG&amp;E)</b>	Electric Vehicles (EVs): What you need to know	Utility	General	Web		
<b>UCLA</b>	Electric and Autonomous Vehicle Systems Certificate	4-year College or University	Engineering, Management, Policy	Los Angeles	90095	1 year
<b>Stanford University</b>	BS Mechanical Engineering (BSME)	4-year College or University	Engineering	Stanford	94305	4 years
<b>Cal State LA</b>	MS Mechanical Engineering (MSEE)	4-year College or University	Engineering	Los Angeles	90032	2 years
<b>San Jose State University</b>	BS Mechanical Engineering (BSME)	4-year College or University	Engineering	San Jose	95192	4 years
<b>San Jose State University</b>	BS Electrical Engineering (BSEE)	4-year College or University	Engineering	San Jose	95192	4 years
<b>San Jose State University</b>	MS Electrical Engineering (MSEE)	4-year College or University	Engineering	San Jose	95192	2 years
<b>University of California Riverside</b>	BS Electrical Engineering (BSEE)	4-year College or University	Engineering	Riverside	92521	4 years
<b>California Polytechnical Institute</b>	BS Electrical Engineering (BSEE)	4-year College or University	Engineering	San Luis Obispo	93407	4 years



<b>University of California Davis</b>	BS Mechanical Engineering (BSME)	4-year College or University	Engineering	Davis	95616	4 years
<b>California State University of Long Beach</b>	BS Electrical Engineering (BSEE)	4-year College or University	Engineering	Long Beach	90840	4 years
<b>ChargePoint</b>	ChargePoint Installer Training Certification Program	Company	Installation	Web		
<b>Clean Tech Institute</b>	Certified Electric Vehicle Training Program	Private Consulting/ Training Firm	Engineering, Manufacturing	Moffet Field	94035	16 Weeks, 12 hours per week
<b>KIGT</b>	Electric Vehicle Network Technician (EVNT) Fellowship Training Program	Company	Installation (electrical)	Los Angeles	90013	
<b>Collaboration of industry stakeholders including Automakers</b>	Electric Vehicle Infrastructure Training Program (EVITP)	Trade Association	Installation (electrical)	Commerce	90040	24-30 Hours
<b>Collaboration of industry stakeholders including Automakers</b>	Electric Vehicle Infrastructure Training Program (EVITP)	Trade Association	Installation (electrical)	San Mateo	94403	24-30 Hours



# APPENDIX C: INDUSTRY GROUP DEFINITIONS

Below are the NAICS code definitions for the immediate Adjacent, secondary Adjacent, and Support Industries described in this report.

Table 6: Immediate Adjacent Manufacturing Industries

NAICS Code	Description
333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing
334419	Other Electronic Component Manufacturing
335312	Motor and Generator Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing
336111	Automobile Manufacturing
336120	Heavy Duty Truck Manufacturing
336390	Other Motor Vehicle Parts Manufacturing
336510	Railroad Rolling Stock Manufacturing
336991	Motorcycle, Bicycle, and Parts Manufacturing
336999	All Other Transportation Equipment Manufacturing

Table 7: Secondary Adjacent Industries

NAICS Code	Description
333921	Elevator and Moving Stairway Manufacturing
333922	Conveyor and Conveying Equipment Manufacturing
333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing
334310	Audio and Video Equipment Manufacturing



334412	Bare Printed Circuit Board Manufacturing
334413	Semiconductor and Related Device Manufacturing
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
334417	Electronic Connector Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing
335311	Power, Distribution, and Specialty Transformer Manufacturing
335313	Switchgear and Switchboard Apparatus Manufacturing
335314	Relay and Industrial Control Manufacturing
335991	Carbon and Graphite Product Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing
336212	Truck Trailer Manufacturing
336213	Motor Home Manufacturing
336214	Travel Trailer and Camper Manufacturing
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
336340	Motor Vehicle Brake System Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336370	Motor Vehicle Metal Stamping
336412	Aircraft Engine and Engine Parts Manufacturing
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing



336414	Guided Missile and Space Vehicle Manufacturing
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
336611	Ship Building and Repairing
336612	Boat Building
336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing

**Table 8: Support Industries**

NAICS Code	Description
331110	Iron and Steel Mills and Ferroalloy Manufacturing
331511	Iron Foundries
332312	Fabricated Structural Metal Manufacturing
332313	Plate Work Manufacturing
332710	Machine Shops
332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing
333613	Mechanical Power Transmission Equipment Manufacturing
333618	Other Engine Equipment Manufacturing
423110	Automobile and Other Motor Vehicle Merchant Wholesalers
423120	Motor Vehicle Supplies and New Parts Merchant Wholesalers
423830	Industrial Machinery and Equipment Merchant Wholesalers
551114	Corporate, Subsidiary, and Regional Managing Offices



# APPENDIX D: GLOSSARY OF TERMS

Below is a glossary of terms used throughout this report. Additional information on some key occupations can be found in Appendix A.

**Aircraft Parts and Auxiliary Equipment Manufacturing:** This U.S. industry comprises establishment primarily engaged in (1) manufacturing aircraft parts or auxiliary equipment (except engines and aircraft fluid power subassemblies) and/or (2) developing and making prototypes of aircraft parts and auxiliary equipment. Auxiliary equipment includes such items as crop dusting apparatus, armament racks, inflight refueling equipment, and external fuel tanks.

**Assemblers and Fabricators (All Other, Including Team Assemblers):** Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned to a specific task on a permanent basis. May participate in making management decisions affecting the work. Includes team leaders who work as part of the team.

**Automobile Merchant Wholesalers:** This industry comprises establishments primarily engaged in the merchant wholesale distribution of new and used passenger automobiles, trucks, trailers, and other motor vehicles, such as motorcycles, motor homes, and snowmobiles.

**Automotive Service Technicians and Mechanics:** Diagnose, adjust, repair, or overhaul automotive vehicles.

**Boat Building Manufacturing:** Establishments primarily engaged in building boats. Boats are defined as watercraft not built in shipyards and typically of the type suitable or intended for personal use. Included in this industry are establishments that manufacture heavy-duty inflatable rubber or inflatable plastic boats (RIBs).

**Computer-Controlled Machine Tool Operators, Metal and Plastic:** Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.

**Cutting, Punching, and Press Machine Setters, Operators, and Tenders:** Set up, operate, or tend machines to saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal or plastic material.



**Electrical, Electronic, and Electromechanical Assemblers (Except Coil Winders, Tapers, and Finishers):**

Assemble or modify electromechanical equipment or devices, such as servomechanisms, gyros, dynamometers, magnetic drums, tape drives, brakes, control linkage, actuators, and appliances.

**Electrical and Electronic Goods Merchant Wholesalers:** This industry comprises establishments primarily engaged in the merchant wholesale distribution of electrical construction materials; wiring supplies; electric light fixtures; light bulbs; and/or electrical power equipment for the generation, transmission, distribution, or control of electric energy.

**Fabricated Structural Metal Manufacturing:** This industry comprises establishments primarily engaged in fabricating structural metal products, such as assemblies of concrete reinforcing bars and fabricated bar joists.

**First-Line Supervisors of Production and Operating Workers:** Directly supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators.

**Heavy Duty Truck Manufacturing:** industry comprises establishments primarily engaged in (1) manufacturing heavy duty truck chassis and assembling complete heavy duty trucks, buses, heavy duty motor homes, and other special purpose heavy duty motor vehicles for highway use or (2) manufacturing heavy duty truck chassis only.

**Industrial Machinery and Equipment Merchant Wholesalers:** This industry comprises establishments primarily engaged in the merchant wholesale distribution of specialized machinery, equipment, and related parts generally used in manufacturing, oil well, and warehousing activities.

**Inspectors, Testers, Sorters, Samplers, and Weighers:** Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. May use precision measuring instruments and complex test equipment.

**Iron and Steel Mills and Ferroalloy Manufacturing:** This industry comprises establishments primarily engaged in one or more of the following: (1) direct reduction of iron ore; (2) manufacturing pig iron in molten or solid form; (3) converting pig iron into steel; (4) making steel; (5) making steel and manufacturing shapes (e.g., bar, plate, rod, sheet, strip, wire); (6) making steel and forming pipe and tube; and (7) manufacturing electrometallurgical ferroalloys. Ferroalloys add critical elements, such as silicon and manganese for carbon steel and chromium, vanadium, tungsten, titanium, and molybdenum for low- and high-alloy metals. Ferroalloys include iron-rich alloys and more pure forms of elements added during the steel manufacturing process that alter or improve the characteristics of the metal.



**Laborers and Freight, Stock, and Material Movers (Hand):** Manually move freight, stock, or other materials or perform other general labor. Includes all manual laborers not elsewhere classified.

**Machine Shops:** Machine shops primarily engaged in machining metal and plastic parts and parts of other composite materials on a job or order basis. Generally machine shop jobs are low volume using machine tools, such as lathes (including computer numerically controlled); automatic screw machines; and machines for boring, grinding, milling, and additive manufacturing.

**Machinists:** Set up and operate a variety of machine tools to produce precision parts and instruments. Includes precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair machine tools or maintain industrial machines, applying knowledge of mechanics, mathematics, metal properties, layout, and machining procedures.

**Mechanical Engineers:** Perform engineering duties in planning and designing tools, engines, machines, and other mechanically functioning equipment. Oversee installation, operation, maintenance, and repair of equipment such as centralized heat, gas, water, and steam systems.

**Motor and Generator Manufacturing:** This U.S. industry comprises establishments primarily engaged in manufacturing electric motors (except internal combustion engine starting motors), power generators (except battery charging alternators for internal combustion engines), and motor generator sets (except turbine generator set units).

**Motor Home Manufacturing:** Type of self-propelled recreational vehicle (RV) which offers living accommodation combined with a vehicle engine.

**Motor Vehicle Manufacturing:** The motor vehicles manufactured in this industry include automobiles, sport-utility vehicles (SUVs), vans and pickup trucks, heavy duty trucks, buses, truck trailers, and motor homes. It also includes the manufacturing of the parts that go into these vehicles, such as the engine, seats, brakes, and electrical systems.

**Multiple Machine Tool Setters, Operators, and Tenders (Metal and Plastic):** Set up, operate, or tend more than one type of cutting or forming machine tool or robot.





**Non-Ferrous Metal Foundries:** Establishments primarily engaged in manufacturing nonferrous metal castings (including alloys), except all die-castings and other castings of aluminum or copper.

**Other Electronic Component Manufacturing:** Manufacturing electronic components (except bare printed circuit boards; semiconductors and related devices; electronic capacitors; electronic resistors; coils, transformers and other inductors; connectors; and loaded printed circuit boards).

**Other Motor Vehicle Parts Manufacturing:** Primarily engaged in manufacturing and/or rebuilding motor vehicle parts and accessories (except motor vehicle gasoline engines and engine parts, motor vehicle electrical and electronic equipment, motor vehicle steering and suspension components, motor vehicle brake systems, motor vehicle transmissions and power train parts, motor vehicle seating and interior trim, and motor vehicle stampings).

**Plate Work Manufacturing:** Industry comprises establishments primarily engaged in manufacturing fabricated metal plate work by cutting, punching, bending, shaping, and welding purchased metal plate.

**Power, Distribution, and Specialty Transformer Manufacturing:** Engaged in manufacturing power, distribution, and specialty transformers (except electronic components). Industrial-type and consumer-type transformers in this industry vary (e.g., step up or step down) voltage but do not convert alternating to direct or direct to alternating current.

**Railroad Rolling Stock Manufacturing:** This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing and/or rebuilding locomotives, locomotive frames and parts; (2) manufacturing railroad, street, and rapid transit cars and car equipment for operation on rails for freight and passenger service; and (3) manufacturing rail layers, ballast distributors, rail tamping equipment and other railway track maintenance equipment.

**Relay and Industrial Control Manufacturing:** Establishments primarily engaged in manufacturing relays, motor starters and controllers, and other industrial controls and control accessories.

**Sales Representatives, Wholesale and Manufacturing (except Technical and Scientific Products):** Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. May use precision measuring instruments and complex test equipment.



**Semiconductor Manufacturing:** A semiconductor chip is an electric circuit with many components such as transistors and wiring formed on a semiconductor wafer. An electronic device comprising numerous these components is called "integrated circuit (IC)". The layout of the components is patterned on a photomask (reticle) by computer and projected onto a semiconductor wafer in the manufacturing processes

**Switchgear and Switch Board Apparatus Manufacturing:** The switchgear and switchboard apparatus manufacturing industry comprise establishments manufacturing switchgear and switchboard apparatus. Switchgear is the combination of electrical disconnect switches and circuit breakers used in electricity transmission to interrupt or reestablish the flow of electricity.

**Truck Trailer Manufacturing:** This U.S. industry comprises establishments primarily engaged in manufacturing truck trailers, truck trailer chassis, cargo container chassis, detachable trailer bodies, and detachable trailer chassis for sale separately.

**Welders, Cutters, Solderers, and Brazers:** Use hand-welding, flame-cutting, hand soldering, or brazing equipment to weld or join metal components or to fill holes, indentations, or seams of fabricated metal products.

**Wholesale and Manufacturing Sales Representatives:** Sell goods for wholesalers or manufacturers to businesses or groups of individuals. Work requires substantial knowledge of items sold.



# APPENDIX E: ET-EMPLOYMENT BY CONGRESSIONAL DISTRICT

The table below provides estimates for ET-related employment by congressional districts in California.

Congressional District	2019 ET Employment	Congressional District	2019 ET Employment	Congressional District	2019 ET Employment
1	228	19	223	36	316
2	186	20	368	37	355
3	398	21	349	38	632
4	292	22	175	39	1,024
5	247	23	508	40	346
6	261	24	342	41	338
7	169	25	443	42	328
8	397	26	433	43	327
9	529	27	702	44	335
10	465	28	341	45	387
11	60	29	344	46	343
12	30	30	455	47	632
13	1,832	31	392	48	321
14	178	32	346	49	546
15	1,861	33	336	50	540
16	190	34	333	51	247
17	13,025	35	702	52	242



18	417			53	238
----	-----	--	--	----	-----

## APPENDIX F: AUTOMOTIVE MANUFACTURING TRAINING PROGRAMS

Education & Training Provider	2019 Completions
NTMA Training Centers of Southern California	225
Orange Coast College	116
Santa Ana College	99
Santa Rosa Junior College	92
San Diego City College	51
El Camino Community College District	47
De Anza College	46
Bakersfield College	37
San Jose City College	28
Reedley College	27
Compton College	19
Laney College	18
Norco College	12
San Bernardino Valley College	12
Hacienda La Puente Adult Education	11
Los Angeles Trade Technical College	11
Allan Hancock College	10



Pomona Unified School District Adult and Career Education	9
Los Angeles Valley College	6
Chabot College	5
Glendale Community College	5
Modesto Junior College	5
California Career School	4
College of the Redwoods	4
Los Angeles Pierce College	4
San Joaquin Delta College	4
Shasta College	4
Cerritos College	3
Napa Valley College	3

